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# Recreation and Health Sciences Center

## Construction Documents Project Specifications

100% Construction Documents

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## SECTION 011000 - SUMMARY

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Work covered by Contract Documents.
2. Owner-furnished/Contractor-installed (OFICI) products.
3. Contractor's use of site and premises.
4. Coordination with occupants.
5. Work restrictions.
6. Specification and Drawing conventions.
7. Temporary generator and switch

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

#### 1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

1. The project includes but is not limited to the following:

The project is a new addition to the existing William Paterson Recreation Center. The project consists of a the building envelope, vertical circulation, public lobby spaces, structure, major building systems, toilet cores, a natatorium, a gymnasium, classrooms and office space. The façade is composed of a metal panel system with aluminum framed storefront and curtainwall windows systems and brick cladding. The exterior walls are largely a cold formed metal framing system with a few exterior walls composed with concrete masonry units.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

#### 1.3 OWNER-FURNISHED/CONTRACTOR-INSTALLED (OFICI) PRODUCTS

A. Owner's Responsibilities: Owner will furnish products indicated and perform the following, as applicable:

1. Provide to Contractor Owner-reviewed Product Data, Shop Drawings, and Samples.

2. Provide for delivery of Owner-furnished products to Project site.
3. Upon delivery, inspect, with Contractor present, delivered items.
  - a. If Owner-furnished products are damaged, defective, or missing, arrange for replacement.
4. Obtain manufacturer's inspections, service, and warranties.
5. Inform Contractor of earliest available delivery date for Owner-furnished products.

**B. Contractor's Responsibilities: The Work includes the following, as applicable:**

1. Designate delivery dates of Owner-furnished products in Contractor's construction schedule, utilizing Owner-furnished earliest available delivery dates.
2. Review Owner-reviewed Product Data, Shop Drawings, and Samples, noting discrepancies and other issues in providing for Owner-furnished products in the Work.
3. Receive, unload, handle, store, protect, and install Owner-furnished products.
4. Make building services connections for Owner-furnished products.
5. Protect Owner-furnished products from damage during storage, handling, and installation and prior to Substantial Completion.
6. Repair or replace Owner-furnished products damaged following receipt.

**1.4 CONTRACTOR'S USE OF SITE AND PREMISES**

- A. **Restricted Use of Site:** Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- B. **Limits on Use of Site:** Limit use of Project site to Work in areas indicated for each phase of construction. Do not disturb portions of Project site beyond areas in which the Work is indicated for each phase of work.
  1. **Driveways, Walkways, and Entrances:** Keep driveways, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
- C. **Condition of Existing Grounds:** Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

**1.5 COORDINATION WITH OCCUPANTS**

- A. **Partial Owner Occupancy:** Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.
- B. **Owner Limited Occupancy of Completed Areas of Construction:** Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with



completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.

## **1.6 WORK RESTRICTIONS**

- A. Comply with restrictions on construction operations.
  - 1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 8a.m. to 5 p.m., Monday through Friday, unless otherwise indicated.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated.
  - 1. Notify Architect, Construction Manager, and Owner not less than seven days in advance of proposed utility interruptions for existing recreation center.
  - 2. Obtain Architect's, Construction Manager's, or Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy with Owner.
  - 1. Notify Architect, Construction Manager, or Owner not less than two days in advance of proposed disruptive operations.
- E. Smoking and Controlled Substance Restrictions: Use of tobacco products, alcoholic beverages, and other controlled substances on Project site is not permitted.
- F. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
- G. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.
  - 1. Maintain list of approved screened personnel with Owner's representative.

## **1.7 SPECIFICATION AND DRAWING CONVENTIONS**

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
  3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
  4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.
- C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

## SECTION 011100 -GENERAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.01 SCOPE OF WORK

- A. Work Items: The project is comprised of the proposed construction of the William Paterson Recreation and Health Science Center Expansion, which includes the utility improvements, stormwater facilities and associated appurtenances. Removal of an existing underground piping and sanitary mains are associated with the proposed construction of the utility yard. These improvements are described herein and on the project drawings. The work generally includes, but is not limited to, the following:
1. Site Demolition
  2. Site Preparation
  3. Earthwork Activities
  4. Construction of the building, foundation, foundation drains, curb and sidewalks, roadway improvements, stormwater management and conveyance systems, utility improvements and associated appurtenances, landscaping and lighting.
  5. Associated work items as described in the project documents and all construction methods and procedures necessary for the performance of the work.

#### 1.02 CONTRACTOR TO ACCEPT SITE CONDITIONS

- A. The Contractor shall accept the site as is. The Contractor shall make, and shall be deemed to have made, a thorough site inspection in order to field check existing site conditions, correlate conditions with the project drawings and resolve any possible construction conflicts with the Engineer prior to start and also during course of the work. Any observable conditions that differ from the existing conditions shown on the drawings that are not brought to the attention of the Engineer prior to the start of work shall not be considered grounds for a change order.
- B. The work to be performed is as shown on the Contract Plans. Attempts have been made to note all specific items on these plans. Incidental items not included shall be constructed in accordance with standard engineering or architectural requirements. It shall be the Contractor's responsibility to repair or replace any existing facilities (utilities, fences, streets, sidewalks, etc.) damaged by him during the work. Such repairs or replacement shall be done at the Contractor's own cost.

#### 1.03 INDEMNIFICATION

- A. The Contractor shall indemnify and save harmless the Owner, and its respective agents, officers, employees and Engineer (herein collectively called the "indemnities") from and against any and all liability, loss, damages, interest, judgments and liens growing out of, and any and all costs and expenses (including, but not limited to, counsel fees and disbursements) arising out of, or incurred in connection with, any and all claims, demands, suits, actions, or proceedings which may be made or brought against any of the indemnities for or in relation to any violation of this Contract, the laws, statutes, ordinances, rules, regulations, executive orders and agreements herein provided here or any injuries, including death at any time resulting therefrom, sustained by any person or persons, or on account of any damage to property, arising out of or in consequence of the performance of or the failure to perform the contract, whether or not such injuries to persons or damage to property are due or claimed to be due to any negligence of the Contractor or its employees, agents, subcontractors or material men, the indemnities or any other person.

#### 1.04 WARRANTIES

- A. The Contractor shall correct defective work at the Contractor's expense which appears within one year's time from acceptance of work. Failure of Contractor to correct such defects within a reasonable time after being notified to do so shall permit the Owner to cause such defects to be corrected and charge the Contractor the cost of corrections.
- B. The Contractor shall submit to the Engineer all material warranties supplied by manufacturers.

#### 1.05 GENERAL QUALITY ASSURANCE

- A. References and Standards: The Contractor shall comply with all rules, regulations, laws and ordinances of all Authorities having jurisdiction. All labor, materials, equipment, and services necessary to make the work comply with such requirements shall be provided without additional cost. All Standards shall be the latest edition and revisions.
- B. The Contractor shall deliver material to the site, in the approved Manufacturer's original and unopened containers and packaging, bearing labels as to type of material, brand name and manufacturer's name. Delivered materials shall be identical to approved samples. Certifications for materials shall be included with the shipment.
- C. The Contractor shall store material under cover (if appropriate) in a clean, dry, above-ground location in accordance with the manufacturers recommendations and remove materials which are damaged or otherwise not suitable for installation from the job site and replace with acceptable materials.

#### 1.06 SECURITY

- A. Protect work, existing premises and Owner's operations from theft, vandalism, and unauthorized entry.
- B. Initiate and maintain security program throughout construction period until Owner acceptance precludes the need for Contractor security.

- C. Restrict entrance of persons and vehicles into project site and existing facilities. Allow entrance only to authorized persons with proper identification. Maintain log of workers and visitors, make available to Owner on request.

**1.07 SAFETY PROVISIONS:**

- A. Site safety is entirely the responsibility of the Contractor. The Contractor is hereby made aware that the Engineer does not have the authority to stop the work on the grounds of unsafe work practices.

**1.08 SUBMITTALS:**

- A. The Contractor shall submit to the Engineer sufficient documentation from the manufacturers that all material and products used by the Contractor meet the required specifications. Such documentation shall be submitted no less than 72 hours prior to the delivery of the material.

This documentation shall include shop drawings, vendor drawings, manufacturer's specifications and catalog cuts. The shop drawings shall include plans, elevations, sections and details of the work showing in detail the methods of installations and all data and assumptions considered in the design.

- B. The Engineer will review and approve appropriate documentation for general compliance to the specifications prior to delivery. The Engineer's review will be made on a timely basis.
- C. The approval of the Engineer or failure to review shall not be constructed as permitting any departure from Contract requirements, or as relieving the Contractor of responsibility for any errors, including details, dimensions or materials. If submittals show variations from Contract requirements, the Engineer may approve such variations, subject to a proper adjustment in the Contract. If the Contractor fails to describe such variations, he shall not be relieved of the responsibility for executing work in accordance with the Contract documents even though such submittals identifying other variations have been approved.
- D. All submittals required by specifications shall be submitted, unless otherwise stated herein, as follows:
  - 1. Specifications –copies of material specifications will be submitted to the Engineer.
  - 2. Shop Drawings –copies will be submitted to the Engineer for review. Engineer will return submittals to the Contractor.
- E. The work shall not begin until all required submittals for each segment of work have been submitted and stamped “REVIEWED” or “EXCEPTIONS AS NOTED” and the noted exceptions are fully complied with.

**1.09 PROJECT COORDINATION**

- A. Cooperate with the Owner and Engineer in allocation of mobilization areas of site; for field offices and sheds, for access, traffic, and parking facilities.
- B. Comply with Owner and Engineer's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.
- C. Comply with instructions of the Owner for use of temporary utilities and construction facilities.
- D. Coordinate field engineering and layout work under instructions of the Engineer.
- E. Submit preliminary progress schedule to the Owner and coordinate with project construction schedule. After review, revise and resubmit schedule to comply with revised project schedule; during progress of work revise and resubmit as directed.
- F. Provide information required by Engineer for preparation of coordination drawings.
- G. Notify Owner and Engineer when work is considered ready for substantial completion. Accompany Engineer on preliminary inspection to determine items to be listed for completion or correction in Contractor's Notice of Substantial Completion and punchlist.

#### 1.10 PROGRESS SCHEDULE

- A. Prepare project schedule using the critical path method. Use a sequence of listings corresponding to the Table of Contents of this Project Manual or the chronological order of the start of each item of work.
- B. Progress schedule to have a minimum 11 x 17 inches sheet size.
- C. Progress schedule shall indicate the following:
  - 1. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
  - 2. Identify each item by specification section number.
  - 3. Identify work of separate stages and other logically grouped activities.
  - 4. Provide sub-schedule to define critical portions of the entire schedule.
  - 5. Show accumulated percentage of completion of each item, and total percentage of work completed, as of the first day of each month.
- D. Provide separate schedule of submittal dates for shop drawings, produce data, and samples. Indicate decision dates for selection of finishes.
- E. Revisions to schedule shall reflect the following:

1. Identify activities modified since previous submittal, major changes in scope, and other identifiable changes.
  2. Provide narrative report to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken, or proposed, and its effect including the effect of changes on schedules of separate contractors.
- F. Distribute copies of reviewed schedules to project site file, subcontractors, suppliers, and other concerned parties.
- G. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

#### **1.11 PERMIT APPLICATIONS AND COMPLIANCE**

- A. The Contractor should determine what outstanding permits may be his responsibility, and shall clarify same with the Engineer.
- B. The Contractor shall carefully plan and coordinate his work so as to comply with all criteria, conditions and the intent of all project permits.
- C. Should any field condition or construction task cause the project to become in violation, or risk becoming in violation, of any project permit, same shall be immediately reported by the Contractor to the Engineer.

#### **1.12 ENVIRONMENTAL PROTECTION**

- A. It is the Contractor's responsibility to assure himself that all applicable Federal, State and local laws, concerning pollution and environmental protection are being complied with by his personnel and subcontractors.
- B. When Contractor is in, or it is anticipated that any part of the work may become in non-compliance with applicable Federal, State, and local laws or regulations, Engineer will notify the Owner who may issue an order stopping all or part of the work until satisfactory corrective actions have been taken, or may order supplemental actions to be taken to stay in, or come into, compliance. No part of the time lost due to any such stop order shall be made subject of a claim for extensions of time, or for extra compensation or damages by the Contractor.
- C. In particular, the Contractor shall not allow the discharge of concrete, mortar, grout, gasoline, diesel, or the washing from vessels containing these materials, or other construction materials, into public areas or the sewage systems.
- D. Contractor shall provide and maintain all facilities necessary for pollution control under this Contract as long as construction operations continue.

#### **1.13 CONTRACTOR'S REPRESENTATIVES**

- A. The Contractor shall provide and maintain a capable and experienced field person to oversee all contract operations. The Contractor shall submit references for his proposed

representative to, and obtain approval from, the Owner and Engineer prior to the start of construction. A representative shall be on-site or available via cell phone during all operating hours of the project.

- B. As appropriate, the Contractor or his subcontractors shall provide qualified supervisory personnel for specialist aspects of the work, such as for concrete, landscaping, utility installation and site furnishings.

#### **1.14 JOB OFFICE**

- A. The Contractor shall provide and maintain a suitable job office for the use of his supervising personnel at the location shown on the plans.

The offices shall be equipped with telephones listed in the Contractor's name and other appropriate facilities. The cost for maintaining the office facilities and the trailer shall be paid for by the Contractor for the duration of the project.

- B. The Contractor shall provide and maintain in a neat and sanitary condition such temporary sanitary conveniences and accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the Department of Health and other governing agencies having legal jurisdiction.
- C. The Contractor shall provide all security necessary and be entirely responsible for protection of equipment and materials supplied and used in conjunction with his work.
- D. The office shall be maintained throughout the course of construction and shall be removed upon final acceptance of the Contract work.

#### **1.15 SITE ACCESS**

- A. The construction site is an integral part of an operating college facility and extreme care and protection of the staff and public is critical. Phased construction plans shall be maintained regularly to ensure compliance with public access and safety issues.
- B. All points of construction access shall receive a crushed stone wheel-cleaning blanket, in accordance with soil erosion and sediment control requirements.
- C. On-site and off-site roadways which are soiled by construction traffic shall be immediately swept clean of spoil/debris.

#### **1.16 EXISTING UTILITIES AND STRUCTURES**

- A. **Verify Locations:** Locations of existing underground utilities and structures as shown on the Plans are approximate and may not necessarily be complete. These locations shall be verified by the Contractor.
- B. **Avoid Damage:** The Contractor shall exercise care to avoid damage to all existing structures, poles, utilities, pipes, etc. which are scheduled to remain. In locations where the excavation is carried beneath or adjacent to such facilities, the Contractor shall adequately support such structures, utilities or pipes as necessary to maintain them in



operation and in their original position. The Contractor shall be responsible for any damage caused to any utilities by this work, without any additional cost to the Owner.

#### **1.17 MAINTENANCE OF RECORD DOCUMENTS AND SAMPLES**

- A. Contractor shall maintain at the site one record copy which will be kept available for review by the Engineer and Owner of:
  - 1. Design Drawings
  - 2. Technical Specifications
  - 3. Addenda and Modifications to Drawings and Specifications
  - 4. Progress Schedule and Critical Path Diagram
  - 5. Change Orders and other modifications to the Contract
  - 6. Engineer Field Orders
  - 7. Inspection Certificates
  - 8. Manufacturer's Certificates
  - 9. Daily Work Activity Reports, including:
    - a. Field Test Records
    - b. Photographs
    - c. Records of all Site Work
    - d. Laboratory Test Records
    - e. Daily Inspection Records
    - f. Reports on all Safety and Accident incidents
    - g. Manifest Documents, Truck-Load Tickets, and Shipping Papers
    - h. Log of Control and Survey Work
    - i. Other items that may be required by Engineer
- B. The Contractor shall also maintain on-site copy of other documents: manufacturer's certifications, inspection certifications, field test records required by individual Specification Sections.
- C. Record Documents and samples are to be stored in Field Office apart from documents used for construction. Files, racks, and secure storage area to be provided for Record Documents and samples.
- D. Record Documents are to be kept in clean, dry, and legible conditions, and are not to be used for construction purposes.

#### **1.18 TEMPORARY ELECTRIC POWER**

- A. Contractor shall extend electrical service to the building at locations approved by the Owner. Temporary electrical service shall be independent of the existing permanent service. Initial temporary service shall be three (3) phase or single phase depending upon closest availability to the project. Temporary light and power installations, wiring, and miscellaneous electrical hardware must meet the National Electric Code. The Contractor shall provide the necessary distributing facilities and meter, and shall pay the cost of running temporary services from the nearest utility company power service. All costs shall be included in his bid.

- B. The Contractor shall pay for cost of all electric energy used on distribution lines installed until the project is accepted by the Owner. The Contractor shall provide and pay for all maintenance, servicing, operation and supervision of the service and distribution facilities. He shall also connect, maintain, and service any electrical equipment installed which may be necessary for maintaining heat whenever heat is required in the job office whether from the temporary or permanent system.
- C. Contractor shall provide temporary light and power to all trades during normal working hours of such trades. Where overtime work necessitates standby electricians or other trades, such Contractor shall be responsible for making appropriate arrangements, financial and otherwise, for such service at no cost to the Owner.
- D. The Contractor shall observe the requirements of the Federal Occupational Safety and Health Act of 1970 with regard to temporary light and power.
- E. In the alternative, the Contractor may use portable generator(s) to provide temporary power, with Town's approval.

#### **1.19 AS-BUILT DOCUMENTS**

- A. The Contractor shall provide and maintain, at his own expense, one set of prints of the Contract Drawings on the Site. The Contractor shall maintain an up-to-date record on these prints showing all changes, additions, or omissions made during construction without regard to how they were initiated. On these prints, the Contractor shall show any demolished, relocated and/or installed utilities or related facilities as the work progresses. Such recording of the installation shall include final and actual sizes as well as location and elevation thereof by figures and off-set distances in feet and inches to permanent surface improvements such as buildings, retaining walls or curbs. Upon completion of the work, the information on these drawings shall be incorporated into a set of As-Built Drawings prepared by the Contractor. The number, titles, and scales of these As-Built Drawings shall equal the Contract Drawings. These As-Built Drawings shall be accurate reductions of the existing conditions in the scale indicated in the Contract Drawings and shall be signed and sealed by a New Jersey Licensed Land Surveyor. The Contractor shall furnish six sets of signed and sealed As-Built drawings and AutoCAD files on CD to the Owner and Engineer upon completion of the project.
- B. With respect to underground utilities, including storm drains, these As-Built Drawings shall show the precise locations, actual sizes, materials, inverts, and recorded lengths of these utilities and related facilities as demolished, relocated, and/or installed. Locations shall be referenced by offsets in feet and inches to permanent surface improvements such as buildings, retaining walls, curbs, light fixtures, and hydrants.
- C. With respect to construction of buildings or other structures, these as-built drawings shall show finished elevations in feet and inches, exterior and interior dimensions in feet and inches, dimensional relationships to other structures, and structural mechanical, electrical, and other building systems.
- D. With respect to other construction work, including, but not limited to, earthwork fine grading, asphalt paving, sidewalk and curb construction, fencing, wall construction, landscaping, general demolition and other civil works, these As-Built Drawings shall

show final locations, elevations, and materials. Elevations shall be indicated by means of a topographic survey including contours at one foot intervals and spot elevations at maximum fifty foot intervals. In steeply sloping areas, spot elevations shall be provided at closer intervals.

- E. Such information shall have been recorded concurrently with construction progress. The required information shall be recorded prior to proceeding with work which would prevent collection of the required information.
- F. The Contractor shall include the following on the six sets of final hard copies of the As-Built Drawings:
  - Company names, address, and telephone number, project title, contract number and drawing date.
  - The words "As-Built".
  - The statement, "I hereby certify that this As-Built Drawing is correct, complete, and accurate."
  - Contractor's signature.
  - Surveyors seal and signature
- G. The Contractor shall submit As-Built Drawings and AutoCAD compact disk to the Engineer within one (1) month of the issuance of the Certificate of Substantial Completion for verification by the Owner. Acceptance of the As-Built Drawings is subject to verification.

#### **1.20 PROJECT CLOSEOUT**

- A. Notify Engineer when work is considered ready for substantial completion. Accompany Engineer on preliminary inspection to determine items to be listed for completion or correction in Contractor's Notice of Substantial Completion and punchlist.
- B. Comply with Engineer's instructions to correct items of work listed in punchlist and executed Certificates of Substantial Completion.
- C. Notify Engineer when work is considered finally complete. Accompany Engineer on preliminary final inspection.
- D. Comply with Engineer's instructions for completion of items of work determined by Engineer's final inspection.
- E. Remove all temporary facilities, temporary erosion and sediment controls, and all construction waste, for legal disposal in an off-site location.
- E. Provide appropriate protection for any interim facilities to remain.
- F. Leave site in a tidy, orderly condition.

**PART 2 MATERIALS**

**2.01 GENERAL**

- A. Use materials appropriate to the work, and meeting with the Engineer's approval.

**PART 3 EXECUTION**

**3.01 GENERAL**

- A. Execute general measures as appropriate, and meeting with the Engineer's approval.

**END OF SECTION 011100**

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## **SECTION 012100 - ALLOWANCES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes administrative and procedural requirements governing allowances.
- B. Types of allowances include the following:
  - 1. Quantity allowances.
- C. Related Requirements:
  - 1. Section 012200 "Unit Prices" for procedures for using unit prices, including adjustment of quantity allowances when applicable.
  - 2. Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

#### **1.3 DEFINITIONS**

- A. Allowance: A quantity of work or dollar amount included in the Contract, established in lieu of additional requirements, used to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

#### **1.4 SELECTION AND PURCHASE**

- A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection, or purchase and delivery, of each product or system described by an allowance must be completed by the Owner to avoid delaying the Work.
- B. At Architect's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by Architect from the designated supplier.

### 1.5 ACTION SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.

### 1.6 INFORMATIONAL SUBMITTALS

- A. Submit surveys and volumes of in-place rock quantities invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

### 1.7 QUANTITY ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include **taxes**, freight, and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
  - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

### 1.8 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, required maintenance materials, and similar margins.
  - 1. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other markups.
  - 2. Submit substantiation of a change in scope of Work, if any, claimed in Change Orders related to unit-cost allowances.
  - 3. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

- B. Submit claims for increased costs due to a change in the scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.
  - 1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of Work has changed from what could have been foreseen from information in the Contract Documents.
  - 2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

**3.2 PREPARATION**

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

**3.3 SCHEDULE OF ALLOWANCES**

- A. Allowance No. 1: Quantity Allowance: Include 1000 cu. yd. of mass rock removal and replacement with satisfactory soil material, as specified in Section 312000 "Earth Moving."
  - 1. Coordinate quantity allowance adjustment with unit-price requirements in Section 012200 "Unit Prices."
  - 2. The allowance above shall be included in the base bid.

**END OF SECTION 012100**

## SECTION 012200 – UNIT PRICES

### PART 1 – GENERAL

#### 1.1 SUMMARY

- A. This Section specifies administrative and procedural requirements for unit prices.
- B. A unit price is an amount proposed by Bidders and stated on the Bid form as a price per unit of measurement for materials or services that will be added to or deducted from the Contract Sum by Change Order in the event the estimated quantities of Work required by the Contract Documents are increased or decreased.
- C. Unit prices include all necessary material, delivery and handling costs, installation costs, overhead, supervision, profit, insurance and applicable taxes.
- D. Refer to specification Section 012100 - Allowances, for quantity allowances associated with below listed Unit Prices. Unit price is to include all make-up amounts and yield final contract change amount when multiplied by the final quantity delta. The final quantity delta is determined by subtracting the actual quantity (agreed upon amount) from the quantity allowance amount listed in section 012100.
- E. A "Unit Price Schedule" is included at the end of this Section. Specification Sections referenced in the Schedule contain requirements for materials and methods described under each unit price.
- F. The Owner reserves the right to reject the Contractor's measurement of work-in-place that involves use of established unit prices, and to have this Work measured by an independent surveyor acceptable to the Contractor at the Owner's expense.

#### 1.2 UNIT PRICE SCHEDULE

##### **Unit Price #1: Rock Removal**

\$ / Cubic Yard (in place volume)

The unit price provided shall include all of the following: costs for pre construction surveys, insurance; all costs for monitoring air and ground vibration; all costs of complying with Federal, State and local laws; all costs of using methods other than blasting to remove rock, protecting all structures; all costs of settling all damage claims due to rock excavation; the cost of hauling and disposing of the excavated rock; the cost for line drilling as required to protect existing foundations, utilities and other areas where rock is not required to be removed; the cost of all labor, material and equipment necessary and incidental to the excavation and disposal of rock.



*Unit of Measurement:* A cubic yard of rock excavation shall be as measured in its pre-removal, in-situ volume that has to be excavated to meet the grades and lines as shown, specified or required. Rock payment volume shall be based upon a 8-foot grid survey of the project area, performed by the Contractor using a NJ-licensed Surveyor, of the exposed ledge or bedrock prior to removal, but only after all attempts for mechanical removal of all fractures and loose rock has occurred. Mechanical removal attempts shall be made with large excavator of comparable scale to CAT 349F and equipment with rock teeth. The Contractor shall submit the signed and sealed (and AutoCAD) survey to the Engineer for review with quantified volume of rock to be removed to meet design grade. The survey shall include an overlay of the project building and utilities. A copy of the project site CAD files will be furnished to the Contractor and their Surveyor for their use. The Contractor and the Engineer shall agree on the rock surface prior to line drilling, jack-hammering or removal method has begun.

The top surface of the rock survey shall determine the top limit of the rock excavation volume for payment. The sides of the rock excavation pay limit shall be measured vertically from the edge of footings or perimeter of mass excavations or sides of trenches at a distance of 1.5 feet away from the edge of pipe, conduit or buried utility, whichever is applicable. The bottom of the rock excavation shall vary and shall be as shown, specified or required in order to place a minimum of 6" of crushed stone or sand bedding where shown, specified, required or ordered by the Engineer. Rock that is removed beyond the pay limits described herein, for any reason other than as ordered by the Engineer, shall not be paid by the Owner but shall be included in the contractors bid. Rock excavation volumes cannot overlap or be counted more than once.

END OF SECTION

## SECTION 01 2300 ALTERNATES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for alternates.

#### 1.2 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
  - 1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
  - 2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.
  - 3. Alternates shall be selected in non-sequential order as follows:
    - a. Award order #1: Add Alternate #1
    - b. Award order #2: Add Alternate #4
    - c. Award order #3: Add Alternate #2
    - d. Award order #4: Add Alternate #3

#### 1.3 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
  - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Execute accepted alternates under the same conditions as other work of the Contract.
- C. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

### PART 2 - PRODUCTS (Not Used)

**PART 3 - EXECUTION**

**2.1 SCHEDULE OF ALTERNATES**

1. ADD Alternate #1 (award order #1): Renovations to area of Existing Building
  - a. Base Bid: Existing weight room to remain
  - b. Alternate: Construct corridor, trainer's room, new ref locker rooms and storage rooms as show in the documents.
2. ADD Alternate #2 (award order #3): Warm Water Spa
  - a. Base Bid: No warm water spa, provide showers and heating lamps as shown in documents behind diving boards. Provide underground piping in drawings as noted in AQ drawings for warm water spa.
  - b. Alternate: Provide and install warm water spa and equipment as noted in the drawings, omit showers and heating lamps behind diving boards as noted in the drawings.
3. ADD Alternate #3 (award order #4): Lighting protection
  - a. Base bid: no lighting protection provided
  - b. Alternate: provide lighting protection system
4. ADD Alternate #4 (award order #2) Gymnasium Bleachers and (4) additional backboards.
  - a. Base bid: omit gymnasium bleachers and provide only 2 backboards as shown on drawings
  - b. Alternate: provide and install bleachers within new gymnasium and installed (4) additional backboards for a total of 6 within the gymnasium.

END OF SECTION 01 2300

## **SECTION 012500 - SUBSTITUTION PROCEDURES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
  - 1. Refer to Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers as substitutes and for evaluation of equivalency.

#### **1.2 DEFINITIONS**

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
  - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
  - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
  - 3. Substitution with comparable product submitted as equal: refer to section 016000 "Product requirements" and requirements herein.

#### **1.3 ACTION SUBMITTALS**

- A. Substitution Requests: Submit one digital copy of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Substitution Request Form: Use form acceptable to Architect or CSI form 13.1A
  - 2. Documentation: Show compliance with requirements of section 016000 product requirements for comparable and evaluation of equivalency and the following, as applicable:
    - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
    - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.

- c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
  - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
  - e. Samples, where applicable or requested.
  - f. Certificates and qualification data, where applicable or requested.
  - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
  - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
  - i. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
  - j. Cost information, including a proposal of change, if any, in the Contract Sum.
  - k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
  - l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- 3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within **15** days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
  - a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
  - b. Submittal of comparable product may also be approved as detailed in submittal procedures
  - c. Use product specified or submit different product for evaluation of equivalency if request is rejected.

#### 1.4 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

## 1.5 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

## 1.6 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than **15** days prior to time required for preparation and review of related submittals.

- 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

- a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    - b. Substitution request is fully documented and properly submitted.
    - c. Requested substitution will not adversely affect Contractor's construction schedule.
    - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
    - e. Requested substitution is compatible with other portions of the Work.
    - f. Requested substitution has been coordinated with other portions of the Work.
    - g. Requested substitution provides specified warranty.
    - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

- B. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.

- 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

- a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
    - b. Requested substitution does not require extensive revisions to the Contract Documents.
    - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    - d. Substitution request is fully documented and properly submitted.
    - e. Requested substitution will not adversely affect Contractor's construction schedule.

- f. Requested substitution has received necessary approvals of authorities having jurisdiction.
  - g. Requested substitution is compatible with other portions of the Work.
  - h. Requested substitution has been coordinated with other portions of the Work.
  - i. Requested substitution provides specified warranty.
  - j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- 2. Substitution with comparable product submitted as equal: refer to section 016000 "Product requirements" and requirements herein.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

## SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

#### 1.2 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on web-based Project management software.
  - 1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.

#### 1.3 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
  - 1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
  - 2. Within 20 days, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
    - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Include costs of labor and supervision directly attributable to the change.
    - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.
  - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.



2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 01 2500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.

#### 1.4 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on form provided as part of web-based Project management software or AIA document in accordance with NJAC 5:30-11.3, NJSA 40A:11-13g, and NJSA 40A:11-23.1a, as applicable. .

#### 1.5 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on form provided as part of web-based Project management software. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
  1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
  1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

#### 1.6 WORK CHANGE DIRECTIVE

- A. Work Change Directive: Architect may issue a Work Change Directive on form provided as part of web-based Project management software. Work Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
  1. Work Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

- B. Documentation: Maintain detailed records on a time and material basis of work required by the Work Change Directive.
  - 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

## SECTION 012900 - PAYMENT PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

#### 1.2 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
  - 1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
  - 2. Submit the schedule of values to Architect at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedules of values. Provide at least one line item for each Specification Section.
  - 1. Schedule of Values shall be separated per phase and with line items provided separately.
  - 2. Arrange schedule of values consistent with format of AIA Document G703.
  - 3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
  - 4. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
    - a. Differentiate between items stored on-site and items stored off-site.
  - 5. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
  - 6. Overhead Costs: Include total cost and proportionate share of general overhead and profit for each line item.
  - 7. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling **five** percent of the Contract Sum and subcontract amount.

8. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

### 1.3 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
- B. Payment Application Times: Submit Application for Payment to Architect by the last day of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.
  1. Submit draft copy of Application for Payment (a “pencil copy”) seven days prior to due date for review by Architect.
- C. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
  1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
  2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
  3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- E. Transmittal: Submit a digitally scanned signed and notarized original copy of each Application for Payment to Architect. One copy shall include waivers of lien and similar attachments if required.
  1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- F. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
  1. List of subcontractors.
  2. Schedule of values.
  3. Contractor's construction schedule (preliminary if not final).
  4. Products list (preliminary if not final).
  5. Sustainable design action plans, including preliminary project materials cost data.
  6. Schedule of unit prices.
  7. Submittal schedule (preliminary if not final).
  8. List of Contractor's staff assignments.

9. List of Contractor's principal consultants.
  10. Copies of building permits.
  11. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
  12. Initial progress report.
  13. Report of preconstruction conference.
- G. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
  2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- H. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
  2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
  3. Updated final statement, accounting for final changes to the Contract Sum.
  4. AIA Document G706.
  5. AIA Document G706A.
  6. AIA Document G707.
  7. Evidence that claims have been settled.
  8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
  9. Final liquidated damages settlement statement.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

- 3.1 All applications for payments, payments, and payment related disputes will be in accordance with the prompt payment act NJSA 2A:30A-1 et seq.

END OF SECTION 012900

## SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. General coordination procedures.
  - 2. Coordination drawings.
  - 3. RFIs.
  - 4. Digital project management procedures.
  - 5. Project meetings.
- B. Related Requirements:
  - 1. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

#### 1.2 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
  - 1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
  - 2. Number and title of related Specification Section(s) covered by subcontract.
  - 3. Drawing number and detail references, as appropriate, covered by subcontract.

#### 1.3 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.

- B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
  2. Preparation of the schedule of values.
  3. Installation and removal of temporary facilities and controls.
  4. Delivery and processing of submittals.
  5. Progress meetings.
  6. Preinstallation conferences.
  7. Project closeout activities.
  8. Startup and adjustment of systems.

#### 1.4 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
    - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    - b. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
  2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
  3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
  4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
  5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door

- floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Review: Architect will review coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.
  7. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
    - a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
    - b. Digital Data Software Program: Drawings are available in AutoCAD release 2017 format.
    - c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.

#### 1.5 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
  1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
  2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
  1. Owner name.
  2. Owner's Project number.
  3. Name of Architect.
  4. Architect's Project number.
  5. Date.
  6. Name of Contractor.
  7. RFI number, numbered sequentially.
  8. RFI subject.
  9. Specification Section number and title and related paragraphs, as appropriate.
  10. Drawing number and detail references, as appropriate.
  11. Field dimensions and conditions, as appropriate.
  12. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  13. Contractor's signature.
  14. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.



- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
  - 1. The following Contractor-generated RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for approval of Contractor's means and methods.
    - d. Requests for coordination information already indicated in the Contract Documents.
    - e. Requests for adjustments in the Contract Time or the Contract Sum.
    - f. Requests for interpretation of Architect's actions on submittals.
    - g. Incomplete RFIs or inaccurately prepared RFIs.
  - 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
  - 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
    - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within five days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Use software log that is part of web-based Project management software.
  - 1. Project name.
  - 2. Name and address of Contractor.
  - 3. Name and address of Architect.
  - 4. RFI number including RFIs that were returned without action or withdrawn.
  - 5. RFI description.
  - 6. Date the RFI was submitted.
  - 7. Date Architect's response was received.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within three days if Contractor disagrees with response.

#### 1.6 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Architect's Digital Data Files: Digital data files of Architect's CAD drawings will be provided by Architect for Contractor's use during construction.

1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project record Drawings.
  2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
  3. Digital Drawing Software Program: Contract Drawings are available in AutoCAD version 2017.
  4. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.
  5. The following digital data files will be furnished for each appropriate discipline:
    - a. Floor plans.
    - b. Reflected ceiling plans.
- B. Web-Based Project Management Software Package: Provide, administer, and use web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion.
1. Web-based Project management software includes, at a minimum, the following features:
    - a. Compilation of Project data, including Contractor, subcontractors, Architect, architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
    - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
    - c. Document workflow planning, allowing customization of workflow between project entities.
    - d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
    - e. Track status of each Project communication in real time, and log time and date when responses are provided.
    - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
    - g. Processing and tracking of payment applications.
    - h. Processing and tracking of contract modifications.
    - i. Creating and distributing meeting minutes.
    - j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
    - k. Management of construction progress photographs.
    - l. Mobile device compatibility, including smartphones and tablets.
  2. Provide web-based Project management software user licenses for use of Owner, Architect, and Architect's consultants.
  3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.
- C. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

#### 1.7 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
- B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
  1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  2. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Responsibilities and personnel assignments.
    - b. Tentative construction schedule.
    - c. Phasing.
    - d. Critical work sequencing and long lead items.
    - e. Designation of key personnel and their duties.
    - f. Lines of communications.
    - g. Use of web-based Project software.
    - h. Procedures for processing field decisions and Change Orders.
    - i. Procedures for RFIs.
    - j. Procedures for testing and inspecting.
    - k. Procedures for processing Applications for Payment.
    - l. Distribution of the Contract Documents.
    - m. Submittal procedures.
    - n. Preparation of Record Documents.
    - o. Use of the premises.
    - p. Work restrictions.
    - q. Working hours.
    - r. Owner's occupancy requirements.
    - s. Responsibility for temporary facilities and controls.
    - t. Procedures for moisture and mold control.
    - u. Procedures for disruptions and shutdowns.
    - v. Construction waste management and recycling.
    - w. Parking availability.
    - x. Office, work, and storage areas.
    - y. Equipment deliveries and priorities.
    - z. First aid.
    - aa. Security.

- bb. Progress cleaning.
  - 3. Minutes: The Architect will be responsible for compiling meeting minutes. Owner to be provided 5 days for review, comment and approval prior to distribution.
  - 4. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent and sustainable design coordinator; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
  - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
    - a. Contract Documents.
    - b. Options.
    - c. Related RFIs.
    - d. Related Change Orders.
    - e. Purchases.
    - f. Deliveries.
    - g. Submittals.
    - h. Review of mockups.
    - i. Possible conflicts.
    - j. Compatibility requirements.
    - k. Time schedules.
    - l. Weather limitations.
    - m. Manufacturer's written instructions.
    - n. Warranty requirements.
    - o. Compatibility of materials.
    - p. Acceptability of substrates.
    - q. Temporary facilities and controls.
    - r. Space and access limitations.
    - s. Regulations of authorities having jurisdiction.
    - t. Testing and inspecting requirements.
    - u. Installation procedures.
    - v. Coordination with other work.
    - w. Required performance results.
    - x. Protection of adjacent work.
    - y. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
6. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
  - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
    - 1) Review schedule for next period.
  - b. Review present and future needs of each entity present, including the following:
    - 1) Interface requirements.
    - 2) Sequence of operations.
    - 3) Status of submittals.
    - 4) Deliveries.
    - 5) Off-site fabrication.
    - 6) Access.
    - 7) Site use.
    - 8) Temporary facilities and controls.
    - 9) Progress cleaning.
    - 10) Quality and work standards.
    - 11) Status of correction of deficient items.
    - 12) Field observations.
    - 13) Status of RFIs.
    - 14) Status of Proposal Requests.
    - 15) Pending changes.
    - 16) Status of Change Orders.
    - 17) Pending claims and disputes.
    - 18) Documentation of information for payment requests.
7. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
  - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

END OF SECTION 013100

## **SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
  - 1. Contractor's Construction Schedule.
  - 2. Construction schedule updating reports.
  - 3. Daily construction reports.
  - 4. Site condition reports.

#### **1.2 DEFINITIONS**

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
  - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
  - 2. Predecessor Activity: An activity that precedes another activity in the network.
  - 3. Successor Activity: An activity that follows another activity in the network.
- B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- D. Event: The starting or ending point of an activity.
- E. Float: The measure of leeway in starting and completing an activity.
  - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
  - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
  - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

### 1.3 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
  - 1. Working electronic copy of schedule file.
  - 2. PDF file.
- B. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
- D. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
  - 1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
  - 2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
  - 3. Total Float Report: List of activities sorted in ascending order of total float.
- E. Construction Schedule Updating Reports: Submit with Applications for Payment.
- F. Daily Construction Reports: Submit at monthly intervals.
- G. Site Condition Reports: Submit at time of discovery of differing conditions.

### 1.4 COORDINATION

- A. Coordinate Contractor's Construction Schedule with the schedule of values, schedule, progress reports, payment requests, and other required schedules and reports.
  - 1. Secure time commitments for performing critical elements of the Work from entities involved.
  - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

### 1.5 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.



1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
  2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
  3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
  4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
  5. Commissioning Time: Include no fewer than 15 days for commissioning.
  6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
  7. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.
- D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
  2. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
  3. Work Restrictions: Show the effect of the following items on the schedule:
    - a. Coordination with existing construction.
    - b. Limitations of continued occupancies.
    - c. Uninterruptible services.
    - d. Partial occupancy before Substantial Completion.
    - e. Use-of-premises restrictions.
    - f. Provisions for future construction.
    - g. Seasonal variations.
    - h. Environmental control.
- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion, and the following interim milestones:
1. Roof installation
  2. Building Enclosure

3. Substantial Completion
  4. Final Completion
- F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
1. Unresolved issues.
  2. Unanswered Requests for Information.
  3. Rejected or unreturned submittals.
  4. Notations on returned submittals.
  5. Pending modifications affecting the Work and the Contract Time.
- G. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
  2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
  3. As the Work progresses, indicate final completion percentage for each activity.
- H. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.
- I. Distribution: Distribute copies of approved schedule to Architect Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
  2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.
- 1.6 GANTT-CHART SCHEDULE REQUIREMENTS
- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for commencement of the Work.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

## 1.7 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
  1. List of subcontractors at Project site.
  2. List of separate contractors at Project site.
  3. Actual count of personnel at Project site.
  4. Equipment at Project site.
  5. Material deliveries.
  6. High and low temperatures and general weather conditions, including presence of rain or snow.
  7. Testing and inspection.
  8. Accidents.
  9. Meetings and significant decisions.
  10. Stoppages, delays, shortages, and losses.
  11. Meter readings and similar recordings.
  12. Emergency procedures.
  13. Orders and requests of authorities having jurisdiction.
  14. Change Orders received and implemented.
  15. **Construction** Change Directives received and implemented.
  16. Services connected and disconnected.
  17. Equipment or system tests and startups.
  18. Partial completions and occupancies.
  19. Substantial Completions authorized.
- B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200

## **SECTION 013300 - SUBMITTAL PROCEDURES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

#### **1.2 DEFINITIONS**

- A. Action Submittals:** Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals:** Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

#### **1.3 SUBMITTAL SCHEDULE**

- A. Submittal Schedule:** Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

#### **1.4 SUBMITTAL FORMATS**

**A. Submittal Information:** Include the following information in each submittal:

1. Project name.
2. Date.
3. Name of Architect.
4. Name of Contractor.
5. Name of firm or entity that prepared submittal.
6. Names of subcontractor, manufacturer, and supplier.
7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
8. Category and type of submittal.
9. Submittal purpose and description.

10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
  11. Drawing number and detail references, as appropriate.
  12. Indication of full or partial submittal.
  13. Location(s) where product is to be installed, as appropriate.
  14. Other necessary identification.
  15. Remarks.
  16. Signature of transmitter.
- B. Options: Identify options requiring selection by Architect.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.
- E. Submittals for Utilizing Web-Based Project Management Software: Prepare submittals as PDF files, or other format indicated by Project management software.

## 1.5 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Email: Prepare submittals as PDF package, and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
  2. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
  3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
  2. Resubmittal Review: Allow 15 days for review of each resubmittal.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

## 1.6 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
  2. Mark each copy of each submittal to show which products and options are applicable.
  3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts.
    - b. Manufacturer's product specifications.
    - c. Standard color charts.
    - d. Statement of compliance with specified referenced standards.
    - e. Testing by recognized testing agency.
    - f. Application of testing agency labels and seals.
    - g. Notation of coordination requirements.
    - h. Availability and delivery time information.
  4. For equipment, include the following in addition to the above, as applicable:
    - a. Wiring diagrams that show factory-installed wiring.
    - b. Printed performance curves.
    - c. Operational range diagrams.
    - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
  5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

- a. Identification of products.
  - b. Schedules.
  - c. Compliance with specified standards.
  - d. Notation of coordination requirements.
  - e. Notation of dimensions established by field measurement.
  - f. Relationship and attachment to adjoining construction clearly indicated.
  - g. Seal and signature of professional engineer if specified.
- C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
  1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
  2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
    - a. Project name and submittal number.
    - b. Generic description of Sample.
    - c. Product name and name of manufacturer.
    - d. Sample source.
    - e. Number and title of applicable Specification Section.
    - f. Specification paragraph number and generic name of each item.
  3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
  4. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
  5. Paper Transmittal: Include paper transmittal including complete submittal information indicated.
  6. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
    - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
  7. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
    - a. Number of Samples: Submit **one** full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
  8. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of

color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

- a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned.
  - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
  - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:
  1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
  2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
  3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
  4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
  5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
  6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.



H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
  - a. Name of evaluation organization.
  - b. Date of evaluation.
  - c. Time period when report is in effect.
  - d. Product and manufacturers' names.
  - e. Description of product.
  - f. Test procedures and results.
  - g. Limitations of use.

1.7 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF files of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
  1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

**1.8 CONTRACTOR'S REVIEW**

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
  - 1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

**1.9 ARCHITECT'S REVIEW**

- A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required.
  - 1. PDF Submittals: Architect will indicate, via markup on each submittal, the appropriate action.
  - 2. Submittals by Web-Based Project Management Software: Architect will indicate, on Project management software website, the appropriate action.
- B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Architect will discard submittals received from sources other than Contractor.
- F. Submittals not required by the Contract Documents will be returned by Architect without action.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION 013300**

## SECTION 014000 - QUALITY REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
  - 2. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

#### 1.2 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of **five** previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
  - 1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
- D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.
  - 1. Mockups are used for one or more of the following:
    - a. Verify selections made under Sample submittals.
    - b. Demonstrate aesthetic effects.
    - c. Demonstrate the qualities of products and workmanship.
    - d. Demonstrate successful installation of interfaces between components and systems.

- e. Perform preconstruction testing to determine system performance.
- 2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
- 3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.
- E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.
- F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."
- I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

### 1.3 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Statement: Submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

#### 1.4 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
  - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
  - 2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- C. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

#### 1.6 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
  - 1. Date of issue.
  - 2. Project title and number.
  - 3. Name, address, telephone number, and email address of testing agency.
  - 4. Dates and locations of samples and tests or inspections.
  - 5. Names of individuals making tests and inspections.
  - 6. Description of the Work and test and inspection method.
  - 7. Identification of product and Specification Section.

8. Complete test or inspection data.
  9. Test and inspection results and an interpretation of test results.
  10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
  11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
  12. Name and signature of laboratory inspector.
  13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Statement on condition of substrates and their acceptability for installation of product.
  2. Statement that products at Project site comply with requirements.
  3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  5. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Statement that equipment complies with requirements.
  2. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  3. Other required items indicated in individual Specification Sections.

## 1.7 QUALITY ASSURANCE

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
  - 1. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
  - 1. Contractor responsibilities include the following:
    - a. Provide test specimens representative of proposed products and construction.
    - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    - c. When testing is complete, remove test specimens and test assemblies, mockups; do not reuse products on Project.
  - 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups of size indicated.
2. Build mockups in location indicated or, if not indicated, as directed by Architect.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
5. Demonstrate the proposed range of aesthetic effects and workmanship.
6. Obtain Architect's approval of mockups before starting corresponding work, fabrication, or construction.
  - a. Allow seven days for initial review and each re-review of each mockup.
7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work..
10. Demolish and remove mockups when directed unless otherwise indicated.

## 1.8 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
  1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
  2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
  1. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
  2. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  3. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  4. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.



- D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
- E. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- F. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
  - 1. Access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
  - 4. Facilities for storage and field curing of test samples.
  - 5. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  - 6. Security and protection for samples and for testing and inspection equipment at Project site.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
  - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.

## 1.9 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, as indicated in the Statement of Special Inspections attached to this Section, and as follows:
  - 1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
  - 2. Notifying Architect Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
  - 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect and Commissioning Authority with copy to Contractor and to authorities having jurisdiction.
  - 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.

5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
  1. Date test or inspection was conducted.
  2. Description of the Work tested or inspected.
  3. Date test or inspection results were transmitted to Architect.
  4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's, Commissioning Authority's, and authorities' having jurisdiction reference during normal working hours.
  1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
  1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

## SECTION 014001 ROOF SYSTEM QUALITY CONTROL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Special Conditions and other Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Quality-control services include inspections, tests, and related actions, including reports performed by Contractor, by independent agencies, and by governing authorities. They do not include contract enforcement activities performed by the Architect, or Owner.
- B. Quality-control services are required to verify compliance with requirements specified or indicated, or to verify that portions of the work are functioning as intended.
- C. Quality-control services specified in this section do not limit the Contractor's responsibility to provide quality-control services specified in other sections or portions of the Contract Documents. Specified quality-control services do not limit the Contractor's quality control procedures that facilitate compliance with Contract Document requirements.
- D. This Section includes administrative and procedural requirements for quality-control services not specified in other sections, including the following:
  - 1. Infrared Roof Moisture Survey
  - 2. Alternative Roof Moisture Survey
  - 3. Roof Drain Testing

#### 1.3 INFRARED ROOF MOISTURE SURVEY

- A. Not sooner than three (3) months and not longer than six (6) months after completion of the roof system, the Contractor shall have an infrared roof moisture survey performed, by an independent testing firm, on all roof areas in the scope of this Contract.
- B. Qualifications of testing firm:
  - 1. The survey shall be performed by a firm specializing in infrared thermography services for a period of at least ten (10) consecutive years.
  - 2. The survey shall be performed by an NDT test technician certified to at least Level 2 in the Thermal/Infrared test method, in accordance with American Society for Non-destructive Testing Recommended Practice SNT-TC-1A, and having at least five (5) years experience in providing infrared inspection services on commercial roofing systems.
  - 3. The Owner has the right to reject any testing firm which does not meet, or does not provide satisfactory evidence of meeting, the above requirements.

- 1) In the event the Owner rejects the Contractor's testing firm, it shall be the responsibility of the Contractor to provide another firm acceptable to the Owner, at no additional cost to the Owner.

C. Survey format:

1. The roof moisture survey shall be ground-based, walk-over type, performed and reported in accordance with ASTM C-1153; "Standard Practice for the Location of Wet Insulation in Roofing Systems Using Infrared Imaging", with the following additional requirements:
  - a. The entire survey shall be recorded on a digital format CD/DVD with audio descriptions of roof area designations and observations. A copy of the CD/DVD shall be submitted with each required copy of the report.
  - b. The report shall include thermograms of all moisture suspect anomalies, with corresponding daylight photographs of the same areas, taken from the same perspective.

D. Submittals:

1. At least thirty (30) days prior to the anticipated performance of the survey, the Contractor shall provide written certification that the proposed testing firm meets the requirements specified in 1.3.B above.
  - a. Certification shall be accompanied by documentation from the testing firm indicating the firm's experience and qualifications, including a list of projects and references for similar testing performed over the last ten (10) years.
  - b. Certification shall be accompanied by documentation of the technician's qualifications, including training, certification and list of similar testing projects performed over the last five (5) years.

- E. Retesting: The Contractor is responsible for retesting where results of inspections, tests, reports or other quality-control services prove unsatisfactory and indicate noncompliance with Contract Document requirements.

- F. Final payment to the Contractor will not be made until the roof moisture survey is complete, including submission of acceptable documentation, and all necessary corrective work is performed to the satisfaction of, and at no additional cost to, the Owner. The Owner will retain the value of any incomplete work and retainage for roofing until final payment. Said retainage shall not limit the costs associated with the roof moisture survey or the extent of corrective work that may be required to remedy any and all subsurface moisture.

#### 1.4 ALTERNATIVE ROOF MOISTURE SURVEY

- A. If it is the Owner's opinion that an infrared roof moisture survey may not be appropriate or effective in detecting suspected subsurface moisture, the Owner may request a supplemental or alternative method of moisture survey.
- B. The Owner will compensate the Contractor for all moisture survey costs in excess of the infrared roof moisture survey cost. Any subsurface moisture encountered by the supplemental or alternative moisture survey shall be corrected at no cost to the Owner.

**1.5 ROOF DRAIN TESTING**

- A. Post-Construction Testing: When all work reaches substantial completion, the Contractor shall water-flow test all roof drains, in the presence of the Owner or Owner's representative if one has been hired, to determine if any full or partial drain clogs exist in the drainage system.
  - 1. Report the results of testing to the Owner in writing prior to preparation of the final punch-list.
  - 2. Any drains, piping or other components, whether exposed, concealed, below grade, etc., found to be clogged shall be cleared, repaired or replaced as required to restore full drainage capacity. All work shall be performed by the Contractor at no additional cost to the Owner, including patching, repair or replacement of any materials, finishes, landscaping, etc., disturbed in gaining access to drainage components.

**PART 2 - PRODUCTS (Not Applicable)**

**PART 3 - EXECUTION**

**3.1 INFRARED ROOF MOISTURE SURVEY**

- A. Notify the Architect and Owner at least seventy-two (72) hours before the anticipated performance of the infrared roof moisture survey.
- B. Confirm that environmental conditions are appropriate for proper performance of the survey and notify the Architect and Owner no later than 1:00pm on the day of the survey to confirm that the survey will or will not proceed as scheduled.
  - 1. If the survey cannot proceed as anticipated, due to environmental conditions, re-schedule and repeat the above notification requirements as necessary.

**3.2 ROOF DRAIN TESTING**

- A. Notify the Architect and Owner at least twenty-four (24) hours before the anticipated testing.
- B. Provide 3/4" diameter (min.) hose in sufficient length as required to utilize water source designated by the Owner.
- C. Run water at full volume, for a period not less than twenty (20) minutes, into each drain.
- D. Report any leaking drainage components observed during testing to the Owner.
- E. Re-test after any corrective work and repeat all procedures as necessary until achieving full drainage capacity.

**3.3 REPAIR AND PROTECTION**

- A. General: Upon completion of inspection, testing, sample taking and similar services, repair damaged construction and restore substrates and finishes.

- B. Protect construction exposed by or for quality-control service activities, and protect repaired construction.
- C. Repair and protection is Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing, or similar services.

END OF SECTION 014010

## SECTION 014200 - REFERENCES

### PART 1 - GENERAL

#### 1.1 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

#### 1.2 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
  - 1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

- C. Copies of Standards: Each entity engaged in construction on the Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
  - 1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from the publication source.

### 1.3 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Abbreviations and acronyms not included in this list shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States." The information in this list is subject to change and is believed to be accurate as of the date of the Contract Documents.

- 1. AABC - Associated Air Balance Council; [www.aabc.com](http://www.aabc.com).
- 2. AAMA - American Architectural Manufacturers Association; [www.aamanet.org](http://www.aamanet.org).
- 3. AAPFCO - Association of American Plant Food Control Officials; [www.aapfco.org](http://www.aapfco.org).
- 4. AASHTO - American Association of State Highway and Transportation Officials; [www.transportation.org](http://www.transportation.org).
- 5. AATCC - American Association of Textile Chemists and Colorists; [www.aatcc.org](http://www.aatcc.org).
- 6. ABMA - American Bearing Manufacturers Association; [www.americanbearings.org](http://www.americanbearings.org).
- 7. ABMA - American Boiler Manufacturers Association; [www.abma.com](http://www.abma.com).
- 8. ACI - American Concrete Institute; (Formerly: ACI International); [www.concrete.org](http://www.concrete.org).
- 9. ACPA - American Concrete Pipe Association; [www.concrete-pipe.org](http://www.concrete-pipe.org).
- 10. AEIC - Association of Edison Illuminating Companies, Inc. (The); [www.aeic.org](http://www.aeic.org).
- 11. AF&PA - American Forest & Paper Association; [www.afandpa.org](http://www.afandpa.org).
- 12. AGA - American Gas Association; [www.aga.org](http://www.aga.org).
- 13. AHAM - Association of Home Appliance Manufacturers; [www.aham.org](http://www.aham.org).
- 14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); [www.ahrinet.org](http://www.ahrinet.org).
- 15. AI - Asphalt Institute; [www.asphaltinstitute.org](http://www.asphaltinstitute.org).
- 16. AIA - American Institute of Architects (The); [www.aia.org](http://www.aia.org).
- 17. AISC - American Institute of Steel Construction; [www.aisc.org](http://www.aisc.org).
- 18. AISI - American Iron and Steel Institute; [www.steel.org](http://www.steel.org).
- 19. AITC - American Institute of Timber Construction; [www.aitc-glulam.org](http://www.aitc-glulam.org).
- 20. AMCA - Air Movement and Control Association International, Inc.; [www.amca.org](http://www.amca.org).
- 21. ANSI - American National Standards Institute; [www.ansi.org](http://www.ansi.org).
- 22. AOSA - Association of Official Seed Analysts, Inc.; [www.aosaseed.com](http://www.aosaseed.com).
- 23. APA - APA - The Engineered Wood Association; [www.apawood.org](http://www.apawood.org).
- 24. APA - Architectural Precast Association; [www.archprecast.org](http://www.archprecast.org).
- 25. API - American Petroleum Institute; [www.api.org](http://www.api.org).



26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
27. ARI - American Refrigeration Institute; (See AHRI).
28. ARMA - Asphalt Roofing Manufacturers Association; [www.asphaltroofing.org](http://www.asphaltroofing.org).
29. ASCE - American Society of Civil Engineers; [www.asce.org](http://www.asce.org).
30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; [www.ashrae.org](http://www.ashrae.org).
32. ASME - ASME International; (American Society of Mechanical Engineers); [www.asme.org](http://www.asme.org).
33. ASSE - American Society of Sanitary Engineering; [www.asse-plumbing.org](http://www.asse-plumbing.org).
34. ASSP - American Society of Safety Professionals (The); [www.assp.org](http://www.assp.org).
35. ASTM - ASTM International; [www.astm.org](http://www.astm.org).
36. ATIS - Alliance for Telecommunications Industry Solutions; [www.atis.org](http://www.atis.org).
37. AVIXA - Audiovisual and Integrated Experience Association; (Formerly: Infocomm International); [www.soundandcommunications.com](http://www.soundandcommunications.com).
38. AWEA - American Wind Energy Association; [www.awea.org](http://www.awea.org).
39. AWI - Architectural Woodwork Institute; [www.awinet.org](http://www.awinet.org).
40. AWMAC - Architectural Woodwork Manufacturers Association of Canada; [www.awmac.com](http://www.awmac.com).
41. AWWA - American Water Works Association; [www.awwa.org](http://www.awwa.org).
42. AWS - American Welding Society; [www.aws.org](http://www.aws.org).
43. AWWA - American Water Works Association; [www.awwa.org](http://www.awwa.org).
44. BHMA - Builders Hardware Manufacturers Association; [www.buildershardware.com](http://www.buildershardware.com).
45. BIA - Brick Industry Association (The); [www.gobrick.com](http://www.gobrick.com).
46. BICSI - BICSI, Inc.; [www.bicsi.org](http://www.bicsi.org).
47. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); [www.bifma.org](http://www.bifma.org).
48. BISSC - Baking Industry Sanitation Standards Committee; [www.bissc.org](http://www.bissc.org).
49. BWF - Badminton World Federation; (Formerly: International Badminton Federation); [www.bissc.org](http://www.bissc.org).
50. CDA - Copper Development Association; [www.copper.org](http://www.copper.org).
51. CE - Conformite Europeenne; <http://ec.europa.eu/growth/single-market/ce-marking>.
52. CEA - Canadian Electricity Association; [www.electricity.ca](http://www.electricity.ca).
53. CFFA - Chemical Fabrics and Film Association, Inc.; [www.chemicalfabricsandfilm.com](http://www.chemicalfabricsandfilm.com).
54. CFSEI - Cold-Formed Steel Engineers Institute; [www.cfsei.org](http://www.cfsei.org).
55. CGA - Compressed Gas Association; [www.cganet.com](http://www.cganet.com).
56. CIMA - Cellulose Insulation Manufacturers Association; [www.cellulose.org](http://www.cellulose.org).
57. CISCA - Ceilings & Interior Systems Construction Association; [www.cisca.org](http://www.cisca.org).
58. CISPI - Cast Iron Soil Pipe Institute; [www.cispi.org](http://www.cispi.org).
59. CLFMI - Chain Link Fence Manufacturers Institute; [www.chainlinkinfo.org](http://www.chainlinkinfo.org).
60. CPA - Composite Panel Association; [www.compositepanel.org](http://www.compositepanel.org).
61. CRI - Carpet and Rug Institute (The); [www.carpet-rug.org](http://www.carpet-rug.org).
62. CRRC - Cool Roof Rating Council; [www.coolroofs.org](http://www.coolroofs.org).
63. CRSI - Concrete Reinforcing Steel Institute; [www.crsi.org](http://www.crsi.org).
64. CSA - CSA Group; [www.csa-group.org](http://www.csa-group.org).
65. CSI - Construction Specifications Institute (The); [www.csiresources.org](http://www.csiresources.org).
66. CSSB - Cedar Shake & Shingle Bureau; [www.cedarbureau.org](http://www.cedarbureau.org).
67. CTA - Consumer Technology Association; [www.cta.tech](http://www.cta.tech).

68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); [www.coolingtechnology.org](http://www.coolingtechnology.org).
69. CWC - Composite Wood Council; (See CPA).
70. DASMA - Door and Access Systems Manufacturers Association; [www.dasma.com](http://www.dasma.com).
71. DHA - Decorative Hardwoods Association; (Formerly: Hardwood Plywood & Veneer Association); [www.decorativehardwoods.org](http://www.decorativehardwoods.org).
72. DHI - Door and Hardware Institute; [www.dhi.org](http://www.dhi.org).
73. ECA - Electronic Components Association; (See ECIA).
74. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
75. ECIA - Electronic Components Industry Association; [www.ecianow.org](http://www.ecianow.org).
76. EIA - Electronic Industries Alliance; (See TIA).
77. EIMA - EIFS Industry Members Association; [www.eima.com](http://www.eima.com).
78. EJMA - Expansion Joint Manufacturers Association, Inc.; [www.ejma.org](http://www.ejma.org).
79. EOS/ESD Association; (Electrostatic Discharge Association); [www.esda.org](http://www.esda.org).
80. ESTA - Entertainment Services and Technology Association; (See PLASA).
81. ETL - Intertek (See Intertek); [www.intertek.com](http://www.intertek.com).
82. EVO - Efficiency Valuation Organization; [www.evo-world.org](http://www.evo-world.org).
83. FCI - Fluid Controls Institute; [www.fluidcontrolsinstitute.org](http://www.fluidcontrolsinstitute.org).
84. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); [www.fiba.com](http://www.fiba.com).
85. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); [www.fivb.org](http://www.fivb.org).
86. FM Approvals - FM Approvals LLC; [www.fmglobal.com](http://www.fmglobal.com).
87. FM Global - FM Global; (Formerly: FMG - FM Global); [www.fmglobal.com](http://www.fmglobal.com).
88. FRSA - Florida Roofing, Sheet Metal Contractors Association, Inc.; [www.floridarooft.com](http://www.floridarooft.com).
89. FSA - Fluid Sealing Association; [www.fluidsealing.com](http://www.fluidsealing.com).
90. FSC - Forest Stewardship Council U.S.; [www.fscus.org](http://www.fscus.org).
91. GA - Gypsum Association; [www.gypsum.org](http://www.gypsum.org).
92. GANA - Glass Association of North America; (See NGA).
93. GS - Green Seal; [www.greenseal.org](http://www.greenseal.org).
94. HI - Hydraulic Institute; [www.pumps.org](http://www.pumps.org).
95. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
96. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
97. HPVA - Hardwood Plywood & Veneer Association; (See DHA).
98. HPW - H. P. White Laboratory, Inc.; [www.hpwhite.com](http://www.hpwhite.com).
99. IAPSC - International Association of Professional Security Consultants; [www.iapsc.org](http://www.iapsc.org).
100. IAS - International Accreditation Service; [www.iasonline.org](http://www.iasonline.org).
101. ICBO - International Conference of Building Officials; (See ICC).
102. ICC - International Code Council; [www.iccsafe.org](http://www.iccsafe.org).
103. ICEA - Insulated Cable Engineers Association, Inc.; [www.icea.net](http://www.icea.net).
104. ICPA - International Cast Polymer Association; [www.theicpa.com](http://www.theicpa.com).
105. ICRI - International Concrete Repair Institute, Inc.; [www.icri.org](http://www.icri.org).
106. IEC - International Electrotechnical Commission; [www.iec.ch](http://www.iec.ch).
107. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); [www.ieee.org](http://www.ieee.org).
108. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); [www.ies.org](http://www.ies.org).
109. IESNA - Illuminating Engineering Society of North America; (See IES).
110. IEST - Institute of Environmental Sciences and Technology; [www.iest.org](http://www.iest.org).
111. IGMA - Insulating Glass Manufacturers Alliance; [www.igmaonline.org](http://www.igmaonline.org).

112. IGSHPA - International Ground Source Heat Pump Association; [www.igshpa.org](http://www.igshpa.org).
113. II - Infocomm International; (See AVIXA).
114. ILI - Indiana Limestone Institute of America, Inc.; [www.iliai.com](http://www.iliai.com).
115. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); [www.intertek.com](http://www.intertek.com).
116. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); [www.isa.org](http://www.isa.org).
117. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
118. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); [www.isfanow.org](http://www.isfanow.org).
119. ISO - International Organization for Standardization; [www.iso.org](http://www.iso.org).
120. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
121. ITU - International Telecommunication Union; [www.itu.int](http://www.itu.int).
122. KCMA - Kitchen Cabinet Manufacturers Association; [www.kcma.org](http://www.kcma.org).
123. LMA - Laminating Materials Association; (See CPA).
124. LPI - Lightning Protection Institute; [www.lightning.org](http://www.lightning.org).
125. MBMA - Metal Building Manufacturers Association; [www.mbma.com](http://www.mbma.com).
126. MCA - Metal Construction Association; [www.metalconstruction.org](http://www.metalconstruction.org).
127. MFMA - Maple Flooring Manufacturers Association, Inc.; [www.maplefloor.org](http://www.maplefloor.org).
128. MFMA - Metal Framing Manufacturers Association, Inc.; [www.metalframingmfg.org](http://www.metalframingmfg.org).
129. MHI - Material Handling Industry of America; [www.mhia.org](http://www.mhia.org).
130. MIA - Marble Institute of America; (See NSI).
131. MMPA - Moulding & Millwork Producers Association; [www.wmmpa.com](http://www.wmmpa.com).
132. MPI - Master Painters Institute; [www.paintinfo.com](http://www.paintinfo.com).
133. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; [www.mss-hq.org](http://www.mss-hq.org).
134. NAAMM - National Association of Architectural Metal Manufacturers; [www.naamm.org](http://www.naamm.org).
135. NACE - NACE International; (National Association of Corrosion Engineers International); [www.nace.org](http://www.nace.org).
136. NADCA - National Air Duct Cleaners Association; [www.nadca.com](http://www.nadca.com).
137. NAIMA - North American Insulation Manufacturers Association; [www.naima.org](http://www.naima.org).
138. NALP - National Association of Landscape Professionals; [www.landscapeprofessionals.org](http://www.landscapeprofessionals.org).
139. NBGQA - National Building Granite Quarries Association, Inc.; [www.nbgqa.com](http://www.nbgqa.com).
140. NBI - New Buildings Institute; [www.newbuildings.org](http://www.newbuildings.org).
141. NCAA - National Collegiate Athletic Association (The); [www.ncaa.org](http://www.ncaa.org).
142. NCMA - National Concrete Masonry Association; [www.ncma.org](http://www.ncma.org).
143. NEBB - National Environmental Balancing Bureau; [www.nebb.org](http://www.nebb.org).
144. NECA - National Electrical Contractors Association; [www.necanet.org](http://www.necanet.org).
145. NeLMA - Northeastern Lumber Manufacturers Association; [www.nelma.org](http://www.nelma.org).
146. NEMA - National Electrical Manufacturers Association; [www.nema.org](http://www.nema.org).
147. NETA - InterNational Electrical Testing Association; [www.netaworld.org](http://www.netaworld.org).
148. NFHS - National Federation of State High School Associations; [www.nfhs.org](http://www.nfhs.org).
149. NFPA - National Fire Protection Association; [www.nfpa.org](http://www.nfpa.org).
150. NFPA - NFPA International; (See NFPA).
151. NFRC - National Fenestration Rating Council; [www.nfrc.org](http://www.nfrc.org).
152. NGA - National Glass Association (The); (Formerly: Glass Association of North America); [www.glass.org](http://www.glass.org).
153. NHLA - National Hardwood Lumber Association; [www.nhla.com](http://www.nhla.com).

154. NLGA - National Lumber Grades Authority; [www.nlga.org](http://www.nlga.org).
155. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
156. NOMMA - National Ornamental & Miscellaneous Metals Association; [www.nomma.org](http://www.nomma.org).
157. NRCA - National Roofing Contractors Association; [www.nrca.net](http://www.nrca.net).
158. NRMCA - National Ready Mixed Concrete Association; [www.nrmca.org](http://www.nrmca.org).
159. NSF - NSF International; [www.nsf.org](http://www.nsf.org).
160. NSI - National Stone Institute; (Formerly: Marble Institute of America); [www.naturalstoneinstitute.org](http://www.naturalstoneinstitute.org).
161. NSPE - National Society of Professional Engineers; [www.nspe.org](http://www.nspe.org).
162. NSSGA - National Stone, Sand & Gravel Association; [www.nssga.org](http://www.nssga.org).
163. NTMA - National Terrazzo & Mosaic Association, Inc. (The); [www.ntma.com](http://www.ntma.com).
164. NWFA - National Wood Flooring Association; [www.nwfa.org](http://www.nwfa.org).
165. NWRA - National Waste & Recycling Association; [www.wasterecycling.org](http://www.wasterecycling.org).
166. PCI - Precast/Prestressed Concrete Institute; [www.pci.org](http://www.pci.org).
167. PDI - Plumbing & Drainage Institute; [www.pdionline.org](http://www.pdionline.org).
168. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); [www.plasa.org](http://www.plasa.org).
169. RCSC - Research Council on Structural Connections; [www.boltcouncil.org](http://www.boltcouncil.org).
170. RFCI - Resilient Floor Covering Institute; [www.rfci.com](http://www.rfci.com).
171. RIS - Redwood Inspection Service; [www.redwoodinspection.com](http://www.redwoodinspection.com).
172. SAE - SAE International; [www.sae.org](http://www.sae.org).
173. SCTE - Society of Cable Telecommunications Engineers; [www.scte.org](http://www.scte.org).
174. SDI - Steel Deck Institute; [www.sdi.org](http://www.sdi.org).
175. SDI - Steel Door Institute; [www.steeldoor.org](http://www.steeldoor.org).
176. SEFA - Scientific Equipment and Furniture Association (The); [www.sefalabs.com](http://www.sefalabs.com).
177. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
178. SIA - Security Industry Association; [www.siaonline.org](http://www.siaonline.org).
179. SJI - Steel Joist Institute; [www.steeljoist.org](http://www.steeljoist.org).
180. SMA - Screen Manufacturers Association; [www.smainfo.org](http://www.smainfo.org).
181. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; [www.smacna.org](http://www.smacna.org).
182. SMPTE - Society of Motion Picture and Television Engineers; [www.smpte.org](http://www.smpte.org).
183. SPFA - Spray Polyurethane Foam Alliance; [www.sprayfoam.org](http://www.sprayfoam.org).
184. SPIB - Southern Pine Inspection Bureau; [www.spib.org](http://www.spib.org).
185. SPRI - Single Ply Roofing Industry; [www.spri.org](http://www.spri.org).
186. SRCC - Solar Rating & Certification Corporation; [www.solar-rating.org](http://www.solar-rating.org).
187. SSINA - Specialty Steel Industry of North America; [www.ssina.com](http://www.ssina.com).
188. SSPC - SSPC: The Society for Protective Coatings; [www.sspc.org](http://www.sspc.org).
189. STI - Steel Tank Institute; [www.steeltank.com](http://www.steeltank.com).
190. SWI - Steel Window Institute; [www.steelwindows.com](http://www.steelwindows.com).
191. SWPA - Submersible Wastewater Pump Association; [www.swpa.org](http://www.swpa.org).
192. TCA - Tilt-Up Concrete Association; [www.tilt-up.org](http://www.tilt-up.org).
193. TCNA - Tile Council of North America, Inc.; [www.tileusa.com](http://www.tileusa.com).
194. TEMA - Tubular Exchanger Manufacturers Association, Inc.; [www.tema.org](http://www.tema.org).
195. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); [www.tiaonline.org](http://www.tiaonline.org).
196. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).

197. TMS - The Masonry Society; [www.masonrysociety.org](http://www.masonrysociety.org).
198. TPI - Truss Plate Institute; [www.tpinst.org](http://www.tpinst.org).
199. TPI - Turfgrass Producers International; [www.turfgrasssod.org](http://www.turfgrasssod.org).
200. TRI - Tile Roofing Institute; [www.tilerroofing.org](http://www.tilerroofing.org).
201. UL - Underwriters Laboratories Inc.; [www.ul.com](http://www.ul.com).
202. UNI - Uni-Bell PVC Pipe Association; [www.uni-bell.org](http://www.uni-bell.org).
203. USAV - USA Volleyball; [www.usavolleyball.org](http://www.usavolleyball.org).
204. USGBC - U.S. Green Building Council; [www.usgbc.org](http://www.usgbc.org).
205. USITT - United States Institute for Theatre Technology, Inc.; [www.usitt.org](http://www.usitt.org).
206. WA - Wallcoverings Association; [www.wallcoverings.org](http://www.wallcoverings.org).
207. WCLIB - West Coast Lumber Inspection Bureau; [www.wclib.org](http://www.wclib.org).
208. WCMA - Window Covering Manufacturers Association; [www.wcmanet.org](http://www.wcmanet.org).
209. WDMA - Window & Door Manufacturers Association; [www.wdma.com](http://www.wdma.com).
210. WI - Woodwork Institute; [www.wicnet.org](http://www.wicnet.org).
211. WSRCA - Western States Roofing Contractors Association; [www.wsrca.com](http://www.wsrca.com).
212. WWPA - Western Wood Products Association; [www.wwpa.org](http://www.wwpa.org).

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. IAPMO - International Association of Plumbing and Mechanical Officials; [www.iapmo.org](http://www.iapmo.org).
2. ICC - International Code Council; [www.iccsafe.org](http://www.iccsafe.org).
3. ICC-ES - ICC Evaluation Service, LLC; [www.icc-es.org](http://www.icc-es.org).
4. COE - Army Corps of Engineers; [www.usace.army.mil](http://www.usace.army.mil).
5. CPSC - Consumer Product Safety Commission; [www.cpsc.gov](http://www.cpsc.gov).
6. DOC - Department of Commerce; National Institute of Standards and Technology; [www.nist.gov](http://www.nist.gov).
7. DOD - Department of Defense; [www.quicksearch.dla.mil](http://www.quicksearch.dla.mil).
8. DOE - Department of Energy; [www.energy.gov](http://www.energy.gov).
9. EPA - Environmental Protection Agency; [www.epa.gov](http://www.epa.gov).
10. FAA - Federal Aviation Administration; [www.faa.gov](http://www.faa.gov).
11. FG - Federal Government Publications; [www.gpo.gov/fdsys](http://www.gpo.gov/fdsys).
12. GSA - General Services Administration; [www.gsa.gov](http://www.gsa.gov).
13. HUD - Department of Housing and Urban Development; [www.hud.gov](http://www.hud.gov).
14. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; [www.eetd.lbl.gov](http://www.eetd.lbl.gov).
15. OSHA - Occupational Safety & Health Administration; [www.osha.gov](http://www.osha.gov).
16. SD - Department of State; [www.state.gov](http://www.state.gov).
17. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; [www.trb.org](http://www.trb.org).
18. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; [www.ars.usda.gov](http://www.ars.usda.gov).
19. USDA - Department of Agriculture; Rural Utilities Service; [www.usda.gov](http://www.usda.gov).
20. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; [www.ojp.usdoj.gov](http://www.ojp.usdoj.gov).
21. USP - U.S. Pharmacopeial Convention; [www.usp.org](http://www.usp.org).
22. USPS - United States Postal Service; [www.usps.com](http://www.usps.com).

- D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. CFR - Code of Federal Regulations; Available from Government Printing Office; [www.govinfo.gov](http://www.govinfo.gov).
  2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; [www.quicksearch.dla.mil](http://www.quicksearch.dla.mil).
  3. DSCC - Defense Supply Center Columbus; (See FS).
  4. FED-STD - Federal Standard; (See FS).
  5. FS - Federal Specification; Available from DLA Document Services; [www.quicksearch.dla.mil](http://www.quicksearch.dla.mil).
    - a. Available from Defense Standardization Program; [www.dsp.dla.mil](http://www.dsp.dla.mil).
    - b. Available from General Services Administration; [www.gsa.gov](http://www.gsa.gov).
    - c. Available from National Institute of Building Sciences/Whole Building Design Guide; [www.wbdg.org](http://www.wbdg.org).
  6. MILSPEC - Military Specification and Standards; (See DOD).
  7. USAB - United States Access Board; [www.access-board.gov](http://www.access-board.gov).
  8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

## SECTION 015001 - TEMPORARY FACILITIES AND CONTROLS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
  - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

#### 1.2 USE CHARGES

- A. Installation, removal, and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.
- B. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use. Provide connections and extensions of services as required for construction operations.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- D. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
  - 1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.



2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
  3. Indicate methods to be used to avoid trapping water in finished work.
- E. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
1. Locations of dust-control partitions at each phase of work.
  2. HVAC system isolation schematic drawing.
  3. Location of proposed air-filtration system discharge.
  4. Waste-handling procedures.
  5. Other dust-control measures.
- F. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by the Owner. Include the following:
1. Methods used to meet the goals and requirements of the Owner.
  2. Concrete cutting method(s) to be used.
  3. Location of construction devices on the site.
  4. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.
  5. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with the Owner.
  6. Indicate locations of sensitive areas or other areas requiring special attention as identified by Owner. Indicate means for complying with Owner's requirements

#### 1.4 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

#### 1.5 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.



## PART 2 - PRODUCTS

### 2.1 TEMPORARY FACILITIES

#### A. MATERIALS

1. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil (0.25-mm) minimum thickness, with flame-spread rating of 15 or less in accordance with ASTM E84 and passing NFPA 701 Test Method 2.
2. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats, minimum 36 by 60 inches (914 by 1524 mm).
3. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

#### B. Field Offices: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading

#### C. Contractor Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
2. Conference room of sufficient size to accommodate meetings of **10** individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot square tack and marker boards.
3. Drinking water and private toilet.
4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
5. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.

#### D. Construction Management Field Office: separate from contractor field office and of sufficient size, minimum 40ft length to accommodate needs of construction manager personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
2. (2) private offices each of sufficient size to accommodate one occupant each. Furnish each office with a desk, desk chair, file cabinet, with electrical power service and 120-vac duplex receptacles on no fewer than 2.
3. Conference room of sufficient size to accommodate meetings of **10** individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot square tack and marker boards.
4. Drinking water and private toilet.

5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
6. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.
7. Provide mobile wireless data connection for use of construction manager personnel such as Verizon Fios 400Mbps service (or equal).

## 2.2 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
  1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
  2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
    - a. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
  3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of each month and at the end of construction and clean HVAC system as required in Section 01 7700 "Closeout Procedures."
- C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

## 2.3 RODENT CONTROL

- A. Institute an effective program of rodent control for the entire site within the construction limits. Cooperate with local authorities and provide the regular services of an experienced exterminator who shall visit the site at least once a month for the entire construction period. Provide marked metal containers for all edible rubbish and enforce their use by all employees. Containers shall be emptied and the contents removed from the site as often as required to maintain an adequate rodent control program. If the program of rodent control used is not effective, take whatever steps are necessary to rid the project of rodents, and such action shall not be the basis of a claim for additional compensation or damages.

## 2.4 TEMPORARY CONSTRUCTION OPENINGS

- A. A. Provide openings in slabs, walls, and partitions where required for moving in large pieces of equipment of all types, ductwork, piping or other assemblies. Close and/or restore all openings and finish them after the equipment is in place. Structural modification, if required, shall be subject to review by the Architect.

## 2.5 TEMPORARY FENCE

- A. Provide and maintain an 8 foot high temporary chain-link fence to enclose the area at the job site and separate staging area and to guard and close effectively the designated area. Provide gates at locations where required for access to the enclosed area. Gates shall be cross-braced, hung on heavy strap hinges, and shall have hasps and padlocks. Submit shop drawings of fence and gates for review of Architect and Owner. Contractor shall ensure that fence is padlocked each night and keep gate closed during daytime activities. Contractor is responsible for keeping pedestrian traffic and vehicles out of worksite
  - 1. Fencing to be provided with full height privacy screen or slats restricting all views
  - 2. Privacy screening if used shall have pre-cut holes for wind. Any torn or ripped panels shall be replaced immediately at contractor expense.
  - 3. Fencing posts shall be driven along full length of Hooper Ave and Indian trail.
  - 4. Remove the fence and all posts upon completion of the work or at such time before final completion as directed by the Owner.

## 2.6 FIRE PROTECTION

- A. Provide and maintain adequate fire protection, ready for instant use, distributed around the project.
- B. Make arrangements for periodical inspection by local fire protection authorities and insurance underwriters inspections. Cooperate with said authorities and promptly carry out their recommendations.
- C. Open fire will not be permitted within the building enclosure or on the project site.

## 2.7 TEMPORARY HEAT AND VENTILATION

- A. Provide and pay for temporary heat including all fuel and equipment rentals as required during construction to protect the work from freezing or frost damage, and as necessary to ensure suitable working conditions for the construction operations of all trades. In areas of the building where work is being conducted, the temperature shall be maintained as specified in the various sections of the Specifications, but not less than 45 degrees Fahrenheit. Under no circumstances shall the temperature be allowed to reach a level that will cause damage to any portion of the work which may be subject to damage by low temperatures.
- B. Until the building, or any major portion thereof, is enclosed, temporary heating shall be by smokeless portable unit heaters of type listed by Underwriter's Laboratories, Factory Mutual, and the Fire Marshall. Pay for fuel, maintenance, and attendants required in connection with the portable unit heaters. Interior or exterior surfaces damaged by the use of these space heaters shall be replaced by new materials or be refinished.
- C. The building shall be considered enclosed when it has reached the stage when exterior walls have been erected, the roof substantially completed, exterior openings closed up
- D. either by the permanently glazed windows and doors, or by adequate temporary closing, and the building is ready for interior masonry and plastering operations.

- E. After the building, or any major portion thereof, has been enclosed, the permanent heating system as specified below may be used for temporary heat.
- F. When the permanent heating system, or a suitable portion thereof, is in operating condition, the system may be used for temporary heating, provided that the Contractor assumes full responsibility for the entire heating system, and pays all costs for fuel, operation, maintenance, and restoration of the system.
- G. Provide adequate ventilation and dehumidification as required to keep the temperature of the building within 10 degrees Fahrenheit of the ambient outdoor temperature when such ambient temperature exceeds 70 degrees Fahrenheit, interior humidity below dew point during any period of time, and to prevent accumulation of excess moisture or to prevent excess thermal movement in the building.
- H. When the permanent air circulation system, or a suitable portion thereof, is in operating condition, it may be used without refrigeration or chilling, provided that the Contractor assumes full responsibility for the system which he is using, and pays costs for power, operation, maintenance, and restoration of the system. Provide temporary filters to adequately filter air being distributed through the duct work to the supply outlets; disposable filters shall be placed in front of all exhaust registers to keep construction dirt out of exhaust duct work. The Contractor shall thoroughly clean the interior of the air handling units and duct work prior to acceptance of the work.
- I. Upon conclusion of the temporary heating period, remove all temporary piping, temporary heating units, or other equipment and pay all costs in connection with repairing any damage caused by the installation or removal of temporary heating equipment. Thoroughly clean and recondition those parts of permanent heating and air circulation systems used for temporary service.

## **2.8 TEMPORARY LIGHT AND POWER**

- A. Make all arrangements with and pay for the local electric company for temporary electrical service to the construction site and construction trailers and staging area; provide all equipment necessary for temporary power and lighting; and pay all charges for this equipment, the installation thereof, and for current used. The electrical service shall be of 120v and 240v for single phase loads up to 30 amps for all construction tools and equipment without overloading the temporary facilities and shall be made available for power, lighting, and construction operations of all trades.
- B. In addition to the electrical service, provide power distribution as required throughout structure. The terminations of power distribution shall be at convenient locations in the building. Terminations shall be provided for each voltage supply complete with circuit breakers, disconnect switches, and other electrical devices as required to protect the power supply system.
- C. Provide double duplex outlets at not more than 200' o.c. both directions throughout this building.
- D. A temporary lighting system shall be furnished, installed, and maintained as required to satisfy minimum requirements of safety and security. The temporary lighting system shall afford

general illumination in all building areas and shall supply not less than 150 watt lamps on 30' centers both directions of floor area for illumination in the areas of the building where work is being performed.

- E. All temporary equipment and wiring for power and lighting shall be in accordance with the applicable provisions of the governing codes. All temporary wiring shall be maintained in a safe manner and used so as not to constitute a hazard to persons or property.
- F. When the permanent electrical power and lighting systems are in operating condition, they may be used for temporary power and lighting for construction purposes, provided that the Contractor assumes full responsibility for the entire power and lighting system, and pays costs for power, operations, maintenance, and restoration of the system.

## **2.9 TEMPORARY ACCESS TO SITE**

- A. Construct and maintain in good usable condition all required temporary access to site, and, when no longer required, remove all temporary construction and restore the site.
- B. Where streets now in use are within or adjacent to the work, keep the passageways of such streets open to vehicular and pedestrian traffic to building fronting thereon. Maintain constant access for police, fire and ambulance service.
- C. Mud carried off the site and into public roads shall be removed immediately by the Contractor.
- D. Provide dust-control treatment that is nonpolluting and non-tracking. Reapply treatment as required to minimize dust.
- E. Access to the site for delivery of construction material or equipment shall be made only from locations designated by the Architect.

## **2.10 TEMPORARY STAIRS, LADDERS, RAMPS, SIDEWALK BRIDGING AND RUNWAYS**

- A. Provide and maintain all equipment such as temporary stairs, ladders, ramps, runways, and chutes as required for the proper execution of the work.
- B. All such apparatus, equipment, and construction shall meet all requirements of the Labor Law and other state or local laws applicable thereto.
- C. As soon as permanent stairs are erected, provide temporary protective treads, handrails, and shaft protection.
- D. Provide wood plank overhead decking, protective plywood enclosure walls, handrails, barricades, warning signs, lights, safe and well drained walkways, and similar provisions for protection and safe passage.
- E. Extend back wall beyond the structure to complete enclosure fence.
- F. Paint and maintain in a manner approved by Owner and Architect.

- G. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8" thick exterior plywood.

## 2.11 TEMPORARY TOILETS

- A. Provide and maintain in a sanitary condition enclosed weathertight toilets for the use of all construction personnel at a location within the contract limits. Upon completion of the work, toilets shall be removed. Installation shall be in accordance with all applicable codes and regulations of authorities having jurisdiction. The number of toilet rooms required shall be in accordance with the ANSI Standard Safety Code for Building Construction or other local authorities.

## 2.12 WATER AND SNOW CONTROL

- A. A. From the commencement of the construction to the completion of the work, keep all parts of the site and the project free from accumulation of water, and supply, maintain, and operate all necessary pumping and bailing equipment.
- B. Remove snow and ice as necessary for the protection and prosecution of the work, and protect the work against weather damage.
- C. The Contractor shall take over responsibility for site drainage upon entering the premises and shall maintain such drainage until completion of the work so as not to adversely affect the adjacent areas.

## 2.13 ENVIRONMENTAL CONTROLS

- A. The Contractor shall comply with all applicable Federal, State and local laws, regulations, ordinances, codes and standards concerning environment control. Particular attention shall be given, without limitations, to:
  - 1. Minimization of dust, containment of chemical vapors, control of engine exhaust gases, and control of smoke from temporary heaters.
  - 2. Reduction of water pollution by control of sanitary facilities, proper storage of fuels and other potential contaminants, and prevention of siltation from land erosion.
  - 3. Minimization of noise levels.
  - 4. Proper and legal disposal, off site unless otherwise provided, of waste and spoil resulting from construction activities.
- B. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
  - 1. Remove snow and ice as required to minimize accumulations.
- C. Traffic Control Devices and Work in Right of Ways:
  - 1. Contractor shall make all arrangements, gain all permits and pay for all costs associated with road closures, lane closures, and traffic control measures required by the township,

county, state, and other Authorities have jurisdiction over any public right of way impacted by the work. Refer also to stage and phasing plan of the contract documents.

### **PART 3 - EXECUTION**

#### **3.1 TEMPORARY FACILITIES, GENERAL**

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
  - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

#### **3.2 INSTALLATION, GENERAL**

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

#### **3.3 TEMPORARY UTILITY INSTALLATION**

- A. General: Install temporary service or connect to existing service.
  - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
  - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- E. Temporary Heating and Cooling: Provide temporary heating and cooling including all fuel required by construction activities for curing or drying of completed installations or for

protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

- F. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
  - 1. Install electric power service overhead unless otherwise indicated.
- G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
  - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- H. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install WiFi cell phone access equipment.
- I. Electronic Communication Service: Provide secure WiFi wireless connection to internet with provisions for access by Architect and Owner.

### 3.4 SUPPORT FACILITIES INSTALLATION

- A. Comply with the following:
  - 1. Provide construction for temporary field offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E136. Comply with NFPA 241.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations.
  - 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
  - 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
  - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: Provide temporary onsite parking areas for construction personnel.
- E. Storage and Staging: Provide temporary onsite area for storage and staging needs.
- F. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
  - 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
  - 2. Remove snow and ice as required to minimize accumulations.



- G. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
  - 1. Identification Signs: Provide Project identification signs as indicated on Drawings.
  - 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
    - a. Provide temporary, directional signs for construction personnel and visitors.
  - 3. Maintain and touch up signs so they are legible at all times.
- H. Waste Disposal Facilities: Comply with requirements specified in Section 01 7419 "Construction Waste Management and Disposal."
- I. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."
- J. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
  - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

### 3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
  - 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. Temporary Erosion and Sedimentation Control: Comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Section 31 1000 "Site Clearing."
- D. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings.
  - 1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
  - 2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
  - 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.

4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
  - E. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
  - F. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
  - G. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
  - H. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
    1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
  - I. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
  - J. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
  - K. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.
  - L. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
    1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- 3.6 MOISTURE AND MOLD CONTROL
- A. Moisture and Mold Protection: Protect stored materials and installed Work in accordance with Moisture and Mold Protection Plan.
  - B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
    1. Protect porous materials from water damage.

2. Protect stored and installed material from flowing or standing water.
  3. Keep porous and organic materials from coming into prolonged contact with concrete.
  4. Remove standing water from decks.
  5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
  2. Keep interior spaces reasonably clean and protected from water damage.
  3. Periodically collect and remove waste containing cellulose or other organic matter.
  4. Discard or replace water-damaged material.
  5. Do not install material that is wet.
  6. Discard and replace stored or installed material that begins to grow mold.
  7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.
- D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
  2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
  3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

### 3.7 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

## SECTION 016000 - PRODUCT REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and equivalent (comparable) products.
- B. Related Requirements:
  - 1. Section 012500 "Substitution Procedures" for requests for substitutions.

#### 1.2 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
  - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
  - 2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.
  - 3. Equivalent Product: Product by named manufacturer that is demonstrated and approved through the equivalent product submittal process described in Part 2 "Equivalent Products" Article submitted by contractor as an "equal", to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.
  - 1. Evaluation of Equivalent Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating equivalent products of additional manufacturers named in the specification. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating equivalent products.

- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a equivalent product request or substitution request, if applicable.
- D. Equivalent (comparable) Product Request Submittal: An action submittal requesting consideration of a equivalent product, including the following information:
  - 1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
  - 2. Data indicating compliance with the requirements specified in Part 2 "Equivalent Products" Article.
- E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."
- F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

### 1.3 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

### 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

### 1.5 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
  - 1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Owner or endorsed by manufacturer to Owner.

2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of the Owner or endorsed by manufacturer to Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
  3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

## **PART 2 - PRODUCTS**

### **2.1 PRODUCT SELECTION PROCEDURES**

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
  4. Where products are accompanied by the term "as selected," Architect will make selection.
  5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
1. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.
    - a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
    - b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.
  2. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.

- a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
    - b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements..
  3. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, provide the specified or indicated product or a equivalent product for evaluation. Equivalent products may be by a named or unnamed manufacturer. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Equivalent Products" Article for consideration of an equivalent and equivalent product by a different manufacturer or an unnamed product by one of the named manufacturers.
  - C. Visual Matching Specification: Where Specifications require the phrase "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
    1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
  - D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.
  - E. Sustainable Product Selection: Where Specifications require product to meet sustainable product characteristics, select products complying with indicated requirements. Comply with requirements in Division 01 sustainability requirements Section and individual Specification Sections.
- ## 2.2 EQUIVALENT (COMPARABLE) PRODUCTS
- A. Conditions for Consideration of equivalent Products: Architect will consider Contractor's request for equivalent product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with the following requirements. Contractor may submit additional evidence of equivalency for product or shall submit named or specified product:
    1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
    2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes, such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
    3. Evidence that proposed product provides specified warranty.



4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
  5. Samples, if requested.
  6. By submission of equivalent product contractor acknowledges familiarity and suitability of the product for its application and responsibility for coordination with adjacent work or trades to install and integrate equivalent product into the work whether difference are identified when submitted or not.
- B. Architect's Action on equivalent (comparable) Products Submittal: If necessary, Architect will request additional information or documentation for evaluation, as specified in Section 013300 "Submittal Procedures."
1. Form of Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
  2. Use product specified if Architect does not issue a decision on use of a equivalent product request within time allocated.
- C. Submittal Requirements, Two-Step Process: Approval by the Architect of Contractor's request for use of equivalent product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.
- D. Submittal Requirements, Single-Step Process: When acceptable to Architect, incorporate specified submittal requirements of individual Specification Section in combined submittal for equivalent products. Approval by the Architect of Contractor's request for use of equivalent product and of individual submittal requirements will also satisfy other submittal requirements.

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION 016000**

## SECTION 017300 - EXECUTION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
  - 1. Construction layout.
  - 2. Field engineering and surveying.
  - 3. Installation of the Work.
  - 4. Cutting and patching.
  - 5. Coordination of Owner's portion of the Work.
  - 6. Coordination of Owner-installed products.
  - 7. Progress cleaning.
  - 8. Starting and adjusting.
  - 9. Protection of installed construction.
  - 10. Correction of the Work.
- B. Related Requirements:
  - 1. Section 011000 "Summary" for coordination of Owner-furnished products and limits on use of Project site.
  - 2. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.

#### 1.2 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Certified Surveys: Submit two original hardcopies signed by land surveyor and digital PDF to Architect and Owner.
- B. Certificates: Submit certificate signed by land surveyor, certifying that location and elevation of improvements comply with requirements.

## 1.4 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
  - 1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
  - 2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
  - 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
  - 4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
  - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.
- C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, and other construction affecting the Work.
  1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
  2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
  1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
  1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
  2. List of detrimental conditions, including substrates.
  3. List of unacceptable installation tolerances.
  4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### **3.2 PREPARATION**

- A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility

appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect in accordance with requirements in Section 013100 "Project Management and Coordination."

### 3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Architect promptly.
- B. Engage a land surveyor experienced in laying out the Work, using the following accepted surveying practices:
  - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
  - 2. Establish limits on use of Project site.
  - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
  - 4. Inform installers of lines and levels to which they must comply.
  - 5. Check the location, level and plumb, of every major element as the Work progresses.
  - 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
  - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

### 3.4 FIELD ENGINEERING

- A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
  - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
  - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
  - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
  - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
  - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- C. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- D. Final Property Survey: Engage a land surveyor to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
  - 1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.

### 3.5 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb, and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
  - 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and [90 inches (2300 mm)] in unoccupied spaces, unless otherwise indicated on Drawings.

- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.
- F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
  - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
  - 2. Allow for building movement, including thermal expansion and contraction.
  - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Architect. Fit exposed connections together to form hairline joints.

### **3.6 CUTTING AND PATCHING**

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of Work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching in accordance with requirements in Section 011000 "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
  - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.
  - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
  - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
    - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    - b. Restore damaged pipe covering to its original condition.
  - 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall



coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

- a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.
4. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

### 3.7 COORDINATION OF OWNER'S PORTION OF THE WORK

- A. Site Access: Provide access to Project site for Owner's construction personnel.
  1. Provide temporary facilities required for Owner-furnished, Contractor-installed products.
  2. Refer to Section 01 1000 "Summary" for other requirements for Owner-furnished, Contractor-installed products
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
  1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.

### 3.8 PROGRESS CLEANING

- A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
  1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
  3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
    - a. Use containers intended for holding waste materials of type to be stored.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
  2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls" and Section 01 7419 "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

### 3.9 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 01 9113 "General Commissioning Requirements."
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 01 4000 "Quality Requirements."

**3.10 PROTECTION OF INSTALLED CONSTRUCTION**

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

**3.11 CORRECTION OF THE WORK**

- A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Restore permanent facilities used during construction to their specified condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

## SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
  - 1. Salvaging nonhazardous demolition and construction waste.
  - 2. Recycling nonhazardous demolition and construction waste.
  - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
  - 1. Section 042000 "Unit Masonry" for disposal requirements for masonry waste.

#### 1.2 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

#### 1.3 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 30 days of date established for commencement of the Work.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Include the following information:
  - 1. Material category.
  - 2. Generation point of waste.
  - 3. Total quantity of waste in tons.
  - 4. Quantity of waste salvaged, both estimated and actual in tons.
  - 5. Quantity of waste recycled, both estimated and actual in tons.
  - 6. Total quantity of waste recovered (salvaged plus recycled) in tons.
  - 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

#### 1.5 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements.
- B. If including refrigerant recovery in this Section, retain first "Refrigerant Recovery Technician Qualifications" Paragraph below and delete second paragraph. Refrigerant Recovery Technician Qualifications: Universal certified by EPA-approved certification program.
- C. Refrigerant Recovery Technician Qualifications: Comply with requirements in Section 02 4116 "Structure Demolition."
- D. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

## 1.6 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
  - 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
  - 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
  - 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
  - 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
  - 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
  - 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of 50 percent by weight of total nonhazardous solid waste generated by the Work. Facilitate recycling and salvage of materials.

## PART 3 - EXECUTION

### 3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
  - 1. Distribute waste management plan to everyone concerned within **three** days of submittal return.
  - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
  - 2. Comply with Section 01 5000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

### 3.2 SALVAGING DEMOLITION WASTE

- A. Comply with requirements in Section 02 4116 "Structure Demolition" for salvaging demolition waste.
- B. Salvaged Items for Reuse in the Work:
  - 1. Clean salvaged items.
  - 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
  - 3. Store items in a secure area until installation.
  - 4. Protect items from damage during transport and storage.
  - 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- C. Salvaged Items for Sale: Not permitted on Project site.
- D. Salvaged Items for Owner's Use:
  - 1. Clean salvaged items.
  - 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
  - 3. Store items in a secure area until delivery to Owner.
  - 4. Transport items to Owner's storage area designated by Owner.
  - 5. Protect items from damage during transport and storage.

### 3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Owner.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
  - 1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
    - a. Inspect containers and bins for contamination and remove contaminated materials if found.
  - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
  - 4. Store components off the ground and protect from the weather.
  - 5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

### 3.4 RECYCLING DEMOLITION WASTE

- A. Asphalt Paving: Grind asphalt to maximum 4-inch (100-mm).
- B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
- C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
  - 1. Pulverize concrete to maximum 4-inch (100-mm) size.
- D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
  - 1. Pulverize masonry to maximum 4-inch (100-mm) size.
  - 2. Clean and stack undamaged, whole masonry units on wood pallets.
- E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- F. Metals: Separate metals by type.



1. Structural Steel: Stack members according to size, type of member, and length.
  2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
- H. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
- I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
- J. Metal Suspension System: Separate metal members, including trim and other metals from acoustical panels and tile, and sort with other metals.
- K. Carpet Tile: Remove debris, trash, and adhesive.
1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.
- L. Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.
- M. Conduit: Reduce conduit to straight lengths and store by material and size.
- N. Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

### 3.5 RECYCLING CONSTRUCTION WASTE

- A. Packaging:
1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
  2. Polystyrene Packaging: Separate and bag materials.
  3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
  4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
- B. Wood Materials:
1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
  2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
- C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.
1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

- D. Paint: Seal containers and store by type.

### 3.6 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
  - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.

END OF SECTION 017419

## SECTION 017700 - CLOSEOUT PROCEDURES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
  - 1. Substantial Completion procedures.
  - 2. Final completion procedures.
  - 3. Warranties.
  - 4. Final cleaning.
- B. Related Requirements:
  - 1. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
  - 2. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
  - 3. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest-control inspection.

#### 1.4 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.

- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
  2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
  3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.
  5. Submit testing, adjusting, and balancing records.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
  2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
  3. Complete startup and testing of systems and equipment.
  4. Perform preventive maintenance on equipment used prior to Substantial Completion.
  5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
  6. Advise Owner of changeover in utility services.
  7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
  8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
  9. Complete final cleaning requirements.
  10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

## 1.5 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:
  - 1. Submit a final Application for Payment in accordance with Section 01 2900 "Payment Procedures."
  - 2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
  - 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
  - 4. Submit pest-control final inspection report.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

## 1.6 LIST OF INCOMPLETE ITEMS

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
  - 1. Organize list of spaces in sequential order, listed by room or space number.
  - 2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
  - 3. Include the following information at the top of each page:
    - a. Project name.
    - b. Date.
    - c. Name of Architect.
    - d. Name of Contractor.
    - e. Page number.
  - 4. Submit list of incomplete items in the following format:
    - a. MS Excel Electronic File: Architect, through Construction Manager if hired by owner, will return annotated file.

## 1.7 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial

Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.

- B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- C. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
  - 1. Submit on digital media acceptable to Architect.
- D. Warranties in Paper Form:
  - 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper.
- E. Provide additional copies of each warranty to include in operation and maintenance manuals.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
  - 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

## **PART 3 - EXECUTION**

### **3.1 FINAL CLEANING**

- A. Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
    - a. Clean Project site of rubbish, waste material, litter, and other foreign substances.

- b. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
  - c. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
  - d. Clean flooring, removing debris, dirt, and staining; clean according to manufacturer's recommendations.
  - e. Vacuum and mop concrete.
  - f. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
  - g. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
  - h. Remove labels that are not permanent.
  - i. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
  - j. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
  - k. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
  - l. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
  - m. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
  - n. Clean strainers.
  - o. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.

### 3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations required by Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 017700

## **SECTION 017823 - OPERATION AND MAINTENANCE DATA**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. Operation and maintenance documentation directory manuals.
  - 2. Emergency manuals.
  - 3. Systems and equipment operation manuals.
  - 4. Systems and equipment maintenance manuals.
  - 5. Product maintenance manuals.

#### **1.2 CLOSEOUT SUBMITTALS**

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
  - 1. Architect will comment on whether content of operation and maintenance submittals is acceptable.
  - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
  - 1. Submit on digital media acceptable to Architect. Enable reviewer comments on draft submittals.
- C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect will return copy with comments.
  - 1. Correct or revise each manual to comply with Architect's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.
- D. Comply with Section 01 7700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.



### 1.3 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
  - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
  - 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

### 1.4 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
  - 1. Title page.
  - 2. Table of contents.
  - 3. Manual contents.
- B. Title Page: Include the following information:
  - 1. Subject matter included in manual.
  - 2. Name and address of Project.
  - 3. Name and address of Owner.
  - 4. Date of submittal.
  - 5. Name and contact information for Contractor.
  - 6. Name and contact information for Construction Manager.
  - 7. Name and contact information for Architect.
  - 8. Name and contact information for Commissioning Authority.
  - 9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
  - 10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the

Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

## **1.5 EMERGENCY MANUALS**

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
  - 1. Type of emergency.
  - 2. Emergency instructions.
  - 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
  - 1. Fire.
  - 2. Flood.
  - 3. Gas leak.
  - 4. Water leak.
  - 5. Power failure.
  - 6. Water outage.
  - 7. System, subsystem, or equipment failure.
  - 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
  - 1. Instructions on stopping.
  - 2. Shutdown instructions for each type of emergency.
  - 3. Operating instructions for conditions outside normal operating limits.
  - 4. Required sequences for electric or electronic systems.
  - 5. Special operating instructions and procedures.

## **1.6 SYSTEMS AND EQUIPMENT OPERATION MANUALS**

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
  2. Performance and design criteria if Contractor has delegated design responsibility.
  3. Operating standards.
  4. Operating procedures.
  5. Operating logs.
  6. Wiring diagrams.
  7. Control diagrams.
  8. Piped system diagrams.
  9. Precautions against improper use.
  10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
  2. Manufacturer's name.
  3. Equipment identification with serial number of each component.
  4. Equipment function.
  5. Operating characteristics.
  6. Limiting conditions.
  7. Performance curves.
  8. Engineering data and tests.
  9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
  2. Equipment or system break-in procedures.
  3. Routine and normal operating instructions.
  4. Regulation and control procedures.
  5. Instructions on stopping.
  6. Normal shutdown instructions.
  7. Seasonal and weekend operating instructions.
  8. Required sequences for electric or electronic systems.
  9. Special operating instructions and procedures.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

## 1.7 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds, as described below.
- C. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
  - 1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
    - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
  - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
  - 3. Identification and nomenclature of parts and components.
  - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
  - 1. Test and inspection instructions.
  - 2. Troubleshooting guide.
  - 3. Precautions against improper maintenance.
  - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - 5. Aligning, adjusting, and checking instructions.
  - 6. Demonstration and training video recording, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

- H. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

## 1.8 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Product Information: Include the following, as applicable:
  1. Product name and model number.
  2. Manufacturer's name.
  3. Color, pattern, and texture.
  4. Material and chemical composition.
  5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
  1. Inspection procedures.
  2. Types of cleaning agents to be used and methods of cleaning.
  3. List of cleaning agents and methods of cleaning detrimental to product.
  4. Schedule for routine cleaning and maintenance.
  5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
  1. Include procedures to follow and required notifications for warranty claims.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

## SECTION 017830 - WARRANTIES

### PART 1 - GENERAL

#### 1.01 Guarantees and Warranties

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of obligations under requirements of the Contract Documents.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
  - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  - 2. Refer to other Divisions for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 1 Section "Closeout Procedures."
- D. Period for all guarantees and warranties shall commence at date of substantial completion for each phase of work. Multiple guarantees and warranties are required and shall be provided for each of the three phases as defined on drawing C-04.
- E. Refer to the Instructions to Bidders and the General Conditions for terms of the Contractor's warranty of workmanship and materials. The project Maintenance Bond is to hold good for one (1) years, which is the minimum general standard warranty for the Work, unless a period of greater warranty is specifically set forth within the individual technical specification sections.
- F. Submittal Time: Submit written warranties on request of Owner for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- G. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- H. Organize warranty documents for each phase into an orderly sequence based on the table of contents of the Project Manual.
  - 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2 by 11-inch paper.
  - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
  - 3. Identify each binder on the front and spine with the typed title, "Warranties," Project Name, and name of Contractor.
- I. Provide additional copies of each warranty to include in operation and maintenance manuals.
- J. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace

components of units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than seven (7) years from the date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than ten (10) years from the date of Substantial Completion.
3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three (3) years from the date of Substantial Completion.

1.02 GENERAL CONSTRUCTION

- A. Refer to the Technical Specifications for the warranties pertaining to each division.

1.03 STANDARD MANUFACTURER WARRANTIES/GUARANTEES

- A. Unless otherwise noted in specifications, contractor shall provide standard of the industry and acceptable warranties/guarantees provided by all manufacturers of products used on this project. Warranties/guarantees shall commence at date of substantial completion for each phase as determined by the Architect and Construction Manager. Review each Technical Section for other warranty requirements.

END OF SECTION 017830

## SECTION 017839 - PROJECT RECORD DOCUMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
  - 1. Record Drawings.
  - 2. Record specifications.
  - 3. Record Product Data.
- B. Related Requirements:
  - 1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

#### 1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
  - 1. Number of Copies: Submit **one** set of marked-up record prints.
  - 2. Number of Copies: Submit copies of Record Drawings as follows:
    - a. Initial Submittal:
      - 1) Submit PDF electronic files of scanned record prints and one set of file prints.
      - 2) Submit Record Digital Data Files and one set of plots.
      - 3) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
    - b. Final Submittal:
      - 1) Submit PDF electronic files of scanned Record Prints.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and Contract modifications.

#### 1.3 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
  - 1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data,



whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

- a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
  - b. Accurately record information in an acceptable drawing technique.
  - c. Record data as soon as possible after obtaining it.
  - d. Record and check the markup before enclosing concealed installations.
  - e. Cross-reference record prints to corresponding photographic documentation.
2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Dimensional changes to Drawings.
    - b. Revisions to details shown on Drawings.
    - c. Depths of foundations.
    - d. Locations and depths of underground utilities.
    - e. Revisions to routing of piping and conduits.
    - f. Revisions to electrical circuitry.
    - g. Actual equipment locations.
    - h. Duct size and routing.
    - i. Locations of concealed internal utilities.
  3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
  4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
  5. Mark important additional information that was either shown schematically or omitted from original Drawings.
  6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Same digital data software program, version, and operating system as for the original Contract Drawings.
  2. Format: DWG, Version 2017.
  3. Format: Annotated PDF electronic file.
  4. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
  5. Refer instances of uncertainty to Architect for resolution.
  6. Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Identification: As follows:
  - a. Project name.
  - b. Date.
  - c. Designation "PROJECT RECORD DRAWINGS."
  - d. Name of Architect.
  - e. Name of Contractor.

#### 1.4 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.
  1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
  3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
  4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
  5. Note related Change Orders and Record Drawings where applicable.
- B. Format: Submit record specifications as annotated PDF electronic file.

#### 1.5 RECORD PRODUCT DATA

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until end of Project.
- B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
  1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
  3. Note related Change Orders and Record Drawings where applicable.
- C. Format: Submit Record Product Data as annotated PDF electronic file.

1. Include Record Product Data directory organized by Specification Section number and title, electronically linked to each item of Record Product Data.

**1.6 MAINTENANCE OF RECORD DOCUMENTS**

- A. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.
- B. Retention of record shall be performed in accordance with NJAC 17:44-2.2
  1. The contractor shall maintain all documentation related to products, transactions or services under this contract for a period of five years from the date of final payment. Such records shall be made available to the New Jersey Office of the State Comptroller upon request."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017839

## SECTION 017900 - DEMONSTRATION AND TRAINING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
  - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.
  - 2. Demonstration and training video recordings.

#### 1.2 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
  - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
  - 1. At completion of training, submit complete training manual(s) for Owner's use prepared in same PDF file format required for operation and maintenance manuals specified in Section 01 7823 "Operation and Maintenance Data."

#### 1.4 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

## 1.5 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.

## 1.6 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
  - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
    - a. System, subsystem, and equipment descriptions.
    - b. Performance and design criteria if Contractor is delegated design responsibility.
    - c. Operating standards.
    - d. Regulatory requirements.
    - e. Equipment function.
    - f. Operating characteristics.
    - g. Limiting conditions.
    - h. Performance curves.
  - 2. Documentation: Review the following items in detail:
    - a. Emergency manuals.
    - b. Systems and equipment operation manuals.
    - c. Systems and equipment maintenance manuals.
    - d. Product maintenance manuals.
    - e. Project Record Documents.
    - f. Identification systems.
    - g. Warranties and bonds.
    - h. Maintenance service agreements and similar continuing commitments.
  - 3. Emergencies: Include the following, as applicable:
    - a. Instructions on meaning of warnings, trouble indications, and error messages.
    - b. Instructions on stopping.

- c. Shutdown instructions for each type of emergency.
  - d. Operating instructions for conditions outside of normal operating limits.
  - e. Sequences for electric or electronic systems.
  - f. Special operating instructions and procedures.
- 4. Operations: Include the following, as applicable:
  - a. Startup procedures.
  - b. Equipment or system break-in procedures.
  - c. Routine and normal operating instructions.
  - d. Regulation and control procedures.
  - e. Control sequences.
  - f. Safety procedures.
  - g. Instructions on stopping.
  - h. Normal shutdown instructions.
  - i. Operating procedures for emergencies.
  - j. Operating procedures for system, subsystem, or equipment failure.
  - k. Seasonal and weekend operating instructions.
  - l. Required sequences for electric or electronic systems.
  - m. Special operating instructions and procedures.
- 5. Adjustments: Include the following:
  - a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
- 6. Troubleshooting: Include the following:
  - a. Diagnostic instructions.
  - b. Test and inspection procedures.
- 7. Maintenance: Include the following:
  - a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of cleaning agents and methods of cleaning detrimental to product.
  - d. Procedures for routine cleaning.
  - e. Procedures for preventive maintenance.
  - f. Procedures for routine maintenance.
  - g. Instruction on use of special tools.
- 8. Repairs: Include the following:
  - a. Diagnosis instructions.
  - b. Repair instructions.
  - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - d. Instructions for identifying parts and components.

- e. Review of spare parts needed for operation and maintenance.

## 1.7 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

## 1.8 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
- C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
  - 1. Schedule training with Owner with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral performance-based test.
- F. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

## PART 2 - PRODUCTS

## PART 3 - EXECUTION

END OF SECTION 017900

## SECTION 024110 SELECTIVE DEMOLITION AND ALTERATION WORK

### PART 1 GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### 1.2 SECTION INCLUDES

- A. The Work of this Section includes all labor, materials, equipment and services necessary to complete the selective demolition and alteration work as shown on the drawings and/or specified herein, including but not limited to the following:
  - 1. Selective demolition and removal of portions of the existing building to remain as indicated and as required to accommodate the indicated construction.
  - 2. Patching and repairs, as indicated or required.
  - 3. Disconnecting, capping, abandonment and removal of utilities, as indicated or required.
  - 4. Temporary protections, weather tight enclosures, and similar protections for utilities, structures, persons, etc.
  - 5. Relocation of pipes, conduits, ducts, and other mechanical and electrical work (including equipment
  - 6. Alterations, selective demolition and removals of exterior façade, where noted.
  - 7. Protection of existing building and spaces to remain.
  - 8. Shoring of the structure as required for structural integrity and personal safety.
  - 9. Protection of existing curbs and sidewalks.
  - 10. Temporary coverage passageways.

#### 1.3 QUALITY ASSURANCE

- A. The Contractor shall comply with the requirements of all applicable Federal, State and local safety and health regulations regarding the demolition of structures including ANSI/NFPD 241-Building Construction and Demolition Operations.
- B. The Contractor shall be responsible for any damage to any adjacent structures or buildings to remain.
- C. Qualifications: Qualifications of Contractor for work of this Section shall not be less than ten (10) years of field experience in work of this nature.



- D. Professional Engineering: The Contractor shall retain the services of a Professional Engineer licensed in the State of New Jersey, who shall design and supervise installation of all underpinning and shoring.

1.4 RELATED SECTIONS

- A. Alteration and removal requirements for mechanical and electrical work - Mechanical and Electrical Sections.

1.5 SUBMITTALS

- A. Schedule of Demolition Operations: Submit demolition procedures and operational sequence for Architect's review prior to start of work. Submit a written request to Architect well in advance of executing any cutting or alteration which affects:
  - 1. The work of tying in or connecting to operational systems of the building, including electrical, mechanical and security systems.
  - 2. The work of the Owner or any separate Contractor.
  - 3. The structural value or integrity of any element of the project or of adjacent structures.
  - 4. The integrity or effectiveness of weather-exposed and moisture-resistant elements or systems.
  - 5. The efficiency, operational life, maintenance, or safety of operational elements or systems.
- B. Notice of Differing Conditions: Submit a written notification if, during the work of demolition and cutting, conditions are discovered which significantly vary from those shown on the drawings. Do not commence work until approval of Architect.
- C. Shop Drawings: Submit the following prior to starting work:
  - 1. Submit for Architect's information shop drawings indicating location and typical construction details of temporary dustproof and weatherproof partitions.
  - 2. Submit drawings of temporary structural shoring, bracing, framing or support, for the information of the Architect. Such drawings will be reviewed by the Structural Engineer for the effects of such temporary members on the structural elements to remain. These drawings shall include the reason for such temporary members, the location, the direction and magnitude of design reaction forces on existing structure, and details showing how these reaction forces will be applied to the existing structure.
    - a. Shop drawings shall be submitted with the Seal of the Professional Engineer engaged by Contractor; Professional Engineer must be licensed in the State of New Jersey.
    - b. The Architect will receive acknowledgment for concepts shown. Such acknowledgments shall be of the concept only and not of actual capacities or

structural design and shall not in any way diminish or limit the Contractor's responsibility for the quality and performance of the work and for protecting existing structures and facilities.

1.6 SPECIAL PRECAUTION

- A. Hazardous materials may be encountered during demolition operations including asbestos; comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.

1.7 JOB CONDITIONS

A. Condition of Structure

- 1. The Contractor for the work of this Section shall be held to have visited the site, examined the premises, determined for himself the existing conditions, character of equipment and facilities needed for the performance of the work, and all matters which may in any way affect the work before submitting a bid.
  - a. Information regarding existing construction or conditions is based on available record drawings which may or may not truly reflect existing conditions. Such information is included on the assumption that it may be of interest to the Contractor, but the Architect, Owner and their consultants do not assume responsibility for its accuracy or completeness.
  - b. Notify the Architect if, during the course of demolition, conditions are discovered which significantly vary from those shown on the drawings. Do not proceed until authorized by Architect.
- 2. The Contractor shall accept the condition of the site and structures as found. The Architect and Owner assume no responsibility for condition of site or structures nor the continuation of the condition existing at time of bidding or thereafter.

- B. Areas of building to be demolished or altered will be vacated and discontinued in use prior to the start of the work.

- 1. Surrounding areas of the building shall remain operational by the Owner.

C. Partial Removal

- 1. Items of savable value to the Contractor may be removed from the structure as the work progresses. Salvaged items must be transported from the site as they are removed.
  - 2. Storage or sale of removed items on the site will not be permitted.

- D. Explosives: The use of explosives will not be permitted.

E. Traffic

1. Conduct demolition operations and the removal of debris to ensure minimum interference with roads, streets, walks and other adjacent occupied or used facilities.
2. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

F. Utilities

1. Refer to Division 22 and 26 of the specifications for special requirements concerning utilities and services.
2. Maintain any existing utilities required to remain; keep in service and protect against damage during demolition operations.
3. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to the governing authorities.
4. Disconnect and seal any abandoned utilities before starting demolition operations. Coordinate all work with local utility companies having jurisdiction.

1.8 SCHEDULING

- A. Before commencing any alteration or demolition work, submit for review by the Architect, and approval of the Owner, a schedule showing the commencement, the order, and the completion dates for the various parts of this work.
- B. Before starting any work relating to existing utilities (electrical, sewer, water, heat, gas, fire lines, etc.) that will temporarily discontinue or disrupt service to the structures to remain, notify the Architect and the Owner 7 days in advance and obtain the Owner's approval in writing before proceeding with this phase of the work.

PART 2 PRODUCTS

Refer to Part 3 - Execution, for Product Requirements

PART 3 EXECUTION

3.1 PROTECTION

- A. Take full precautions to protect workmen, passersby or any other persons from falling debris and other hazards of demolition operations.
- B. Execute demolition work to insure protection of existing portions of building to remain against damages which might occur from falling debris or other cause. Do not interfere

with use of adjacent occupied buildings and areas. Maintain free, safe passage to and from occupied adjacent buildings.

- C. **Materials Placement:** Do not load structure with weight that will endanger, overload or cause excessive deflection of the existing structure, or that will damage finished surfaces adjacent to and/or supported by the existing structure, except portions being removed.
- D. **Construction Operations:** Do not employ any construction operation, equipment or vehicles that will endanger, overload or cause excessive deflection of the existing structure, or that will damage finished surfaces adjacent to and/or supported by the existing structure, except portions being removed.
- E. Take precautions to guard against movement, settlement, damage, or collapse of any part of building, sidewalks, adjacent property or street passages; be liable for any such movement, settlement or collapse. If such damage does accidentally occur, Contractor shall repair promptly at no cost to Owner.
- F. Provide the necessary safeguards to prevent accidents, to avoid all necessary hazards and protect the public, the work and property at all times, including Saturdays, Sundays, and holidays.
- G. Be responsible for any and all damages which may arise or occur to any party whatsoever by reason of the neglect in providing proper lights, guards, barriers, or any other safeguards to prevent damage to property, life and limb.
- H. Make such explorations and probes as are necessary to ascertain any required protective measures before proceeding with demolition and removal. Give particular attention to shoring and bracing requirements so as to prevent any damage to existing construction.
  - 1. Provide interior and exterior shoring, bracing, or support to prevent movement or settlement or collapse of structures to be demolished and adjacent facilities to remain. The Contractor's Professional Engineer shall advise on bracing, shoring, underpinning, or other structural requirements. The Contractor shall bear all responsibility for prevention of movement or other structural fault.
  - 2. The Contractor shall restore, by repair or otherwise, the portions of structure or their contents altered by the Contractor in furtherance of his underpinning and support operations. Restoration shall be completed to the conditions which existed prior to the start of the work. Any damage caused by inadequate support shall also be restored by the Contractor at no cost to the Owner.
- I. Provide, erect and maintain catch platforms, lights, barriers, weather protection, warning signs, and other items as required for proper protection of the workmen engaged in demolition and alteration operations, occupants of the building, public and adjacent property. Any damage caused by the Contractor's operations shall be promptly repaired by the Contractor at no cost to the Owner.

- J. Provide and maintain temporary protection of the existing structure designated to remain where demolition, removal, and new work are being done, connections made, materials handled, or equipment moved.
- K. Take necessary precautions to prevent dust and dirt from rising. Protect unaltered portions of the existing building affected by the operations under this Section by dustproof partitions and other adequate means.
- L. Provide adequate fire protection in accordance with local Fire Department requirements.
- M. Do not close or obstruct walkways, passageways, or stairways. Do not store or place materials in passageways, stairs, or other means of egress. Conduct operations with minimum traffic interference.
- N. Be responsible for any damage to the existing structure or contents by reason of the insufficiency of protection provided.
- O. Erect temporary covered passageways at street level as required by authorities having jurisdiction.
- P. Promptly repair damages caused to adjacent facilities by demolition operations at no cost to the Owner.
- Q. Provide and maintain weather protection at exterior openings so as to fully protect the interior premises against damage from the elements until such openings are closed by new construction.

### 3.2 INSPECTION

- A. Verify that areas of demolition work are protected and temporary dustproof partitions have been installed.
- B. Verify that construction to be removed is not load bearing or has been properly braced, framed or supported.
- C. Inspect existing conditions of the project, including elements subject to damage or to movement during demolition and cutting.
- D. After uncovering work, inspect the conditions affecting the installation or performance of the work.
  - 1. Report differing or questionable conditions to the Architect in writing; do not proceed with the work until the Architect has provided further instructions.

### 3.3 PREPARATION

- A. Provide adequate temporary support as necessary to assure the structural value or integrity of the affected portion of the work
- B. Provide devices and methods to protect other portions of the project from damage.

C. Pollution Controls

1. Use water sprinkling, temporary enclosures, and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.
  - a. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.
2. Clean adjacent structures and improvements of dust, dirt and debris caused by demolition operations. Return adjacent areas to condition existing prior to the start of the work.
3. Provide drainage for temporary water use.

3.4 DEMOLITION AND CUTTING

- A. Selectively demolish existing construction in conformance with the drawings and these specifications.
1. Execute cutting and demolition by methods which will prevent damage to other work and will provide proper surface to receive installation of work by others and patching of finish surfaces.
  2. Do all cutting or removal so as to leave neat, true, plumb and square edges, at edges to remain. Use carborundum or diamond saw equipment for cutting masonry, concrete and stone work, where edges or surfaces are to remain.
  3. Do not cut or remove construction which might weaken or impair the structural integrity or strength of the structural framing or support systems which are to remain.
  4. Demolish and remove materials as shown on the drawings without damage to the remaining parts of the structure or mechanical/electrical/utility systems.
  5. Remove materials so as to not impose excessive loads in supporting walls, floors or framing and so as not to damage remaining undemolished portions of the structure.
  6. Where portions of structures are to be removed, remaining portions shall be protected from damage and prepared to fit new construction. Damage to portions of structures to remain shall be repaired.
  7. Reinforcing steel in existing structures shall be left in place, cleaned and aligned to provide tie with new work.
  8. Existing waterproofing systems and flashings shall be carefully exposed and protected to maintain workable conditions of fitting new work with existing construction.
  9. Proceed with demolition in a systematic manner.

10. Demolish concrete and masonry in small sections.
11. Remove structural framing members and lower to ground by means of hoists, derricks, or other suitable methods.

**B. Shoring**

1. Design, provide, erect and maintain necessary temporary shoring, bracing, framing, or support where load bearing structural or supporting members are removed or weakened by cuts or openings or are subject to damage from demolition operations, and otherwise as required for safety or to protect finish surfaces from damage.
2. Construction and adequacy of the shoring shall be the entire responsibility of the Contractor. Any damage caused by the inadequacy of the shoring or other support shall be the responsibility of the Contractor to remedy at no additional expense to the Owner.
3. Shoring and bracing shall remain until new structural framing and/or supports are installed. Coordinate operations fully with other trades.
4. Be ready at any time to promptly provide, add to, or strengthen temporary shoring, bracing, or support for existing work, in case existing construction begins to show signs of structural stress.

**3.5 WORKMANSHIP STANDARDS FOR ALTERATION AND REMOVAL WORK**

- A. Cut, remove, alter, temporarily remove and replace, or relocate existing work as required for performance of the work. Perform such work required with due care, including shoring and bracing.
- B. Coordinate patching involving the various trades whether or not specifically mentioned in the respective specification Sections.
- C. Materials or items demolished and not designated to become the property of the Owner or to be reinstalled shall become the property of the Contractor and shall be removed from the Owner's property.
- D. Execute the work in a careful and orderly manner, with the least possible disturbance to the public and to the occupants of the adjacent buildings.
- E. In general, demolish masonry in small sections. Where necessary to prevent collapse of any construction, install temporary shores, struts, or bracing.
- F. Materials to be removed by existing elevators shall be put in enclosed containers.
- G. Where existing equipment and/or fixtures are indicated to be reused, repair such equipment and/or fixtures and refinish to put in perfect working order. Refinish as directed.

- H. Cut out embedded anchorage and attachment items as required to properly provide for patching and repair of the respective finishes.
- I. Confine cutting of existing roof areas designated to remain to the limits required for the proper installation of the new work. Cut and fold back existing roofing. Cut and remove insulation and related items. Provide temporary weathertight protection as required until new roofing and flashings are installed. Consult the Owner to ascertain if existing guarantee bonds are in force and execute the work so as not to invalidate such bonds.
- J. Where utilities are removed, relocated or abandoned, cap, valve, plug, or by-pass to make complete and working installation.
- K. Restore existing pipe and duct coverings damaged by work under this Contract to original undamaged condition.
- L. Immediately restore to service and repair any damage caused by Contractor's workmen to existing pipe and conduits, wires, cables, etc., of utility services or of fire protection systems and communications systems which are not scheduled for discontinuance or abandonment.
- M. Upon completion of contract, deliver work complete. Damage that may be caused by Contractor or Contractor's workmen to existing structures designated to remain, grounds, and utilities shall be repaired by Contractor and left in as good condition as existed prior to damaging.
- N. Restore finish work of floors, walls, and ceilings remaining in place but damaged or defaced because of demolition or alteration work to condition equal that which existed at beginning of work under this Contract.
- O. Where alteration or removals expose damaged or unfinished surfaces or materials, refinish such surfaces or materials, or remove them and provide new or salvaged materials to make continuous surfaces uniform.
- P. Perform new work and restore and refinish existing work in conformance with applicable requirements of the specifications, except as follows:
  - 1. Materials for use in repair of existing surfaces, but not otherwise specified, shall conform to the highest standards of the trade involved, and be in accordance with approved industry standards, and shall be as required to match existing surfaces.
  - 2. Workmanship for repair of existing materials shall, unless otherwise specified, be equal to similar workmanship existing in or adjacent to the space where the work is being done.
  - 3. Installation of salvaged items where no similar items exist shall be done in accordance with the highest standards of the trade involved and in accordance with approved shop drawings.



- Q. Materials or items designated to become the property of the Owner shall be as shown on the drawings. Remove such items with care and store them in a location at the site to be designated by the Owner.
- R. Materials or items designated to be reinstalled shall be as shown on the drawings. Remove such items with care under the supervision of the trade responsible for reinstallation; protect and store until required. Replace materials or items damaged in their removal with similar new material.
- S. The existing building shall not be used as a workshop, nor shall the furnishings or equipment in any room be used as work benches. Should any damage occur during the progress of the work to any furniture, fixtures, equipment, or appurtenances therein, such damage shall be repaired, replaced or made good by the Contractor without extra cost to the Owner.
- T. Where removing existing floor finish and base, remove all adhesive and leave floors and walls smooth and flush, ready to receive new finish.
- U. Finish new and adjacent existing surfaces as specified for new work. Clean existing surfaces of dirt, grease and loose paint before refinishing.

### 3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. General
  - 1. Remove from the site debris, rubbish and other materials resulting from work of this Section.
  - 2. Burning of removed materials from demolished structures will not be permitted on the site.
- B. Removal: Transport materials removed from demolished structures and legally dispose of off site. Pay any and all fees associated with disposal work. Leave the site in an orderly condition to the approval of the Architect.

### 3.7 CLEANING UP

- A. Remove debris as the work progresses. Maintain existing premises in a neat and clean condition.

END OF SECTION

**SECTION 024119 -SITE DEMOLITION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Demolition of designated site structures, retaining walls and foundations and removal of materials from site.
- B. Demolition and removal of pavements, curbs and gutters, drainage structures, utilities, signage or landscaping.
- C. Disconnecting and capping or removal of identified utilities.
- D. Filling voids in subgrade created as a result of removals or demolition.
- E. Hazardous material compliance.

**1.02 RELATED SECTIONS**

- A. Section 331000 – Protection of Existing Utilities
- B. Section 311000 – Site Preparation
- C. Section 312000 – Earthwork
- D. Section 312100 - Aggregate Materials
- E. Construction Drawings

**1.03 REGULATORY REQUIREMENTS**

- A. Conform to applicable State and local codes for demolition of structures, safety of adjacent structures, dust control, and runoff control.
- B. Obtain required permits and licenses from appropriate authorities. Pay associated fees including disposal charges.
- C. Notify affected utility companies before starting work and comply with their requirements.
- D. Do not close or obstruct public or private roadways, sidewalks, or fire hydrants without appropriate permits or written authorization.
- E. Conform to applicable regulatory procedures when hazardous or contaminated materials are discovered.
- F. Test soils around buried tanks for contamination.

**1.04 PROJECT RECORD DOCUMENTS**

Accurately record actual locations of capped utilities and subsurface obstructions that will remain after demolition.

**1.05 PROJECT CONDITIONS**

- A. Structures to be demolished will be discontinued in use and vacated prior to start of work.
- B. Owner assumes no responsibility for condition of structures to be demolished.
- C. Conditions, existing at time of inspection for bidding purposes will be maintained by Owner as reasonably practical. Variations within structures may occur by Owner's removal and salvage operations prior to start of demolition work.
- D. Unless otherwise indicated in Contract Documents or specified by the Owner, items of salvageable value to Contractor shall be removed from site and structures. Storage or sale of removed items on site will not be permitted and shall not interfere with other work specified in Contract Documents.
- E. Explosives shall not be brought to site or used without written consent of authorities having jurisdiction. Such written consent will not relieve Contractor of total responsibility for injury to persons or for damage to property due to blasting operations. Performance of required blasting shall comply with governing regulations.
- F. Maintain safe and adequate access to existing adjacent structures on the site that shall remain occupied during the demolition operations.

**PART 2 PRODUCTS**

**2.01 FILL MATERIALS**

Aggregate materials as specified in Section 312100.

**PART 3 EXECUTION**

**3.01 PREPARATION**

- A. Provide, erect, and maintain erosion control devices, temporary barriers, and security devices at locations indicated on Construction Drawings.
- B. Protect existing landscaping materials, appurtenances, and structures (adjacent or in proximity to the Work), which are not to be demolished. Repair damage caused by demolition operations at no cost to Owner.
- C. Prevent movement or settlement of adjacent structures. Provide bracing and shoring as needed.

- D. Mark location of utilities. Protect and maintain in safe and operable condition utilities that are to remain. Prevent interruption of existing utility service to occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities as acceptable to governing authorities and Owner.
- E. Notify adjacent owners of work that may affect their property, potential noise, utility outages or disruptions. Contractor to coordinate with Owner.

### **3.02 DEMOLITION REQUIREMENTS**

- A. Conduct demolition to minimize interference with adjacent structures or pavements.
- B. Cease operations immediately if adjacent structures appear to be in danger. Notify authority-having jurisdiction. Do not resume operations until directed by authority.
- C. Conduct operations with minimum of interference to public or private access. Maintain ingress and egress at all times.
- D. Obtain written permission from adjacent property owners when demolition equipment will traverse, infringe upon, or limit access to their property.
- E. Sprinkle work with water to minimize dust. Provide hoses and water connections for this purpose.
- F. Comply with governing regulations pertaining to environmental protection.
- G. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing prior to start of work.

### **3.03 DEMOLITION**

- A. Selectively demolish buildings and remove from site using methods as required to complete work within limitations of governing regulations. Small structures may be removed intact when acceptable to Owner and authorities having jurisdiction.
- B. Locate demolition equipment and remove materials so as to prevent excessive loading to supporting walls, floors, or framing.
- C. Demolish concrete and masonry in small sections. Break up concrete slabs-on-grade that are within 2-feet or more below proposed subgrade to permit moisture drainage. Contractor shall remove slabs-on-grade and below grade construction in accordance with the contract document plans.

### **3.04 FILLING BASEMENTS AND VOIDS**

- A. Completely fill below grade areas and voids resulting from demolition or removal of structures, underground fuel storage tanks, wells, cisterns, etc., using approved select fill or crushed concrete materials from on site building demolition operations consisting of stone, gravel, and sand free from debris, trash, frozen materials, roots, and other organic matter.

- B. Ensure that areas to be filled are free of standing water, frost, frozen or unsuitable material, trash, and debris prior to fill placement.
- C. Place and compact fill materials in accordance with Section 312000 unless subsequent excavation for new work is required.
- D. Grade surface to match adjacent grades and to provide flow of surface drainage after fill placement and compaction.

**3.05 DISPOSAL OF DEMOLISHED MATERIALS**

- A. Remove site debris, rubbish, and other materials resulting from demolition operations and dispose of in accordance with State, County and Local regulations. Leave areas of work in clean condition.
- B. No burning of any material, debris, or trash on-site or off-site will be allowed.
- C. Transport materials removed from demolished structures with appropriate vehicles and dispose off-site to disposal facilities that are approved for disposal of such material by governing authorities and appropriate property owners.

**END OF SECTION 024119**

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## SECTION 031000 - CONCRETE FORMWORK

### PART 1 - GENERAL

#### 1.1 DESCRIPTION OF WORK

- A. Provide forms wherever necessary to confine concrete and shape it to required dimensions. Provide special formwork or formliners for concrete with smooth or special finishes.

#### 1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Miscellaneous metal fabrications (concrete, inserts) - Section 055000

#### 1.3 RELATED SECTIONS

- A. Concrete Reinforcement - Section 032000
- B. Cast-in-Place Concrete Section 033000

#### 1.4 REFERENCES

- A. References and industry standards listed in this Section are applicable to the Work. Unless more restrictive criteria or differing requirements are explicitly stated in the Specifications, or mandated by governing codes or regulations, the recommendations, suggestions, and requirements described in the referenced standards shall be deemed mandatory and applicable to the Work.

- 1. American Concrete Institute (ACI) standards, latest editions per International Building Code 2021, New Jersey Edition.

ACI 301	Specifications for Structural Concrete for Buildings.
ACI 347	Guide to Formwork for Concrete.

- 2. American Association of State Highway and Transportation Officials

T318 Water Content of Freshly Mixed Concrete Using Microwave Oven Testing

#### 1.5 DESIGN REQUIREMENTS

- A. The design and engineering of the formwork, as well as its construction, is the responsibility of the Contractor.
- B. Design formwork in accordance with ACI 347 and in accordance with the International Building Code 2021, New Jersey Edition.

## 1.6 SUBMITTALS

- A. Product Data: Submit manufacturers' information for the following:
  - 1. Overlaid plyform formwork or formliners
  - 2. Ties, each type and where to be used
  - 3. Form-release agent. Form-release agent to be submitted for review only.
- B. Samples
  - 1. Submit 12" x 12" samples of the following items:
    - a. Overlaid plyform formwork or formliners
- C. Shop Drawings
  - 1. Prepare and submit formwork shop drawings and calculations prepared and sealed by a Professional Engineer licensed in the State of New Jersey for review.
- D. Quality Control Submittals
  - 1. Contractor Qualifications
    - a. Provide proof of Formwork Installer qualifications specified under "Quality Assurance".

## 1.7 QUALITY ASSURANCE

- A. Qualifications
  - 1. Company specializing in performing the Work of this Section shall have three years minimum experience.
- B. Regulatory Requirements
  - 1. Building Code: Work of this Section shall conform to all requirements of the 2021 IBC NJ Edition and all applicable regulations of governmental authorities having jurisdiction including safety, health, noise, and anti-pollution regulations. Where more severe requirements than those contained in the Building Code are given in this Section and ACI 347, the requirements of this Section and ACI 347 shall govern.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protection
  - 1. Protect formwork materials before, during and after installation.
  - 2. Protect installed work and materials of other trades.
- B. Replacement

1. Repair or replace damaged formwork as approved by the Owner.
2. Repair overlaid plyform formwork as per manufacturer's instructions. Replace pieces when number of manufacturer recommended reuses is up or when finish deteriorates.

## **PART 2 -PRODUCTS**

### **2.1 MANUFACTURERS**

#### **A. Overlaid Plyform Formwork**

1. Simpson Timber Company, or approved equal.
2. Dayton Richmond Concrete Accessories, or approved equal.

#### **B. Form Liners**

1. Greenstreak, or approved equal.
2. Architectural Polymers, or approved equal.
3. Fitzgerald Formliners, or approved equal.

### **2.2 MATERIALS**

#### **A. Rough Formwork**

1. Shall be Commercial Douglas Fir, DFPA: 5/8" thick minimum or modular metal units.

#### **B. Overlaid Plyform Formwork**

1. Plywood with thermosetting phenolic resin or urethane coating bonded to it to provide a flat matte finish. Shall be equal to B-Matte Formguard by Simpson Timber Company.

#### **C. Smooth Form Finish Formliner**

1. Shall be equal to #340 Smooth Face by Greenstreak.
2. Nails and staples used to attach formliner to formwork are to be Type 304 stainless steel.

#### **D. Release Agent**

1. VOC compliant material such as those of the Cresset Chemical Company for coating forms.

#### **E. Form Ties**

1. Form ties for exposed concrete shall be adjustable.
2. Form ties for exposed concrete and concrete to receive membranes shall be a break-off type and leave no metal closer than 1 1/2" to the surface.
3. Form ties for concrete stated in 2 above shall be free of devices which leave holes or depressions larger than 7/8" back of exposed surface.
4. Wire ties not permitted.



## **PART 3 - EXECUTION**

### **3.1 PREPARATION OF FORMWORK SURFACES**

- A. Clean all surfaces of forms and embedded items of any accumulated mortar or grout from previous concreting and other foreign material before concrete is placed in them. Repair or replace any formwork as required.
- B. Before placing either reinforcing steel or concrete, cover the surfaces of the rough or overlaid plyform formwork (when used) with an approved form release agent that will effectively prevent absorption of moisture, prevent bond with the concrete, and which will not stain the concrete surfaces. Material shall be carefully applied at the amount recommended by the release agent manufacturer to obtain the desired finish. Do not apply oil or release agents on formwork for concrete to receive coatings such as membrane waterproofing, plaster, or additional concrete (such as at construction joints). Follow manufacturer's recommendations for alternatives. For the overlaid plyform formwork, release agent should be a chemically reactive agent compatible with the factory treatment. Do not allow excess form coating material to stand in puddles in the forms nor allow coating to come in contact with hardened concrete against which fresh concrete is to be placed.

### **3.2 CONSTRUCTION AND DETAILS**

- A. Adequately support and substantially brace formwork to hold lines and shape.
- B. Formwork shall be tight jointed to prevent leakage of mortar from the concrete.
- C. Place chamfer strips in the corners of forms to produce beveled edges (chamfers) on permanently exposed surfaces (such as exposed columns). Do not provide beveled edge for interior corners of such surfaces and where members are flush with partitions or walls, unless required by Drawings or specified elsewhere.
- D. Set slab-forms with camber of 1/4" per 10 feet of span to maintain tolerances. For two way slabs the lesser span dimension shall govern.
- E. Provide positive means of adjustment (wedges or jacks) for shores and struts to take up all settlement during concrete placing operations. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check. Securely brace forms against lateral deflection.
- F. Provide mud sills where shores rest on compressible materials.
- G. Provide temporary openings to permit cleaning and inspection. Provide ample time for proper inspection before placement of concrete.
- H. Provide "Rough Form Finish" for surfaces not exposed to view. Use plywood or metal forms coated with a release agent.
- I. Form holes for pipes, pipe sleeves, electric outlets, electric conduits, etc. as required. Construct woodforms for wall forms to facilitate loosening, if necessary, to counteract swelling of forms.

- J. Provide runways for moving equipment with struts or legs, which shall be supported directly on the formwork or structural member without resting on the reinforcing steel.
- K. Provide for rebates, reglets, grooves keys, pockets, ground nailers, projections and other built-in work prior to placement of concrete. Install reglets as per manufacturer's instructions.
- L. Install dovetail slots, concrete inserts, and other metal fabrications. Secure to inside forms and space as specified in Section 055000 or as shown on Drawings.
- M. At construction joints, contact surface of the form sheathing for flush surfaces exposed to view shall overlap the hardened concrete in the previous placement by not more than 1". The forms shall be held against the hardened concrete to prevent offsets or loss of mortar at the construction joint and to maintain a true surface.
- N. Form accessories to be partially or wholly embedded in the concrete, such as ties and hangers, shall be of a commercially manufactured type. Use of non-fabricated wire is not permitted. Construct form ties so that the ends or end fasteners can be removed without causing appreciable spalling at the faces of the concrete. After the ends or end fasteners of the form ties have been removed, terminate the embedded portion of the ties not less than 2 diameters or twice the minimum dimension of the tie from the formed faces of concrete to be permanently exposed to view, except that in no case shall this distance be less than 3/4". When the formed face of the concrete is not to be permanently exposed to view, form ties may be cut off flush with the formed surfaces.
- O. Carefully check all forms before placement of concrete. Give special care to suspended first floor slabs resting on compressible material to prevent settlement.
- P. Notify the Engineer of Record if openings are required but not shown on the Drawings, who will issue instructions accordingly.

### 3.3 REMOVAL OF FORMS AND SHORING

- A. Remove forms in such a manner as to assure the complete safety of the structure. In no case remove forms or shoring supporting the weight of concrete in beams, slabs or structural members until the members have reached the minimum compressive strength specified on the Drawings or as permitted by the Engineer of Record.
- B. Formwork for columns, walls, sides of beams, and other parts not supporting the weight of the concrete may be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations and as required by C below. For normal temperature conditions, this shall be a minimum of 12 hours. For cold weather conditions, this shall be increased to 24 hours. Concrete shall remain protected at all times.
- C. When repair of surface defects or finishing is required at an early age, remove forms as soon as the concrete has hardened sufficiently to resist damage from removal operations.
- D. Remove top forms on sloping surfaces of concrete as soon as the concrete has attained sufficient stiffness to prevent sagging. Perform any needed repairs or treatment required on such sloping surfaces at once and follow it with the specified curing.

- E. Loosen wood forms for wall openings as soon as this can be accomplished without damage to the concrete.
- F. Proper safe shoring, number of shores, adequacy, size and location of these shores and forms shall be in accordance with acceptable good construction practice and it is the sole responsibility of the Contractor to provide safe conditions at all times during stripping.

### 3.4 TOLERANCES

- A. Construct formwork so that concrete surfaces will conform to the tolerance limits listed in ACI 117.
- B. Establish and maintain in an undisturbed condition and until final completion and acceptance of the project sufficient control points and bench marks to be used for reference purposes to check tolerances.
- C. Regardless of the tolerances listed, do not extend any portion of the concrete work beyond the lot or street line.

### 3.5 INSPECTION

- A. Under the requirements of the 2021 IBC NJ Edition, formwork, including shores, reshores, braces, and other supports shall be inspected by an engineer for controlled inspection engaged by the Owner. The engineer shall make inspections prior to placement of steel to verify correct sizes of members formed subsequently, periodically after placement, and during placement of concrete to detect incipient problems. The engineer will also inspect the forms for conformance with form design drawings when such drawings are required. The engineer is to maintain and submit a record of all inspections to the Owner.
- B. Under the requirements of the 2021 IBC NJ Edition, the Owner will assign a Special Inspector to inspect formwork for size of members and to verify in-situ concrete strengths prior to removal of formwork and shores from beams and slabs.
- C. During and after concrete placement, check elevations, camber, and vertical alignment of formwork systems using tell-tale devices.
- D. Keep a record of all inspections, the name of the persons making them, and the name of the foreman in charge of formwork at the site. Submit to the Owner's representative on the site a copy of the inspection records prior to each concrete placement.

END OF SECTION 031000

## SECTION 032000 - CONCRETE REINFORCEMENT

### PART 1 - GENERAL

#### 1.1 DESCRIPTION OF WORK

- A. Provide and install all reinforcement and associated items required for cast-in-place in accordance with the Contract Documents. The Contract Documents are as defined in the "AGREEMENT". The "GENERAL CONDITIONS" shall apply to all work under the Contract.

#### 1.2 RELATED SECTIONS

- A. General Requirements - Division 1
- B. Concrete Formwork - Section 031000
- C. Cast-in-Place Concrete - Section 033000

#### 1.3 REFERENCES

- A. References and industry standards listed in this Section are applicable to the Work. Unless more restrictive criteria or differing requirements are explicitly stated in the Specifications, or mandated by governing codes or regulations, the recommendations, suggestions, and requirements described in the referenced standards shall be deemed mandatory and applicable to the Work.

- 1. American Society of Testing and Materials (ASTM) standards, latest editions.

- A82 Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
- A184 Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
- A185 Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
- A496 Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
- A497 Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
- A615 Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- A706 Standard Specifications for Low-Alloy Steel Deformed and Plain Bars for Concrete reinforcement
- A775 Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
- A884 Standard Specifications for Epoxy-coated Wires and Welded Wire Reinforcement.

- 2. American Concrete Institute (ACI) standards, latest editions.

- ACI 301 "Specification for Structural Concrete for Buildings."
- ACI 315 "Details and Detailing of Concrete Reinforcement."
- ACI 318 "Building Code Requirements for Structural Concrete."

3. "Placing Reinforcing Bars - CRSI-WCRSI Recommended Practices", latest edition. Concrete Reinforcing Steel Institute.
4. "Structural Welding Code - Reinforcing Steel" D1.4 - American Welding Society (AWS).
5. "Near-White Blast Cleaning" SSPC-SP10 - Steel Structures Painting Council (SSPC).

#### 1.4 DESIGN REQUIREMENTS

- A. In lieu of placing reinforcement bars, the contractor has the option of using welded wire reinforcement (WWR).
  1. WWR must be demonstrated to the satisfaction of the engineer of record that they are of equivalent strength to the reinforcing bars that are being substituted.
  2. As per ACI 318, yield strength greater than 60,000 psi may be used (for WWR) provided the yield strength is measured at a strain of 0.0035 in./in. in accordance with ACI code requirements.

#### 1.5 SUBMITTALS

- A. Product Data: Submit manufacturers' information for the following:
  1. Steel reinforcing bars
  2. Steel welded wire fabric
  3. Steel welded wire reinforcement.
  4. Supports
  5. Mechanical connectors
- B. Shop Drawings
  1. Immediately after award of Contract, prepare shop drawings showing all fabrication dimensions and locations for placing of the reinforcing steel and accessories. Shop Drawings are to be prepared by a rebar detailer.
  2. Follow detailing recommendations of ACI 315.
  3. Submit drawings gradually and not all at the same time so that sufficient time is allowed for checking and approval. Improperly prepared and incomplete shop drawings will be disapproved without review.
  4. Shop drawings will be checked for size of material and spacing by the Engineer of Record, which shall not render the Engineer responsible for any errors in construction dimensions, quantities, bends, etc. that have been made in preparation of the shop drawings. The Contractor shall assume full responsibility for the correctness of quantities, dimensions and fit.
  5. Do not order or deliver reinforcement to job site prior to approval of drawings.
  6. Indicate location of epoxy-coated bars on the drawings.
- C. Quality Control Submittals
  1. Certificates
    - a. Submit certificate stating that reinforcement meets or exceeds the specified requirements.

- b. Submit certification that properly identifies the number of each batch of epoxy coating material used on the project, material, quantity represented, date of manufacture, name and address of manufacturer and a statement that the supplied epoxy-coated reinforcing bars meet the requirements of this specification and the requirements of ASTM A775 including Annex A1.
- 2. Contractor Qualifications
  - a. Provide proof of Installer and Detailer qualifications specified under “Quality Assurance”.

## 1.6 QUALITY ASSURANCE

### A. Qualifications

- 1. Rebar Installer: Company specializing in performing the Work of this Section shall have three years minimum experience on successful projects of similar size.
- 2. Rebar Detailer: Company shall be specialized in the detailing of reinforcing bar shop drawings with a minimum of three years experience.

### B. Regulatory Requirements

#### 1. Building Code

- a. Work of this section shall conform to all requirements of the 2021 IBC NJ Edition, "Identification of metal-reinforcement", deliveries will be rejected unless:
  - 1) All reinforcing bars are identifiable as to point of origin, grade of steel and size.
  - 2) All bundles or rolls of cold drawn steel wire reinforcement are securely tagged to identify the manufacturer, the grade of steel and the size.
- b. Where more severe requirements than those contained in the 2021 IBC NJ Edition are given in this Section and ACI 318, the requirements of this Section and ACI 318 shall govern.

#### 2. Industry Standards

- a. Details of Concrete reinforcement not covered herein shall be in accordance with "Building Code Requirements for Reinforced Concrete" (ACI 318) and "Details and Detailing of Concrete Reinforcement" (ACI 315), latest editions and the Concrete Reinforcing Steel Institute Manual on "Placing Reinforcing Bars" (CRSI).

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in location to prevent rusting, etc.
- B. Protect reinforcement before, during, and after installation.
- C. Insure proper identification after bundles are broken.
- D. Epoxy-Coated Reinforcing Bars

1. Equipment for handling epoxy-coated bars shall have protected contact areas. Lift Bundles of coated bars at multiple pick-up points to minimize bar-to-bar abrasion from sags in the bundles.
  2. Do not drop or drag coated bars or bundles of coated bars. Store coated bars on protective cribbing.
  3. Fading of the color of the coating shall not be cause for rejection of epoxy-coated reinforcing bars. Coating damage due to handling, shipment, and placing need not be repaired in cases where the damaged areas is 0.1 in<sup>2</sup> or smaller. Repair damaged areas larger than 0.1 in<sup>2</sup> in accordance with Article 2.02. The maximum amount of damage, including repaired and un-repaired areas, shall not exceed 2% of the surface area of each bar. Bars with greater than 2% damaged areas will be rejected.
- E. WWR is shipped in two forms; rolls or sheets. If the rolls or sheets must be lifted by crane at the job site, the contractor may request the manufacturer to install lifting eyes. At all times during off loading of materials, caution must be exercised and all safety regulations and practices must be observed.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

#### **A. Non-coated Reinforcing Bars**

1. All non-coated reinforcing bars, except those to be welded, shall be of deformed type of new billet steel conforming to current requirements of ASTM A615. No rail or re-rolled steel will be permitted. Reinforcement to be welded shall conform to the requirements of ASTM A706.
2. Grade or yield strength of reinforcing bars are indicated on Drawings.

#### **B. Welded Steel Wire Fabric (WWF)**

1. Wire Fabric shall conform to the requirements of ASTM A185.
2. Required net area, placement details, and other requirements are indicated on Drawings.
3. Epoxy coating of Welded Wire Fabric shall be in accordance with ASTM A884.

#### **C. Welded Wire Reinforcement (WWR)**

1. Welded Wire Reinforcement shall conform to ASTM A497 and shall be made of wire conforming to ASTM A496.
2. Epoxy coating of Welded Wire Reinforcement shall be in accordance with ASTM A884.

#### **D. Epoxy-Coated Reinforcing Bars**

1. All steel reinforcing bars to be coated shall be of deformed type of new steel conforming to current requirements of ASTM A615. Bars shall be free of contaminants such as oil, grease or paint. No rail or re-rolled steel will be permitted. Reinforcement to be welded shall conform to the requirements of ASTM A706.
2. Grade or yield strength of reinforcing bars is indicated on Drawings.
3. Bars shall be epoxy-coated in accordance with ASTM A775.

4. The coating material shall be of organic composition meeting the requirements listed in ASTM A775 Annex A1 entitled "Requirements for Organic Coating." Resistance to chemicals, applied voltage, chloride permeability, flexibility, bond strength, abrasion resistance, impact, and hardness shall be tested in accordance with Annex A1.

**E. Supports for Reinforcement**

**1. Non-coated Reinforcement**

- a. Supports for reinforcement supported by formwork or deck shall consist of metal bolsters and chairs of adequate strength, size, and number. Provide CRSI Class C supports (plastic tipped) for formed concrete surfaces and Class A (bright basic) for metal deck.
- b. Supports for reinforcement of slabs supported by ground shall consist of above supports with sand plates or horizontal runners. Support for reinforcement of footings/ pile caps shall consist of the above supports or precast concrete block, 4" square, having a compressive strength equal to that of the concrete being placed.

**2. Epoxy-coated Reinforcement**

- a. Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports, or on bar supports made of dielectric material or other acceptable materials. Wire bar supports shall be coated with dielectric material for a minimum distance of 2" from the point of contact with the epoxy-coated reinforcing bars.
- b. Reinforcing bars used as support bars shall be epoxy-coated. In walls having epoxy-coated reinforcing bars, spreader bars, where specified on the Drawings or shop drawings, shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing bars shall be made of corrosion-resistant material.

**F. Tie Wire**

1. Tie wire for fastening epoxy-coated reinforcing bars shall be nylon-epoxy, plastic-coated, or other material acceptable to the Owner.

**2.2 FABRICATION**

**A. General**

1. Fabricate reinforcing bars in accordance with fabricating allowances given in ACI 315.

**B. Epoxy-Coated Bars**

**1. Surface Preparation**

- a. Clean the surface of the steel reinforcing bars to be coated by abrasive blast cleaning to near-white metal in accordance with SSPC-SP10.

**2. Application of Coating (In Shop)**



- a. Apply the coating to the cleaned surface as soon as possible after cleaning and before oxidation of the surface discernible to the unaided eye occurs. However, in no case delay application of the coating more than 8 hours after cleaning.
  - b. The coating shall be applied by the Electrostatic Spray Method and fully cured in accordance with the recommendations of the manufacturer of the coating material.
  - c. Coat ends of bars in accordance with the manufacturer's standards.
3. Thickness of Coating Material
  - a. The film thickness of the coating after curing shall be 5 to 12 mils inclusive. Take a minimum of 15 measurements approximately evenly spaced along each side of the test bar. At least 90% of these measurements shall be within the specified limits.
  - b. Test the thickness of the film coating in accordance with ASTM G12.
4. Coating Repair: Repair coating damage due to fabrication or handling in cases where damaged area is 0.1 in<sup>2</sup> or greater. Repair all damaged areas larger than 0.1 in<sup>2</sup> with patching material. The maximum amount of damage shall not exceed 24% of the surface area of each bar. Patch in accordance with the patching material manufacturer's recommendations. Repair ends of bars cut in the field with the patching material.
5. Bending of Epoxy-Coated Reinforcement: Bend all epoxy-coated reinforcement cold unless otherwise approved by the Owner. When epoxy coated reinforcement bars are field or shop bent, repair coating damage in accordance with paragraph B.4 above. Rollers of bending apparatus shall have neoprene collars.

## 2.3 SOURCE QUALITY CONTROL

- A. The Owner shall have the right to inspect the material at all times while work on the Contract is being performed. Epoxy-coated reinforcing bars that do not meet the requirements of this Specification will be rejected. Replace all rejected bars at no cost to the Owner.

## PART 3 - EXECUTION

### 3.1 PLACEMENT

#### A. General

1. Place reinforcement in accordance with CRSI "Placing Reinforcement Bars."
2. Unless otherwise permitted, welding of crossing bars (tack welding) for assembly of reinforcement is prohibited.
3. Avoid cutting or puncturing vapor barrier during placement.

#### B. Supports

1. Support and fasten together all reinforcement to prevent displacement by construction loads or placing of concrete.
2. Provide supports specified in Article 2.01.

3. Provide Continuous High Chair Upper (CHCU) or Continuous Support (CS) for welded wire fabric in the metal deck and place every four feet (4') parallel to the supporting beams.
4. Lifting of bars, welded wire fabric, and welded wire reinforcement into position during placement of concrete is not permitted.
5. Where the concrete surface will be exposed to the weather in the finished structure, the portions of all accessories within 1/2" of the concrete surface shall be non-corrosive or protected against corrosion.
6. The following guidelines for WWR support spacing can be used for supported concrete slabs whether formed or placed on composite metal decks.

<u>Wire Size</u>	<u>Wire Spacing</u>	<u>Support Spacing</u>
W or D9 and larger	12" and greater	4-6 ft.
W or D5 to W or D8	12" and greater	3-4 ft.
W or D9 and larger	Less than 12"	3-4 ft.
W or D4 to W or D8	Less than 12"	2-3 ft.
Less than W or D4	Less than 12"	2-3 ft. or less.

C. Cover

1. Provide minimum protective cover given in Chapter 7 of ACI 318 if not indicated on Drawings.

D. Splices

1. All splices not shown on the Project Drawings shall be shown on the shop drawings and approved by the Engineer of Record.
2. Welded splices - Provide where indicated on Drawings. All welding shall conform to AWS D1.4. At these locations, only reinforcement conforming to ASTM A706 shall be used.
  - a. Provide suitable ventilation when welding epoxy-coated reinforcing bars.
  - b. After completion of welding on epoxy-coated reinforcing bars, repair coating damage in accordance with Article 2.02. All welds, and all steel splice members when used to splice bars, shall be coated with the same material used for repair of coating damage.
3. Mechanical Connectors
  - a. Provide where indicated on Drawings. Install in accordance with splice device manufacturer's recommendations.
  - b. After installing mechanical connectors on epoxy-coated reinforcing bars, coating damage shall be repaired in accordance with Article 2.02. All parts of mechanical connectors used on coated bars, including steel splice sleeves, bolts, and nuts shall be coated with the same material used for repair of coating damage.

E. Embedment Lengths

1. All embedment lengths not shown on the Project Drawings shall be shown on the shop drawings and approved by the Engineer of Record.

3.2 FIELD CUTTING

- A. When epoxy-coated reinforcing bars are cut in the field, coat the ends of the bars with the same material used for repair of coating damage.

### 3.3 TOLERANCES

- A. Place reinforcing bars in accordance with the tolerances given in paragraph 5.6.2 of ACI 301.
- B. Move bars as necessary to avoid interference with other reinforcement, conduits, or imbedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangements are subject to approval by the Engineer of Record.

### 3.4 FIELD QUALITY CONTROL

- A. Under the requirements of the 2021 IBC NJ Edition, the Owner will designate an Engineer for Controlled Inspection to inspect the size and placement of reinforcement. A record will be made of all inspection of reinforcement at the bending bench and in place.
- B. Do not proceed with the completion of wall forms until all reinforcement has been approved and recorded by the Engineer for Controlled Inspection.
- C. Do not proceed with concreting until all reinforcing in place has been approved and recorded.
- D. Promptly correct all reinforcement displaced during pouring of concrete.
- E. Damaged reinforcement shall not be used.

### 3.5 CLEANING

- A. Steel reinforcement shall be free of all rust, scale, oil, paint, grease, loose mill scale, and all other foreign matter that will prevent bonding of concrete and steel just prior to pouring of concrete.

END OF SECTION 032000

## SECTION 033000 - CAST-IN-PLACE CONCRETE

### PART 1 - GENERAL

#### 1.1 DESCRIPTION OF WORK

- A. Furnish material, equipment, labor, services required to provide for cast-in-place concrete. Work includes but is not limited to structural, sitework, slabs, concrete fire protection, equipment pads, and installation of miscellaneous inserts, waterstops, vapor barriers, toppings, expansion joints and other items listed herein. Allow ample time and facility for the Work of other Divisions to be installed.

#### 1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Anchor bolts and other anchors cast into concrete - Section 051200
- B. Wedge inserts and other miscellaneous items cast into concrete - Section 055000
- C. Joint fillers - Section 079200
- D. Sleeve for pipe and conduit, other items Cast into concrete - Divisions 22, 23, & 26

#### 1.3 RELATED SECTIONS

- A. Concrete Reinforcement - Section 032000
- B. Sheet Membrane Waterproofing, Board Insulation, & Drainage Panel - Division 7

#### 1.4 REFERENCES

- A. References and industry standards listed in this Section are applicable to the Work. Unless more restrictive criteria or differing requirements are explicitly stated in the Specifications, or mandated by governing codes or regulations, the recommendations, suggestions, and requirements described in the referenced standards shall be deemed mandatory and applicable to the Work.

- 1. American Society of Testing and Materials (ASTM) standards, latest editions.

- C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- C33 Standard Specifications for Concrete Aggregates.
- C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- C78 Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Three-point Loading)
- C94 Standard Specification for Ready-Mixed Concrete.

- C127 Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Course Aggregate.
  - C131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
  - C143 Standard Test Method for Slump of Hydraulic Cement Concrete.
  - C150 Standard Specification for Portland Cement.
  - C172 Standard Method of Sampling Freshly Mixed Concrete.
  - C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
  - C192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
  - C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
  - C260 Standard Specifications for Air-Entraining Admixtures for Concrete.
  - C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
  - C330 Standard Specification for Lightweight Aggregates for Structural Concrete.
  - C387 Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
  - C494 Standard Specification for Chemical Admixture for Concrete.
  - C496 Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
  - C567 Standard Test Method for Density of Structural Lightweight Concrete.
  - C685 Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.
  - C882 Standard Test Method for Bond Strength of Epoxy-Resin Systems used with Concrete by Slant Shear
  - C1315 Standard Specification for Liquid-Forming Compounds Having Special properties for Curing and Sealing Concrete
  - E96 Standard Test Methods for Water Vapor Transmission of Materials
  - E154 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs
  - E329 Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials used in Construction
  - E1643 Standard Practicew for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
  - E1745 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
2. American Concrete Institute (ACI) standards, latest editions per International Building Code 2021, New Jersey Edition.
- ACI 117 Standard Tolerances for Concrete Construction and Materials
  - ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
  - ACI 211.2 Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
  - ACI 212.3R Chemical Admixtures for Concrete.

ACI 214	Evaluation of Results of Tests Used to Determine the Strength of Concrete.
ACI 301	Specifications for Structural Concrete for Buildings.
ACI 302.1R	Guide for Concrete Floor and Slab Construction.
ACI 304R	Guide for Measuring, Mixing, Transporting and Placing Concrete.
ACI 305R	Hot Weather Concreting.
ACI 306R	Cold Weather Concreting.
ACI 308	Standard Practice for Curing Concrete.
ACI 309R	Guide for Consolidation of Concrete.
ACI 311.4R	Guide for Concrete Inspection.
ACI 318	Building Code Requirements for Reinforced Concrete

3. American Association of State Highway and Transportation Officials

T318 Water Content of Freshly Mixed Concrete Using Microwave Oven Testing

1.5 DEFINITIONS

A. Exposed to view

1. Situated so that it can be seen from eye level from a public location. A public location is that which is accessible to persons not responsible for operation or maintenance of the building.

B. Lightweight concrete

1. Concrete intentionally made to have low density by use of lightweight aggregate conforming to ASTM C330 and required to have an air-dry unit weight less than 115 lb/ft<sup>3</sup>.

C. Normal weight concrete

1. Concrete for which density is not a controlling attribute, made with aggregates of the types covered by ASTM C33 and usually having unit weights in the range of 135 to 160 lb/ft<sup>3</sup>.

D. Reveal: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.

1.6 DESIGN REQUIREMENTS

A. Performance Characteristics:

1. Interior slabs on grade: Normal weight concrete with a minimum compressive strength of 4000 psi, non-air entrained, and a maximum water to cement ratio of 0.45.
2. Foundations, footings, foundation walls, piers, and buttresses: Normal weight concrete with a minimum compressive strength of 4000 psi, air entrained, and a maximum water to cement ratio of 0.40.
3. Exterior slabs on grade (pavements, stairs, areaways, ramps, etc), exposed to the elements: Normal weight concrete with a minimum compressive strength of 4000 psi, air entrained, and a maximum water to cement ratio of 0.40.

4. Exterior framed slabs exposed to the elements: Normal weight concrete with a minimum compressive strength of 4000 psi, air entrained, and a maximum water to cement ratio of 0.40.
5. Concrete for retaining walls: Normal weight concrete with a minimum compressive strength of 4500 psi, air entrained, and a maximum water to cement ratio of 0.40.
6. Interior slabs of superstructure: Normal weight concrete with a minimum compressive strength of 4000 psi, air-entrained, and a maximum water to cement ratio of 0.45.
7. Concrete curbs on roof: Normal weight concrete with a minimum compressive strength of 4000 psi, air-entrained and a maximum water to cement ratio of 0.40.
8. Concrete parapet: Normal weight concrete with a minimum compressive strength of 4000 psi, air-entrained and a maximum water to cement ratio of 0.40.

## 1.7 SUBMITTALS

### A. Product Data: Submit manufacturers' information for the following:

1. Admixtures
2. Curing compounds
3. Hardener
4. Bonding Agent
5. Waterstop

### B. Quality Control Submittals

1. Design Data: Submit design mixes for concrete, including list of admixtures to be used, to the Testing Agency, the Special Inspector, and the Engineer of Record. Design mix for lightweight concrete shall include both the dry and saturated (SSD) weights of the aggregate.
2. Test Reports: Strength Test Report (28 day) for preliminary trial mix (with all admixtures).
3. Certificates
  - a. Approval for the admixtures and cement used.
  - b. Admixture manufacturer's certificate stating that the chloride content of the admixture will not exceed 0.05% by weight.
  - c. Concrete laboratory license number and certification of meeting ASTM E329 standards.
  - d. Concrete producer's certificate stating the plant and trucks are NJDOT approved.
  - e. Concrete producer's certificate must be presented at site before concrete is placed in accordance with the 2021 IBC NJ Edition.
4. Manufactures' Instructions
  - a. Waterstop manufacturer's instructions for proper installation of waterstop, including manner in which splices are to be made.
5. Contractor Qualifications
  - a. Provide proof of Installer and Producer qualifications specified under "Quality Assurance".

C. Survey

1. Submit signed and sealed copies of surveys conducted by a Licensed Land Surveyor showing elevations of all finished slab surfaces taken on a 15-foot grid pattern. Indicate discrepancies between contract elevation and actual.

D. Mock-up

1. Provide mock-up as indicated under Quality Assurance.

1.8 QUALITY ASSURANCE

A. Qualifications

1. Concrete Installer: Company specializing in performing the Work of this Section shall have three years minimum experience on successful projects of similar size.
2. Concrete Producer: Company specializing in the production of concrete shall be certified by the National Ready Mixed Concrete Association (NRMCA) and shall have certification by either a New Jersey Agency or the NJ Department of Transportation. The plant shall use NJDOT approved trucks and drivers shall be certified by the NRMCA.
3. Concrete Laboratory: Concrete laboratory providing design mixes shall be New Jersey licensed and shall meet the requirements of ASTM E329.

B. Regulatory Requirements

1. Building Code: Work of this Section shall conform to all requirements of the 2021 IBC NJ Edition and all applicable regulations of governmental authorities having jurisdiction including safety, health, noise, and anti-pollution regulations. Where more severe requirements than those contained in the Building Code are given in this Section, the requirements of this Section shall govern.
2. Industry Standards: The ACI Standards listed under references apply to Work of this Section. Where more severe requirements than those contained in the Standards are given in this Section or the Building Code, requirements of this Section or the Building Code shall govern. The Contractor shall keep a copy of ACI SP-15 - "Field Reference Manual" at the site.
3. Recommendations or suggestions in the codes and references listed in this Article and under "References" shall be deemed to be mandatory unless they are in violation of the Building Code.

C. Certifications

1. Cement and aggregate shall be acquired from the same source for all work. If a change in suppliers is required, a new mix submittal must be produced with the new material and submitted for approval.

D. Coordination

1. Coordinate this work with the work of other Divisions so that items to be installed are done so correctly and in proper sequence.



E. Mock-up

1. Provide mock-up of texture for exterior pavements, etc. All mock up to be verified by RU PM.

F. Pre-Concrete Conference

1. At least 35 days prior to the start of the concrete construction schedule, conduct a meeting to review the proposed mix designs and to discuss the required methods and procedures to achieve the required concrete quality. The contractor shall send a pre-concrete conference agenda to all attendees 20 days prior to the scheduled date of the conference. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
  - a. Contractor's superintendent.
  - b. Independent testing agency responsible for concrete design mixtures.
  - c. Ready-mix concrete manufacturer.
  - d. Concrete subcontractor.
  - e. Special Inspector.
  - f. Structural Engineer of Record.
2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semi-rigid joint fillers, forms and form removal limitations, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect material from the elements and from other damage on the site.
- B. Replace and pay for material and work damaged to the satisfaction of the Owner.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Adequately protect concrete placed during rain, sleet, or snow, or when the mean daily temperature falls below 40°F or rises above 90°F as provided in Article 3.05.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Lightweight Aggregate
  1. Northeast Solite Corporation, or approved equal.

2. Norlite Corporation, or approved equal.

**B. Admixtures**

1. Euclid Chemical Company, or approved equal.
2. Master Builders, or approved equal.
3. Sika Chemical Corporation, or approved equal.
4. Anti Hydro Company, or approved equal.
5. Chem Masters, or approved equal.
6. W.R. Grace & Co., or approved equal.
7. St. Lawrence Cement Company, or approved equal.

**C. Curing Compounds**

1. Euclid Chemical Company, or approved equal.
2. Master Builders, or approved equal.
3. Sika Corporation; SikaFilm, or approved equal.

**D. Bonding Agent**

1. Sto Concrete Restoration Division, or approved equal.
2. Sika Corp, or approved equal.
3. Euclid Chemical Company, or approved equal.

**E. Densifier/Sealer**

1. Euclid Chemical Company, or approved equal.
2. Curecrete Chemical Company, Inc., or approved equal.

**F. Fireproofing Accessories**

1. Equipment Distribution Corporation, or approved equal.

**G. Waterstops**

1. Sika Corp, or approved equal.
2. W.R. Meadows, or approved equal.
3. BoMetals Inc., or approved equal.
4. ConSeal, or approved equal.

**2.2 MATERIALS**

**A. Cement: Shall conform to ASTM C150 and shall be of the non air-entrained types:**

1. Unless otherwise specified or approved by the Engineer of Record, cement shall be Type I or II.
2. Type II shall be used for exterior pavements.
3. Cement shall not contain ingredients that would result in more than two percent air being entrained in the concrete.

**B. Admixtures**

1. General

- a. The final soluble chloride content in concrete, percent by weight of cement, due to the addition of admixtures and other ingredients shall not exceed 0.05 at 28 days. All admixtures shall be non-corrosive.
- b. The amount of cement required by the Building Code may be reduced by 40% as per the code with the use of slag cement that has been reviewed and approved by the Architect and Engineer.
- c. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2. Air-entraining admixture: Shall conform to ASTM C260.
3. Water-reducing admixture: Shall conform to ASTM C494, Type A or D, and contain no more chloride ions than found in drinking water.
4. High range, water-reducing admixture (super- plasticizer): Shall conform to ASTM C494, Type F or G, and contain no more chloride ions than found in drinking water.
5. Water reducing, accelerating admixture: Shall conform to ASTM, Type C or E, and contain no more chloride ions than found in drinking water.
6. Water reducing, retarding admixture: Shall conform to ASTM C494, Type D, and contain no more chloride ions than found in drinking water.
7. Slag cement: ASTM C989, Grade 100 or 120. Shall be GranCem slag cement as manufactured by the St. Lawrence Cement Company.
8. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
  - a. Basis-of-Design Product: Subject to compliance with requirements provide "CHROMIX P Admixture" manufactured by L.M. Scofield Company, or approved equal by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to:
    - 1) ChemMasters, or approved equal.
    - 2) Dayton Superior Corporation, or approved equal.
    - 3) Lambert Corporation, or approved equal.
  - b. Color: Chromix No. C-34 Dark Gray.

C. Aggregates

1. Fine and coarse aggregates shall be regarded as separate ingredients. Each size of coarse aggregate, as well as the combination of sizes when two or more are used, shall conform to the appropriate grading requirements of the applicable ASTM specifications. Maximum size of coarse aggregate shall conform to paragraph 3.3.2 of ACI 318.
  - a. Aggregates for normal weight concrete shall conform to ASTM C33 and be of Size No.67 and/or No.8.
  - b. Aggregates for lightweight concrete shall conform to ASTM C330 and be of sizes 3/4" to No.4, 1/2" to No.4, and/or 3/8" to No.8.

D. Curing Compounds

1. Non-strippable
    - a. Clear Curing and Sealing Compound (A.I.M. Regulations - VOC Compliant, 350 g/l): Liquid type membrane-forming curing compound, clear styrene acrylate type, complying with ASTM C1315, Type I, Class A, 25% solids content minimum. Moisture loss shall be not more than 0.40 Kg/m<sup>2</sup> when applied at 300 sq. ft./gal. Manufacturer's certification is required.
    - b. Curing Compounds shall be "Super Diamond Clear VOX" by The Euclid Chemical Company, "Masterkure 100W" by Master Builders, or approved equal.
  2. Strippable
    - a. Clear Curing Compound: Liquid type membrane-forming curing compound, complying with ASTM C309.
    - b. Curing Compounds shall be "Kurez DR Vox, Kurez W Vox by The Euclid Chemical Company, "Masterkure N-Seal VOC" by Master Builders, or approved equal.
- E. Bonding Agent
1. Epoxy/acrylic resin that will not form a vapor barrier with the concrete with the following properties:
    - a. Bond strength of 1800 psi in 2 hours when tested in accordance with ASTM C882.
    - b. Flexural strength of 2000 psi in 28 days when tested in accordance with ASTM C78.
    - c. Tensile strength of 600 psi in 28 days when tested in accordance with ASTM C496.
  2. Bonding agent shall be "CR246 Sto Bonding and Anti-corrosion Agent" by Sto Concrete Restoration Division, Armatec 110 by Sika Corp, Corr-bond by Euclid Chemical Company, or approved equal.
- F. Densifier/Sealer
1. The densifier/sealer compound shall be a silicate-based sealer that penetrates concrete surfaces, increases abrasion resistance and provides a "low-sheen" surface that is easy to clean. The compound shall contain a minimum solids content of 20%, of which 50% is silicate.
  2. Densifier/Sealer shall be "Euco Diamond Hard" by The Euclid Chemical Co., "Ashford Formula" by Curecrete Chemical Co., or approved equal.
    - a. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- G. Below Grade Waterstops & Vertical Drainage Panels
1. Provide PVC waterstops to all below grade basement retaining wall stem to footing joints. Install in accordance with the Manufacturer's Installation Instructions and as shown on the Construction Documents.
    - a. Greenstreak PVC Waterstop by SIKA
    - b. Sealtight PVC Waterstop by W.R. Meadows
    - c. PVC Waterstop by BoMetals, Inc.

- d. Or approved equal.
- 2. Provide Controlled Expansion Hydrophilic waterstops to all below grade basement retaining wall stem to ground slab. Install in accordance with the Manufacturer's Installation Instructions and as shown on the Construction Documents.
  - a. Swellstop Hydrophilic Waterstop by SIKA
  - b. ConSeal CS-231 Hydrophilic Waterstop by ConSeal
  - c. Hydro-Flex Waterstop by BoMetals, Inc.
  - d. Or approved equal.
- 3. Provide Drainage Panel to all below grade basement retaining wall stems. Install in accordance with the Manufacturer's Installation Instructions and as shown on the Construction Documents.
  - a. CCW MiraDRAIN 6000 by Carlisle
  - b. Or approved equal.

#### H. FORM-FACING MATERIALS

- 1. Form-Facing Panels for Exposed-Aggregate Finishes: Exterior-grade plywood panels, nonabsorptive, that will provide continuous, true, and smooth architectural concrete surfaces, high-density overlay, Class 1, or better, complying with DOC PS 1.
- 2. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or Type S, Grade NS, that adheres to form joint substrates.
- 3. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.
- 4. Exposed Aggregate Walls: Furnish internally disconnecting ties that will leave no metal closer than 1 ½ inches (38 mm)

#### I. LIQUID FLOOR TREATMENTS

- 1. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
  - a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) Conspec by Dayton Superior; Intraseal, or approved equal.
    - 2) Euclid Chemical Company, an RPM company; Euco Diamond Hard, or approved equal.
    - 3) Meadows, W. R., Inc.; LIQUI-HARD, or approved equal.

### 2.3 MIXES

#### A. General

1. Concrete for all parts of the Work shall be of the specified quality capable of being placed without excessive segregation and, when hardened, of developing all characteristics required by the Specifications and Drawings.

**B. Strength**

1. Strength requirements given in Part 1 of this Specification are based on 28-day compressive strength (56 days for concrete containing 40% alternate cementitious material - slag), unless high early strength is specified, in which case required strengths are based on 7-day compressive strength (28-day for concrete containing 40% alternate cementitious material - slag).

**C. Method of Proportioning**

1. Proportion, batch, and mix concrete in accordance with ASTM C 94/C 94M and furnish batch ticket information.
2. Mix designs are specific to material used, concrete producer, and method of placement. Each mix design must be reviewed by the Engineer of Record and accepted prior to placement.

**D. Normal Weight Concrete**

1. Unless otherwise specified, proportion and produce normal weight concrete to have a maximum slump of 4" or less. A tolerance of up to 1" above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. The slump shall be determined by ASTM C143. Concrete containing High Range Water Reducer shall have a slump not exceeding 9", unless otherwise approved by the Engineer of Record. The concrete shall arrive at the job site at a slump of 2" to 3", be verified, and the HRWR admixture added to increase the slump to the approved level.
2. Where Normal weight concrete is indicated to be air-entrained, provide the following air content for the grading size of coarse aggregate as follows:
  - a. No.8.....7½%
  - b. No.67.....6%
3. Tolerance on air content as delivered shall be +1.5%.

**E. Structural Lightweight Concrete:** Lightweight concrete, including concrete used as roof fill and other locations indicated to receive fill, shall conform to the following requirements:

1. Coarse aggregate shall be 100% lightweight aggregate, expanded clay, shale, or slate produced by the rotary kiln method, conforming to the requirements of ASTM C330. Provide 3/8" maximum size coarse aggregate for beam and/or column encasement.
2. The concrete shall not exceed an air dry unit weight of 115 lb/ft<sup>3</sup> as measured in accordance with ASTM C567. The wet unit weight of the fresh concrete shall be within +3 lbs of the wet unit weight which is to be determined and established from the preliminary tests or prequalified mixes.
3. Unless otherwise specified, proportion and produce lightweight concrete to have a slump of 3" or less. A tolerance of up to 1" above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested,

whichever is fewer, does not exceed the maximum limit. The slump shall be determined by ASTM C143. Concrete containing High Range Water Reducer shall have a slump not exceeding 9", unless otherwise approved by the Engineer of Record. The concrete shall arrive at the job site at a slump of 3" to 4", be verified, and the HRWR admixture added to increase the slump to the approved level.

4. Provide the following air content for the grading size of coarse aggregate as follows:
  - a. 3/8" ... 4 1/2 - 7 1/2 %
  - b. 3/4" ... 4 - 6 %
5. Tolerance on air content as delivered shall be +1.5%.
6. Mix design shall include the dry and saturated (SSD) weights of the lightweight aggregate. The saturated weight shall take into account the internal and surface moisture content that will be in the aggregate at the time of mixing.
7. Mix design shall be based on the recommendations of the lightweight aggregate producer.

## 2.4 SOURCE QUALITY CONTROL

### A. Tests

1. The Owner's Testing Laboratory will review and/or check test proposed materials for compliance with the Specifications prior to construction.
2. The Testing Laboratory will perform field tests as work progresses as listed in "Field Quality Control".

### B. Inspection

#### 1. Testing Laboratory

- a. The Owner will engage a Licensed Concrete Testing Laboratory to inspect batching of the concrete, at the Owner's discretion, and perform all field tests. The Laboratory will perform the following services:
  - 1) Review and/or check-test the Contractor's proposed materials for compliance with the Specifications.
  - 2) Review and/or check-test the Contractor's proposed mix design.
  - 3) Secure production samples of materials at plants or stock-piles during the course of the Work and test for compliance with the Specifications.
  - 4) Perform tests during construction as required by the International Building Code 2021, New Jersey Edition & applicable ACI codes. The Laboratory will obtain samples at the mixer and when directed by the Engineer at the point of placement by the following methods:
    - a) Secure composite samples in accordance with ASTM C172. Each sample shall be obtained from a different batch of concrete on a random basis, avoiding any selection of the test batch other than by a number selected at random before commencement of concrete placement.
    - b) Mold and cure specimens from each sample in accordance with ASTM C31 and perform strength tests.

- b. The Owner may assign a qualified concrete technician to be stationed at the batch plant depending on the size of the project or evidence of poor concrete breaks. At least one qualified concrete technician will be stationed at the site to obtain the test specimens.
  - c. The Laboratory will be responsible to and under the supervision of the Special Inspector.
- 2. Special Inspector
  - a. The Owner will assign, under the requirements of Section BC 1704.2.1 a Special Inspector who will supervise the testing of the materials and the inspection of concrete construction. The Special Inspector is responsible any required filing with the Building Department, as well as maintaining a log book of the concrete work.
  - b. The Special Inspector will check that all required tests are made and the results submitted and shall have the right to order the Contractor to make such changes of the mix of concrete as required to produce concrete of the necessary strength. The Special Inspector will also report to the Building Department Superintendent any deviation from the requirements of the Building Code, as indicated by records of inspection and reports of tests.
- 3. Notification
  - a. Notify the Owner in writing at least forty-eight hours in advance of each concrete placement. The Owner will notify the Testing Laboratory immediately to order out the necessary concrete technicians to cover the work.
  - b. Once the concrete technicians are ordered out and a cancellation follows, the Contractor will be charged Six Hundred Dollars for each technician so ordered to appear, unless a cancellation order is issued to the Laboratory by 3 PM the day before the concrete placement.
  - c. During the placement of the concrete, notify the Owner immediately of any delay at the concrete plant or at the job site. Where the Owner decides to provide a technician at the plant, do not mix concrete or add admixtures unless the Technician is present. Do not add admixtures to be added at the site unless the Technician is present.
- 4. Contractors Responsibility for Quality Control
  - a. The Contractor will receive a copy of all reports prepared by the Laboratory and/or Special Inspector. Copies of the daily concrete reports prepared by the Special Inspector will be available for reference.
  - b. The Contractor will therefore be afforded an opportunity to review all reports and mix data and submit to the Special Inspector any recommendations in changing the mixes provided they conform to the Code and Specifications. Any testing required because of changes in materials or proportions of the mix requested by the Contractor, as well as any extra testing of concrete or materials occasioned by the failure to meet Specification requirements shall be at the Contractor's expense. The Contractor, at any time, can arrange to have independent tests made at own expense by an approved laboratory and submit the reports and recommendations to the Special Inspector and Engineer of Record.
  - c. The tests and inspections, as provided in the Code, do not in any way relieve the Contractor of responsibility to construct the Work in accordance with the Drawings and Specifications and to use safe, standard methods of construction at all times,



safeguarding the public, workmen, and structure. The Contractor shall be solely responsible for the physical control of the materials and concrete mixes, and shall see that such mix designs, tests, and controls are in accordance with the Code and Specifications.

- d. It shall be the Contractor's complete responsibility to adjust, alter, and/or correct any controls necessary in materials and/or concrete operation based upon tests and inspections made by the Owner or the Contractor's independent tests. If, during the course of the concrete operations, a lower water content or more cement is needed per cubic yard above that used in the approved design mix, provide same at no additional cost to the Owner.
- e. If the Contractor requests any deviation from the Specifications and Drawings, or makes or causes to be made any change of construction from Drawings and Specifications, and such request requires the time and investigation of the Engineer of Record, pay all costs incurred by the Owner relating to such time and investigation.

### **PART 3 -EXECUTION**

#### **3.1 EXAMINATION**

- A. Prior to placement of concrete, verify that the concrete cover over the reinforcement is that specified on Drawings.
- B. Verify that anchor bolts, reinforcement, and all other embedded items are provided and held securely, positioned accurately, and will not be a detriment to concrete placement.
- C. Examine all adjoining work on which this Work is in anyway dependent for proper installation and workmanship. Report to the Owner any condition that prevents the performance of this Work.

#### **3.2 PROTECTION**

- A. Protect concrete members on grade and the subgrade from freezing before and after installation. Provide blankets and other items necessary.
- B. Protect adjacent finish materials and previously poured concrete against spatter during concrete placement.
- C. Protect hardener and concrete coating flooring systems from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by hardener/sealer and concrete coating flooring systems manufacturers.
- D. Provide and maintain barricades and safeguards around openings, etc. to protect workmen from injury and to comply with all Building Code, OSHA, and other authorities having jurisdiction regulations.

#### **3.3 PREPARATION**

- A. Remove ice, excess water, trash, and rubbish from forms.
- B. Remove hardened concrete from inner surfaces of conveying equipment and all formwork, reinforcement, and dowels.
- C. Prepare previously placed concrete to be in contact with new concrete in the manner described under "Construction Joints".
- D. Prepare existing concrete to be in contact with new concrete by roughening and cleaning the surface and applying a bonding agent. Surface must be free of laitance. Concrete must be placed after agent cures and within 20 hours of applying bonding agent. If time elapses, apply a new application in accordance with the directions of the manufacturer.
- E. In case a conflict arises between concrete as poured and other Work that requires cutting into concrete beams, columns, walls, or slabs, submit requests to the Engineer of Record, who will issue instructions accordingly. Cutting of concrete is otherwise prohibited.
- F. Do not place concrete on frozen ground.

### 3.4 JOINTS AND EMBEDDED ITEMS

#### A. Construction Joints

- 1. Make joints not shown on Drawings at locations that will least impair the strength of the structure. Such location is subject to the approval of the Engineer of Record.
- 2. Continue reinforcement across joints. Provide longitudinal keys at least 1½" deep in walls and provide other keys as required. Drawings indicate keys or roughened surface at interface of walls and footings.
- 3. Thoroughly clean concrete surface of oil, grease, and other contaminants and remove all laitance prior to placement of adjoining concrete. Roughen surface of the concrete in an approved manner that will expose the aggregate uniformly to a 1/4" amplitude and will not leave laitance, loosened particles of aggregate, or damaged concrete at the surface. Dampen surface immediately prior to placement.
- 4. Properly install all embedded items where required.
- 5. Install waterstops.

#### B. Expansion Joints

- 1. Do not extend reinforcement or other embedded metal items bonded to concrete continuously through expansion joint. Provide smooth dowels greased on one end at the joints with end cap or insert into pvc sleeve of length greater than the dowel length by .75" minimum.
- 2. Provide joint filler of type specified in Section 079200 at the expansion joint of the sizes indicated on the Drawings or specified herein.

#### C. Other embedded items

- 1. Place all fence sleeves and shoes, pipe sleeves, inserts, anchors, anchor bolts, and other embedded items required for the Work of other Divisions or for their support prior to concreting. Install Link-seal Watertight Sleeves by Thunderline Corp. through foundation

walls and other locations where watertight construction is required and where indicated on Drawings as per manufacturer's instructions. Coordinate with other trades, all Drawings, and manufacturer for sizes, location, and quantity.

2. Provide ample notice and opportunity for items of other Division to be introduced and/or furnished for installation before concrete is placed. Coordinate the Work of the other Divisions so all items are placed in their proper location.
3. Set metal pipe sleeves, sockets, shoes, etc. into concrete to receive fence posts or any other items, all as indicated on details.

D. Placement of Embedded Items

- E. Position expansion joint material, waterstops, and other embedded items accurately and support against displacement. Fill voids in sleeves, anchor slots, and inserts temporarily with readily removable material to prevent the entry of concrete into the voids.

### 3.5 MIXING AND PLACING CONCRETE

A. General

1. Notify Owner at least 48 hours in advance of each concrete placement. Do not place concrete without approval of the Special Inspector.
2. Do not allow rainwater to increase mixing water nor damage surface finish.
3. When placing concrete in cold weather (air temperature below 40°F), concrete shall contain either an accelerating admixture or use Type III cement.

B. Mixing

1. Batch, mix, and transport ready-mixed concrete in accordance with ASTM C 94/C 94M and furnish batch ticket information. Truck mixers and agitators shall meet the requirements of the Truck Mixers Manufacturer's Bureau or shall comply with Section 8.1.2 of ASTM C94 and shall be NJDOT approved. All trucks shall have working revolution counters and site gages. Batch all other concretes in accordance with subsection 4.3.1 of ACI 301 only if permitted by the Engineer of Record and Special Inspector.
2. Batch ready-mixed concrete only in plants that are NRMCA certified and NJDOT approved. Only plants that are NJDOT approved with current certification meeting the requirements for certification of the NRMCA for automatic batching and automatic recording will be permitted. Concrete shall be batched by the use of automation.
3. Unless otherwise approved by the Engineer of Record, concrete shall be deposited within 1½ hours or 300 revolutions of the mixing drum, whichever comes first, after introduction of water to the cement or cement to the aggregate. When the ambient temperature rises above 90°F, the time shall be decreased to 1 hour.
4. Batch lightweight concrete using the saturated weight of aggregate, which shall take into account the internal and surface moisture content.
5. Tempering and control of mixing water
  - a. Mix concrete only in quantities for immediate use. Concrete that has started to set shall not be rettempered, but shall be discarded. Water shall not be added at the site.
  - b. For concrete containing HRWR (Superplasticizer), if loss of slump occurs, HRWR may be redosed at the site as long as a "flash set" has not occurred. Redosage

procedures must be discussed and approved by the Engineer and the admixture manufacturer at the Pre-Concrete Conference.

6. Weather Conditions

a. Cold weather (Air Temperatures below 40°F)

- 1) Concrete shall have either an accelerating admixture or use Type III cement.
- 2) The temperature of concrete delivered at the site shall conform to the temperature limitations given in Section 5 of ACI 301.
- 3) If water or aggregate is heated above 100°F, combine the water with the aggregate in the mixer before cement is added. Cement shall not be mixed with water or with mixtures of water and aggregate having a temperature greater than 100°F.
- 4) Detailed requirements are given in ACI 306R.

b. Hot Weather (Air Temperatures above 90°F)

- 1) Cool the ingredients before mixing, or substitute flake ice or well-crushed ice of a size that will melt completely during mixing for all or part of the mixing water if, due to high temperature, low slump, flash set, or cold joints are encountered.
- 2) Detailed requirements are given in ACI 305.

7. Admixtures - General

- a. Add all admixtures prior to mixing unless otherwise specified or directed.
- b. Air-entraining admixtures and other chemical admixtures shall be charged into the mixer as solutions and shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if so recommended by the manufacturer. The accuracy of measurement of any admixture shall be within +3 percent.
- c. If two or more admixtures are used in the concrete, add them separately to avoid possible interaction that might interfere with the efficiency of either admixture or adversely affect the concrete. Do not charge admixtures into the mixer in such a manner that they will come in direct contact with the cement.
- d. Use of accelerating admixtures or Type III cement shall not relax cold weather placement requirements.
- e. Use of retarding admixtures in hot weather must be approved by the Special Inspector. Use of such admixtures will not relax hot weather placement requirements.

C. Placing

1. General: Place concrete in accordance with ACI 304R and ACI 318.
2. Conveying
  - a. Handle concrete from the mixer to place of final deposit as rapidly as practicable by methods that will prevent separation or loss of ingredients and in a manner that will assure that the required quality of concrete is obtained.

- b. Conveying equipment shall be approved and shall be of a size and design such that detectable setting of concrete shall not occur before adjacent concrete is placed. Conveying equipment shall be cleaned at the end of each operation or workday. Conveying equipment and operations shall conform to the following additional requirements:
  - 1) Truck mixers, agitators, and non-agitating units and their manner of operation shall conform to the applicable requirements of ASTM C94.
  - 2) Belt conveyors shall be horizontal or at a slope which will not cause excessive segregation or loss of ingredients. Concrete shall be protected against undue drying or rise in temperature. An approved arrangement shall be used at the discharge end to prevent apparent segregation. Mortar shall not be allowed to adhere to the return length of the belt. Long runs shall be discharged into a hopper or through a baffle.
  - 3) Chutes shall be metal or metal-lined and shall have a slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20' long and chutes not meeting the slope requirements may be used provided they discharge into a hopper before distribution.
  - 4) Pumping or pneumatic conveying equipment shall be of suitable kind with adequate pumping capacity. Pneumatic placement shall be controlled so that segregation is not apparent in the discharged concrete. The loss of slump in pumping or pneumatic conveying equipment shall not exceed 2". Pumping is permitted only if a pump mix is approved. Concrete shall not be conveyed through pipe made of aluminum or aluminum alloy.
- 3. Depositing: Detailed recommendations are given in ACI 304R.
  - a. General
    - 1) Deposit concrete continuously, or in layers of such thickness that no concrete will be deposited on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, locate construction joints at points as provided for in the Drawings, shop drawings, or as approved.
    - 2) Carry out placement at such a rate that the concrete that is being integrated with fresh concrete is still plastic. Do not deposit concrete that has partially hardened or has been contaminated by foreign material.
    - 3) Place concrete in a manner that uniformly distributes the material over the metal deck in order to avoid overloading the deck joints.
    - 4) Remove temporary spreaders in forms when the concrete placing has reached an elevation rendering their service unnecessary. They may remain embedded in the concrete only if made of metal or concrete and if prior approval has been obtained.
    - 5) Placing of concrete in supported elements shall not be started until the concrete previously placed in columns and walls is no longer plastic.
  - b. Segregation: Deposit concrete as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure that will cause segregation. The maximum drop height shall be five feet. Provide drop tubes for placement in forms and other locations where drop height exceeds the indicated maximum.

- c. Consolidation
  - 1) Consolidation of concrete and the use and type of concrete shall be in accordance with ACI 309R.
  - 2) Where a surface mortar is to be the basis of the finish, the coarse aggregate shall be worked back from the forms with a suitable tool so as to bring a full surface of mortar against the form, without the formation of excessive surface voids.
  - 3) Consolidate all concrete by vibration so that the concrete is thoroughly worked around the reinforcement, around embedded items and into corners of forms, eliminating all air or stone pocket or weakness. Internal vibrators shall be the largest size and most powerful that can be used in the Work, as described in Table 5.1.5 of ACI 309R, with a minimum frequency of 7000 revolutions per minute and shall be operated by competent workmen. Overvibrating and use of vibrators to transport concrete within forms is not permitted. Insert and withdraw vibrators at many points, from 18" to 30" apart. At each insertion, the duration shall be sufficient to consolidate the concrete but not sufficient to cause segregation, generally from 5 to 15 sec duration, and shall reach the bottom of the pour. Keep a spare vibrator on the job site during all concrete placing operations.
- 4. Cold Weather Concrete Placement and Protection: Detailed requirements are given in ACI 306.
  - a. When the mean daily temperature of the atmosphere is less than 40°F during concreting, or within 72 hours there after (or the air temperature is not greater than 50°F for more than one-half of any 24-hr period for a period of 3 consecutive days), follow the procedures outlined in ACI 306R to protect the concrete. Provide a cold weather concreting plan as well as list of equipment and material (e.g. thermometers, blankets) to be used to the Special Inspector. Temperature of the plastic concrete shall be no lower than 55°F. Heat all forms, reinforcing steel, and surfaces to receive concrete above the freezing point and keep them completely free of frost, snow, and ice. Protection shall consist of insulating boards, blankets, or heated enclosures. Underside of slabs shall be heated during placement and protection period. Initial protection period shall be as indicated in tables 5.1 and 5.3 of ACI 306R. Maximum temperature drop of concrete surface after protection is removed shall follow table 5.5 of ACI 306R.
- 5. Hot Weather Placement and Protection: When the mean daily temperature of the atmosphere is over 90°F during concreting, follow the procedures outlined in ACI 305R to protect the concrete.
  - a. All concrete, at the time it is actually deposited in the forms, shall have a temperature not lower than 50°F but never above 90°F.
  - b. Cover reinforcement with water-soaked burlap to cool steel so its temperature will not exceed the ambient air temperature immediately before concrete placement.
  - c. Dry surfaces that are to receive concrete should be wet down before commencing placement of concrete and the temperature of such surfaces should not exceed the temperature of the concrete being placed.

6. For elevated slabs, anticipate deflection of the structure and shoring during concrete placement and during removal of shoring and provide additional concrete as required to achieve the levelness specified.

### 3.6 FINISHING OF FORMED SURFACES AND REPAIR OF SURFACE DEFECTS

#### A. General

1. Remove forms as soon as practicable. Refer to Section 031000.
2. Repair surface defects, including tie holes and cracks, immediately after form removal. Patches shall be of quality to match the specified finish.
3. Remove oil, grease, compounds, and other contaminants from surfaces and areas to be repaired, those surfaces in contact with sprayed fireproofing, and those receiving coatings (ie. plaster, waterproofing, paint, and membranes of any kind).
4. Provide finishes specified below immediately after form removal.
5. Provide curing and protection.

#### B. Repair of Surface Defects

1. Remove all honeycombed and other defective concrete down to sound concrete. If chipping is necessary, the edges shall be perpendicular to the surface or slightly undercut. Undercut all cracks a minimum of 1" x 1". No featheredges will be permitted. Dampen the area to be patched and an area at least 6" wide surrounding it to prevent absorption of water from the patching mortar. A bonding grout shall be prepared using a mix of approximately 1 part cement to 1 part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream, and then well brushed into the surface.
2. The patching mortar shall be made of the same materials and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2½ parts sand by damp loose volume. Substitute white Portland cement for a part of the gray portland cement on exposed concrete in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch. If the material color cannot be matched properly, the Contractor shall use a specialty repair mortar of the Engineer of Record's choice at the Engineer's discretion. The quantity of mixing water shall be no more than necessary for handling and placing. Mix the patching mortar in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.
3. After surface water has evaporated from the area to be patched, brush the bond coat well into the surface. When the bond coat begins to lose the water sheen, apply the premixed patching mortar. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, leave it undisturbed for at least 1 hr before final finishing. Keep the patched area damp for 7 days. Do not use metal tools for finishing a patch in a formed wall that will be exposed.
4. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.
  - a. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete

**C. Tie Holes and Other Repairs**

1. Remove ties, nails, and other form accessories below the concrete surface when the surface is exposed to view, the elements, or for surfaces to receive waterproofing or dampproofing. For surfaces not exposed to view or the above-mentioned conditions, remove metal to the surface. Refer to Section 031000.
2. Undercut surfaces of holes. After cleaning and thoroughly dampening the holes, fill them solid with the patching mortar. The mortar shall match the color of the existing concrete for concrete exposed to view as specified in paragraph B.2 above.

**D. Formed Finishes**

**1. Rough Form Finish**

- a. Provide for concrete not exposed to view unless otherwise indicated under "Finishing" below.
- b. Formwork material given in Section 031000.
- c. Repair surface as indicated in B. and C. above.
- d. Chip or rub off fins exceeding 1/4" in height.

**2. Smooth Form Finish**

- a. Provide for concrete exposed to view, concrete receiving sheet membrane waterproofing, or as indicated under "Finishing" below. Areas exposed to view shall have a CS 3 or better finish as developed by the Cresset Chemical Company.
- b. Formwork material is given in Section 031000.
- c. Repair surfaces as indicated in B. and C. above.
- d. Chip or rub off fins completely and grind smooth.
- e. Provide smooth rubbed finish unless otherwise indicated below.

**E. Finishing**

**1. Smooth Rubbed Finish**

- a. Provide for smooth form finish except for those items listed in 2 below.
- b. Produce on newly hardened concrete no later than the day following form removal.
- c. Wet the surfaces and rub with a No. 16 carborundum brick or other equal abrasive to obtain a smooth, even surface of uniform appearance without applying any cement or other coating.
- d. Obtain the final finish by thoroughly rubbing with a No. 30 carborundum brick. The surface shall be wet for a period of 3 days. The Owner shall be the sole judge of whether the finish is proper.

**2. Ceiling Surfaces, Beams and Columns**

**a. Non-painted Concrete**

- 1) Work Required: Provide smooth form finish without rubbing.



- b. Acoustical Tile Ceiling: When the Drawings indicate that the tile is to be applied directly to the underside of concrete slabs, provide the non-painted concrete finish. However, exposed beam haunches and exposed columns shall be "CRP".
- c. Hung Ceiling: Where hung ceilings are indicated on Drawings or specified, provide a rough form finish.
- d. Columns: Exposed concrete surfaces of columns shall be non-painted concrete finish or "CRP" as determined by the required ceiling finish of the room in which columns are located.

3. Liquid Floor Treatments

- a. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
  - 1) Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
  - 2) Do not apply to concrete that is less than seven days' old.
  - 3) Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
- b. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.
- c. Concrete floors which are to be exposed within the finished building, and which are not scheduled to receive an applied finish, shall be sealed. Membrane-forming curing and sealing compounds shall not be used where slabs are to receive liquid floor hardener or other coatings or finish materials, as incompatibility issues can lead to failures of the finish system or materials. Wet curing is required where resilient flooring is to be applied directly to the concrete slab. Curing compounds, when approved by EOR and architect, must be completely removed from the surface of the concrete prior to installation of resilient flooring.

F. Acceptance of Concrete Finish

- 1. If the finish produced is not acceptable to the Owner, the Contractor shall be responsible for all costs incurred to produce an acceptable finish by whatever means determined by the Owner.

3.7 SLABS

A. Placement

- 1. Mixing and placing shall be carefully coordinated with finishing. Do not place concrete on the subgrade or forms more rapidly than it can be spread, straightedged, and darbied or bull floated. Provide leveling, floating, troweling, etc. at the correct time interval after pouring to prevent dusting and a non-durable surface as specified in ACI 302.1R. These operations must be performed before bleeding water has an opportunity to collect on the surface.

2. To obtain good surfaces and avoid cold joints, the size of finishing crews shall be planned with due regard for the effects of concrete temperature and atmospheric conditions on the rate of hardening of the concrete.
3. Provide extra concrete as required to make up for any deflections in the metal deck and steel beams in order to provide a level surface using a laser. The beam, girder, and deck deflections may total up to 1½”.

B. Leveling and Finishing

1. General

- a. Carefully provide slab depressions as required for the finishes indicated on the Drawings.
- b. Unless otherwise indicated on the Drawings or specified herein, make all slabs even and uniform in appearance and, where no slope is required, level within plus or minus 3/16” in ten feet. All float-finished slabs shall achieve a tolerance of 5/16” in 10 feet and all trowel-finished surfaces shall achieve a tolerance of 3/16” in 10 feet. For small areas such as stairs, and for areas that will be finished with wood flooring, tolerance shall be 1/8” in ten feet. Tolerance is measured by placing a freestanding 10-foot straight edge anywhere on the slab and allowing it to rest upon two high spots within 72 hours after slab concrete placement. The gap between the straight edge and floor shall not exceed the above-specified tolerance.
- c. Where floor drains or floor slopes are indicated, slope slabs uniformly to provide even fall for drainage.
- d. Floors shall achieve flatness and levelness using the “F” number system, according to ACI 302.1R and tested according to ASTM E1155.
- e. Protect finishes from contamination from time of placing until time of acceptance, placement of topping, etc.
- f. Remove defects of sufficient magnitude to show through floor coverings or that do not meet tolerances by grinding.

2. Finishes

- a. Surfaces which receive bonded applied cementitious applications such as full-set vitreous ceramic tile, concrete fills and toppings, cementitious membrane waterproofing: Strike off and level to the proper elevation. After the topping has stiffened sufficiently to permit the operation, float the surface to a uniform sandy texture. The surface shall then be broomed to a texture as approved by the Architect.
- b. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
  - 1) Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
- c. Surfaces to receive floor coverings, such as resilient flooring, thin-set terrazzo and vitreous ceramic tile, carpeting, wood floors, or surfaces that are exposed or painted finishes such as at auditorium floors and stairs, unless specified otherwise: Steel trowel surface to a smooth dense finish, free of trowel marks, grooves, depressions and ripples with a tolerance no greater than 3/16” in ten feet (1/8” at wood floors). Exposed or painted slabs are to have a “hard trowel” finish (a second steel hand

troweling). Apply densifier/sealer to slabs exposed or painted, except for those specified below to have no finish. Apply two coats in accordance with the manufacturer's instructions at the proper time.

- d. Surfaces intended to receive roofing, water-proofing membranes: Level and wood float surface. Leave surface free from depressions, bulges, rough spots, and other defects.
- e. Surfaces with no finishes: Areaways, pipe and duct, and crawl spaces; Level and wood float surface level or toward drains if required.
- f. Pavements: Finish surface to a true smooth plane and texture with a toothed roller or float with a wood float. Score concrete pavement in squares of approximately 5'-0" and/or as shown on Drawings. Each rectangular slab shall have all edges neatly rounded with proper tools and be bounded on all sides by a troweled border about 1" in width.
- g. Ramps, Driveways, Exterior Concrete Steps: Level and float surface. Follow with a broom finish perpendicular to direction of traffic.

C. Slabs on Grade

1. General

- a. Aggregate base and crushed stone base material and preparation is part of Work of Section 310000.
- b. Where pavements to remain are damaged or destroyed as a result of the Work, patch, repair, or replace as required. Color to match existing.
- c. Subgrade and/or aggregate base/crushed stone base shall be free of frost before concrete placing begins.
- d. Control Joints:
  - 1) Primary Method: Soff-Cut System method, by Soff-Cut International, Corona, CA (800)776-3328. Finisher must have documented successful experience in the use of this method prior to this project. Install cuts within 2 hours after final finish at each saw cut location. Use 1/8 inch thick blade, cutting 1 1/4 inch into slab.
  - 2) Optional Method (Where Soff-Cut System Method Equipment is Not Available): Properly time cutting with the set of the concrete. Saw-cut control joints within 12 hours after finishing. Start cutting as soon as the concrete has hardened sufficiently to prevent aggregates being dislodged by the saw. Complete cutting before shrinkage stresses become sufficient to produce cracking. Use 1/4" thick blade, cutting 1/4 slab depth.

2. Pavements, Areaways

- a. Provide 4" thick concrete slab unless otherwise indicated.
- b. Provide 6x6-W2.9xW2.9 WWF placed 2" from top surface.

3. Driveways

- a. Provide 7" thick concrete slab.
- b. Provide 4x4-W4xW4 WWF placed 2" from top surface.

4. Expansion joints

- a. Provide expansion joints for all exterior concrete pavements, driveways, etc. specified under this Section or as shown on Drawings. Expansion joints shall occur at intervals not to exceed 20' in each direction or as indicated on Drawings.
- b. Provide continuous expansion joints at the following locations: Driveways and other concrete pavements abutting area walls, buildings, retaining or any other walls, check pieces, steps, curbs. Also provide at the perimeter of interior slabs on grade (except for framed slabs) and as indicated on contract drawings.
- c. Expansion joint shall be 1/2" wide, full depth, and flush except where sealer is to be provided at exterior pavements, driveways, and where indicated on Drawings. In this case joint shall be full depth minus 1/4" to allow for the poured joint sealer.

D. Structural Lightweight Concrete Fill

1. Structural lightweight concrete fill is required at the following location:
  - a. As a gradient fill on the roof slab to obtain the required slope.
  - b. As a gradient fill to receive setting beds where structural slab is more than 2" below finished floor level.
  - c. Other areas as indicated on Drawings.
2. Prepare concrete surface to receive fill by cleaning laitance, grease, oil, dust, etc. by mechanical or other acceptable means.
3. Immediately prior to placement of fill, dampen surface (without leaving standing water) and scrub in bonding grout composed of a mix of approximately 1 part cement to 1 part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream or the bonding agent. Do not allow bonding grout to set or dry before fill is placed.
4. Provide finish as specified in paragraph B of this Article.

3.8 MISCELLANEOUS CONCRETE WORK

- A. Provide trap-pits, curbs, walls, retaining walls, ramps and other miscellaneous concrete items.

3.9 PATCHING AND BONDING TO EXISTING CONCRETE

- A. Provide bonding agent whenever new concrete is to be poured against existing concrete, whenever the time between concrete pours is longer than that allowed for proper bond, and wherever bonding agent is indicated on the Drawings to be applied.
- B. Remove loose concrete from surface to be bonded with new concrete and clean. Remove rust from reinforcement and structural steel by power chipping and power driven brushes.
- C. Apply bonding agent in accordance with manufacturer's specifications. Pour concrete as soon as bonding agent has cured and within 20 hours after application. If the 20-hour period has elapsed, then the bonding agent must be reapplied.

3.10 CURING AND PROTECTION

- A. General

1. Begin curing concrete immediately after placement and finishing. Protect all freshly deposited concrete from premature drying and excessively hot or cold temperatures and maintain it with minimal moisture loss at a relatively constant temperature for the period of time necessary for the hydration of the cement and proper hardening of the concrete. Detailed procedures are given in ACI 308 and the International Building Code 2021, New Jersey Edition.
2. Cure floor surfaces in accordance with ACI 308.
3. Do not apply curing compounds to surfaces receiving waterproofing, adhesives, membranes or additional concrete unless approved by adhesive or material manufacturer or compound is removed in an approved manner. As an alternate, provide wet curing. Coordinate curing requirements with all related specifications.

**B. Procedure**

1. Concrete surfaces not in contact with forms:
  - a. Ponding or continuous non-manual sprinkling.
  - b. Absorptive mat or fabric, sand, or other covering kept continuously wet.
  - c. Curing compounds conforming to ASTM C1315 or strippable curing compound conforming to ASTM C309.
2. Concrete surfaces in contact with forms:
  - a. Minimize moisture loss from forms exposed to heating by the sun by keeping forms wet until they are removed.
  - b. After form removal, cure with one of the methods listed in 1 above.
3. Continue curing until a total of 7 days has elapsed during which the temperature of the air in contact with concrete has remained above 50°F. Prevent rapid drying during and at the end of the curing period.
4. Remove all curing compounds with cleaners recommended by curing compound manufacturer.

**C. Cold Weather Curing**

1. Concrete must be protected from water loss. This shall be accomplished by the application as soon as possible without harm to the concrete surfaces of either (a) exhaust steam, or vapor-resistant paper or polyethylene film, or (b) curing compounds. In all other respects, curing shall conform to applicable provisions of this Section. Concrete temperature shall be maintained between 50°F and 70°F. Comply with ACI 306.1-90 for cold-weather protection.

**D. Hot Weather Curing**

1. During the period June 1 to October 1 or when hot weather conditions require it, maintain continuous water curing for a minimum period of twenty-four hours. Provide for windbreaks, shading, and other necessary provisions.
2. After 24 hours, curing shall be by one of the methods specified under B above. In all other respects, curing shall conform to applicable provisions of this Specification. Upon termination of the specified moist curing, every effort should be made to reduce the rate of

drying by avoiding air circulation. Comply with ACI 301-10 for hot-weather protection during curing.

- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
  2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
    - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
  3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
    - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
  4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.
- F. Where curing is delayed by low temperature and fly ash content, provide additional heating as required to cure concrete as required to achieve the scheduled completion date for the work.
- G. Protection from mechanical injury: Protect concrete from mechanical disturbances during curing period as described under "Protection and Cleaning".

### 3.11 ARCHITECTURAL CONCRETE FINISH

1. Finish Preparation: Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair and patch tie holes and defects.
2. Abrasive-Blast Finish: Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi (13.8 MPa). Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at same age for uniform results.
  - a. Surface Continuity: Perform abrasive-blast finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in depths of blast to match design reference sample or mockup.
  - b. Abrasive Blasting: Abrasive blast corners and edges of patterns carefully, using backup boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match design reference sample or mockup.

### 3.12 FIELD QUALITY CONTROL

- A. Tests to be performed by the Owner's Testing Laboratory during construction are as follows:
  1. Compliance of materials to Specifications tested from production samples.
  2. Determination of the slump of the concrete for each sample taken and whenever consistency of the concrete appears to vary using ASTM C143. The Special Inspector will reject any concrete that does not meet the slump requirements.
  3. Determination of water content of freshly mixed normal weight concrete utilizing the procedure of AASHTO T318. Concrete that does not meet the maximum water to cement ratio or the proportions given in the approved design mix will be immediately rejected regardless of slump.
  4. Strength tests on the specimens in accordance with ASTM C39:
    - a. The frequency of conducting strength tests of concrete, with additional cylinders taken for an additional strength test and one cylinder for a 7-day break. Strength tests shall be performed for each 50 cubic yards, or portions thereof, of concrete placed in any one day's concreting. Specimens will be stored at the site in the insulated curing box provided by the Contractor. Each group of specimens is considered one strength test. One cylinder will be broken at 7 days for information.
      - 1) Portland cement concrete: A strength test shall be performed at 28 days for acceptance. The remaining cylinders for the additional strength test will be tested only if the 28-day breaks are low or durability of the concrete is in question.
      - 2) Portland cement concrete with 40% alternate cementitious material: A strength test will be performed at 28 days to determine if the strength has been made and/or if the strengths are sufficient to continue work, even if not at the required design compressive strength. Depending on temperature, concrete strength can be attained at 28 days even though the strength is considered a 56-day strength. If the first cylinder tested indicates the strength has not been met, the remaining cylinders of the test will be broken at a later date. One set of strength test will be done at 56 days.

- b. If one specimen in a test manifests evidence of improper sampling, molding, or testing, it shall be discarded and the average strength of the remaining cylinders shall be considered the test result. Should all specimens in a test show any of the above defects, the entire test shall be discarded.
5. Determination of air content and unit weight of normal weight concrete sample for each strength test in accordance with ASTM C173 or C231 and ASTM C138.
6. Determination of air content and unit weight of lightweight concrete sample for each strength test in accordance with ASTM C173 or C231 and ASTM C567.
7. Determination of temperature of concrete sample for each strength test.

B. Inspection

1. Refer to "Source Quality Control" for responsibility and procedure.
2. The Contractor shall cooperate in the making of all tests by the Laboratory Technician by:
  - a. Providing a well-constructed shanty, to be approved by the Owner, located adjoining the Owner's inspector's office. This shanty shall have an area of not less than 50 sq ft, be well lighted, and provided with a table for mixing concrete, shelves for storage of the Laboratory's equipment, molds, etc., one chair, hinged door with suitable lock.
  - b. Providing an insulated curing box of sufficient size and strength to contain all specimens made in any four consecutive working days. The Contractor shall furnish an outlet to provide the necessary temperature in the storage box, pending delivery to the Laboratory of the test cylinders.
  - c. Providing a buggy for transporting the concrete taken from the mixer (and/or point of placement) to the shanty for testing and the preparation of specimens.
  - d. Protecting the property of the Laboratory to be stored in the shanty and keeping test specimens free from vibration and other disturbances.
  - e. Providing a microwave of the size specified in AASHTO T318 and a portable generator.

C. Evaluation and Acceptance of Concrete

1. Strength tests on structural concrete will be evaluated according to ASTM C39/C39M.
2. When the average strength of the test cylinders, according to ASTM C39/C39M, falls consistently below the specified strength ( $f'_c$ ), the Owner shall have the right to order the Contractor to change the proportions or the water content of the concrete to secure the required strength for the remaining portion of the structure, all at the Contractor's expense. It is the Contractor's complete responsibility to modify the concrete mix design, material controls, and/or concrete operations where necessary to obtain the compressive strength required by the design and Specification.
3. When the average strength of test cylinders for any portion of the structure is less than that required by the design or Specification, or where there is other evidence that the quality of the concrete is below Specification requirements, the adequacy of the concrete will be checked according to the requirements of ACI 318, Section 5.6.5 either by structural analysis or by core or load tests or by any combination of these procedures. The Engineer of Record will determine which procedures to use.
4. Exterior concrete exposed to the elements with low strength test results or other evidence of poor durability will be rejected.
5. Low Strength Tests of Concrete or evidence of poor durability - Results



- a. Pay for additional costs of labor and materials required at the job for all damages resulting from load tests and the taking of cores. Remove and replace concrete work that is not of adequate strength or durability and cannot be made to work by remedial methods acceptable to the Owner at own cost. The Contractor shall be held responsible for all delays and damages to the work of other Divisions that occur as a result of non-conformance.
- b. Pay for all expenses borne by the Owner resulting from low strength test procedures or evidence of poor durability (such as high slump) specified above.

D. Contractor's Surveys

1. Provide surveys of finished concrete elevations for all building slabs. Provide elevations taken on a 15-foot grid pattern. Indicate discrepancies between contract elevation and actual. Interpolate sloped areas such as roof slabs. Do not proceed with finish work until slabs are repaired.

3.13 PROTECTION AND CLEANING

A. General

1. During the curing period, and thereafter as conditions may require, protect the concrete from damaging mechanical disturbances, particularly excessive load stresses, heavy shock, and excess vibration. Protect all finished concrete surfaces from damage caused by construction equipment, materials or methods, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to overstress the concrete.

B. Floors

1. Floors that have received their final finish shall be closed to all traffic for at least 48 hours following the completion of troweling. Avoid damage to the floor and repair, clean, and prep floor for finishes.

3.14 ACCEPTANCE OF CONCRETE WORK

A. General

1. Completed concrete work that meets all applicable requirements will be accepted without qualification.
2. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.
3. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Specifications or in the Contract Documents. In this event, modifications may be required to assure that remaining work complies with the requirements.
4. Concrete work judged inadequate by structural analysis, core test, results of load test or deemed unacceptable due to appearance or durability concerns shall be repaired, reinforced with additional construction if so directed by the Engineer of Record, or be replaced if so directed by the Engineer at the Contractor's expense.

5. Pay all costs incurred by the Owner in providing additional testing and/or analysis required by this Section.
6. The Owner will pay all costs of additional testing and analysis made at its own request that is not required by this Section or that shows concrete is in compliance with the Contract Documents.

**B. Dimensional Tolerances**

1. Formed surfaces resulting in concrete outlines smaller than permitted by the tolerances of Section 031000 shall be considered potentially deficient in strength and subject to the provisions of paragraph D below.
2. Formed surfaces resulting in concrete outlines larger than permitted by the tolerances of Section 031000 may be rejected and the excess material subject to removal. If removal of the excess material is permitted, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other applicable requirements of function and appearance.
3. Concrete members cast in the wrong location may be rejected if the strength, appearance, or function of the structure is adversely affected or if misplaced items interfere with other construction.
4. Inaccurately formed concrete surfaces exceeding the limits on Section 031000 and which are exposed to view may be rejected and shall be repaired or removed and replaced if required.
5. Slab tolerance from theoretical elevation is 1/2" plus or minus in accordance with ACI 117. Finished slabs exceeding the tolerances, including specified levelness tolerances, may be repaired provided that the strength or appearance is not adversely affected. High spots may be removed with a terrazzo grinder, low spots filled with a structural repair mortars, or other remedial measures performed as permitted. Provide self-leveling cement based materials for large expanses of deficient areas. All materials shall be approved by the Engineer of record and installed by the Contractor at its cost.
6. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 48 hours of finishing.
7. For tolerances not specifically indicated in the Contract Document, follow requirements of ACI 117.

**C. Appearance**

1. Concrete exposed to view with defects that adversely affect the appearance of the specified finish may be repaired only by approved methods.
2. Concrete not exposed to view is not subject to rejection for defective appearance.

**D. Strength of Structure**

1. The strength of the structure in place will be considered potentially deficient if it fails to comply with any requirements that control the strength of the structure, including but not necessarily limited to the following conditions:
  - a. Low concrete strength as described under "Field Quality Control".
  - b. Reinforcing steel size, quantity, strength, position, or arrangement at variance with the requirements of Section 032000 or the Contract Documents.
  - c. Concrete that differs from the required dimensions or location in such a manner as to reduce the strength.

- d. Curing less than that specified.
  - e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
  - f. Mechanical injury as defined under "Protection and Cleaning", construction fires, accidents, or premature removal of formwork likely to result in deficient strength.
- 2. Structural analysis and/or additional testing may be required when the strength of the structure is considered potentially deficient.
  - 3. Core tests may be required when the strength of the concrete in place is considered potentially deficient.
  - 4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required and their results evaluated in accordance with Chapter 20 of ACI 318.

END OF SECTION 033000

**SECTION 035416 CEMENT LEVELING COMPOUND**

**PART 1 GENERAL**

**1.1 DESCRIPTION**

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

**1.2 SECTION INCLUDES**

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the cement leveling compound as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:
  - 1. Self-leveling cement compound applied over precast concrete substrates, thickness shall be 1/8" minimum.

**1.3 RELATED SECTIONS**

- A. Cast-in-Place Concrete - Section 033000.

**1.4 QUALITY ASSURANCE**

- A. Applicator: Company specializing in performing the work of this Section with a minimum of 3 years' experience and approved by the manufacturer of the product used.

**1.5 SUBMITTALS**

- A. Submit catalog information and product data for material to be used.
- B. Submit approval letter as required by Article 3.1, para. B. herein.

**1.6 PRODUCT HANDLING**

- A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.
- B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

**1.7 MOCK-UP**

- A. Construct a mock-up of underlayment material, 8 feet long by 8 feet wide.
- B. Locate where directed by the Architect.
- C. Approved mock-up may remain as part of the Work.

**1.8 JOB REQUIREMENTS**

- A. Do not install underlayment until floor penetrations and peripheral work are complete.

- B. Maintain minimum ambient temperatures of 50 degrees F. 24 hours before, during, and 72 hours after installation of underlayment.
- C. During the curing process, ventilate spaces to remove excess moisture and until underlayment is dry, allow a minimum of seven (7) days.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURER**

- A. Subject to the requirements specified herein, provide one of the following products:
  - 1. "Supercap SC500" by Laticrete.
  - 2. "Sikalevel 325" by Sika.
  - 3. "Level Set 200" by ProSpec.
  - 4. "Super Flo-Top" made by Euclid Chemical Co.
  - 5. "K-15" made by Ardex.
  - 6. "Ultraplan 1 Plus" by the Mapei Corp. (rapid setting).
  - 7. "Novoplan 2" by the Mapei Corp. (standard setting).
  - 8. "Level Quick R/S" or "E/S" by Custom Building Products.
  - 9. Or approved equal

### **2.2 MATERIALS**

- A. Underlayment: One of the above listed products.
- B. Water: Potable and not detrimental to underlayment mix materials.
- C. Primer: Manufacturer's recommended type.
- D. Joint and Crack Filler: Latex based.

### **2.3 MIXING**

- A. Site mix materials in accordance with manufacturer's instructions.
- B. Mix to achieve following characteristics:
  - 1. Density: 115 lb./cu. ft. minimum dry density.
  - 2. Compressive Strength: 4,000 psi minimum in accordance with ASTM C 109.
  - 3. Fire Hazard Classification: Flame/Smoke rating of 0/0 in accordance with ASTM E 286.
- C. Mix to self-leveling consistency.

### **PART 3 EXECUTION**

#### **3.1 INSPECTION**

- A. Examine the areas and conditions where cement leveling compounds are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.
- B. Manufacturer's representative must inspect surfaces to receive cement leveling compound and approve those surfaces in writing to the Architect prior to start of application.

#### **3.2 PREPARATION**

- A. Vacuum clean surfaces; remove any material (curing compounds, film, dirt) that would be detrimental to bond of cement leveling compound.
- B. Prime substrate in accordance with manufacturer's instructions. Allow to dry.
- C. Close floor openings.

#### **3.3 APPLICATION**

- A. Install underlayment in accordance with manufacturer's instructions.
- B. Place to minimum 1/8" thickness.
- C. Transition to existing floor; use stiff mix to slope to align with existing adjacent floor.

#### **3.4 CURING**

- A. Air cure in accordance with manufacturer's instructions.

#### **3.5 APPLICATION TOLERANCE**

- A. Top Surface: Level to 1/8 inch in 10 ft.

#### **3.6 PROTECTION OF FINISHED WORK**

- A. Do not permit traffic over unprotected floor underlayment surfaces and until underlayment is completely dry.

**END OF SECTION**

## **SECTION 04 2000 - UNIT MASONRY**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Concrete masonry units.
2. Clay Brick.
3. Thin Clar Brick – locations indicate only.
4. Mortar and grout materials.
5. Masonry joint Reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Accessories.

**B. Products Installed but not Furnished under This Section:**

1. 1. Steel lintels in unit masonry.

**C. Steel reinforcing bar, grout and accessories: Refer to Structural sections and drawings.**

#### **1.2 PREINSTALLATION MEETINGS**

**A. Preinstallation Conference: Conduct conference at Project site.**

#### **1.3 ACTION SUBMITTALS**

**A. Product Data: For each type of product.**

**B. Shop Drawings: For reinforcing steel: Indicate bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315R. Indicate elevations of reinforced walls.**

**C. Samples:**

1. Full-size unit For each type and color of exposed masonry unit
2. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
3. Cavity drainage material.
4. Weep holes/ vents.
5. Accessories embedded in masonry.

#### **1.4 INFORMATIONAL SUBMITTALS**

**A. Material Certificates: For each type and size of product and for masonry units, include data on material properties, material test reports substantiating compliance with requirements.**

1. Masonry units.
    - a. Include data on material properties.
    - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
    - c. For exposed brick, include test report for efflorescence per ASTM C 67.
    - d. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
  2. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
  3. Grout mixes. Include description of type and proportions of ingredients.
  4. Reinforcing bars.
  5. Joint reinforcement.
  6. Anchors, ties, and metal accessories.
- B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
  2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.
- C. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

## 1.5 QUALITY ASSURANCE

- A. Sample Panel Mockups: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects.
1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 60 inches long by 48 inches high by full thickness.
  2. Include and install minimum 1 masonry expansion joint with sealant
  3. Clean mockup faces after installation

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.



- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

## 1.7 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
  - 1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.
  - 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe, and hold cover in place.
  - 3. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
  - 4. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that meets masonry.
  - 5. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
  - 6. Protect sills, ledges, and projections from mortar droppings.
  - 7. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
  - 8. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.
- C. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

## PART 2 - PRODUCTS

### 2.1 2.1 MANUFACTURERS

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

## 2.2 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602, except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
  - 1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

## 2.3 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
  - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
  - 2. Provide square-edged units for outside corners unless otherwise indicated.
- B. CMUs: ASTM C90, lightweight unless otherwise indicated.
  - 1. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
  - 2. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

## 2.4 LINTELS

- A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
- B. Offset Angle Supports: galvanized Steel angle anchored to structure through thermal isolation plate with thermal bushings and washers, allowing continuous insulation behind shelf angle supporting veneer. Refer to structural drawings for bolt and anchor spacing and sizes
  - 1. Structural thermal isolation Plates specified in section 055000 metal fabrications
- C. Galv. Steel Lintels: refer to section 055000 metal fabrications. Loose lintels to be primed and painted

## 2.5 BRICK

- A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
1. For ends of sills and caps, below grade brick, and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
  2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
  3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
  4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Clay Face Brick: Facing brick complying with ASTM C216 Grade SW, Type FBX
1. As Manufactured by and subject to compliance for BRICK-1 at locations designated on the drawings
    - a. BRICK-1 as designated on the drawings
      - 1) Taylor Clay Inc ,
        - a) color: Cobalt, River Birch texture
      - 2) Or approved equal
    - b. BRICK-2 as designated on the drawings
      - 1) Taylor Clay Inc ,
        - a) color: Cobalt, Wirecut texture
      - 2) Or approved equal
    - c. BRICK-3 as designated on the drawings
      - 1) Glen-Gerry Inc ,
        - a) color: pumpkin glazed
      - 2) Or approved equal
  2. Unit compressive strength: Minimum average compressive strength not less than 15,600psi
  3. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested in accordance with ASTM C67/C67M.
  4. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
  5. Size (Actual Dimensions): MODLAR BRICK, 2-1/4 inches high by 7-5/8 inches long, by 3-5/8" wide.
  6. Texture: as indicated on drawings to match architects sample
- C. Thin Clay Brick: Acceptable only at locations indicated on plans at site retaining wall. Complying with ASTM C 1088, exterior grade, Type TBX, tested in accordance with ASTM C67
1. Color and texture to match facing brick in type designated on drawings.
  2. Thickness: 3/4" & provide corner units at all corners.

## 2.6 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
  - 1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Colored Cement Products: Packaged blend made from portland cement and hydrated lime cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
- E. Preblended Dry Mortar Mix: Packaged blend made from portland cement and hydrated lime , masonry cement, sand, mortar pigments, water repellents, and admixtures and complying with ASTM C1714/C1714M.
- F. Aggregate for Mortar: ASTM C144.
  - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
  - 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
  - 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
- G. Aggregate for Grout: ASTM C404.
- H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with [ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated. Not acceptable for use in thin brick.
  - 1. BASF Corporation; Construction Systems.
  - 2. Euclid Chemical Company (The); an RPM company.
  - 3. Grace Construction Products; W.R. Grace & Co. -- Conn.
  - 4. Or approved equal.
- I. Water: Potable.
- J. Mortar for thin brick:
  - 1. Mortar shall conform to ASTM C 270 standard specification for mortar for unit masonry under guidelines provided in BIA technical notes #8 series.
    - a. Type S
  - 2. Cold weather additives (including accelerators) shall not ne used in thin brick mortar mix.

## 2.7 CMU MASONRY REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60 .
- B. CMU Masonry-Joint Reinforcement, General: ASTM A951/A951M.
  - 1. Interior Walls: Hot-dip galvanized carbon steel.
  - 2. Exterior Walls: Hot-dip galvanized carbon steel.
  - 3. Wire Size for Side Rods: 0.148-inch diameter.
  - 4. Wire Size for Cross Rods: 0.148 diameter.
  - 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
  - 6. Provide in lengths of not less than 10 ft., with prefabricated corner and tee units.
- C. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
  - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Dur-O-Wal; a Hohmann & Barnard company.
    - b. Heckmann Building Products, Inc.
    - c. Hohmann & Barnard, Inc.
    - d. Wire-Bond.
    - e. Or approved equal.
- D. CMU Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.
  - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Dur-O-Wal; a Hohmann & Barnard company.
    - b. Heckmann Building Products, Inc.
    - c. Hohmann & Barnard, Inc.
    - d. Wire-Bond.
    - e. Or approved equal.

## 2.8 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
  - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
  - 2. Stainless Steel Wire: ASTM A580/A580M, Type 304.
  - 3. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
  - 4. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.

- C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized steel wire.
  2. Tie Section: Triangular-shaped wire tie made from 0.187-inch- diameter, hot-dip galvanized steel wire where anchoring CMU masonry
- D. Adjustable Masonry-Veneer Anchors:
1. General: Provide anchors that allow vertical adjustment but resist a 100 lbf load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.
  2. Fabricate wire ties from 0.187-inch- diameter, Stainless-steel wire
  3. Continuous wire reinforcement to be provided at stacked bond masonry veneer, made from 0.148-inch diameter, stainless steel wire
  4. Screw attached Masonry-Veneer Anchors for use at metal studs:
    - a. Dual diameter single-Barrel stainless steel Screw with single or double Pintle Wingnut:
      - 1) Self-drilling, single-barrel screw with thermally resistant wingnut head designed to receive pintle wire tie.
      - 2) Screw has a smooth barrel the same thickness as insulation with factory-installed gasketed washer to seal at face of insulation and additional gasket to seal at weather barrier installed direct to sheathing.
      - 3) Screw to have a coating to reduce thermal conductivity.
    - b. Where stack bond masonry: Provide with seismic tie, clip, and continuous stainless steel wire reinforcement in veneer.
    - c. Basis-of-Design, Product: Subject to compliance with requirements, provide the following:
      - 1) Hohmann & Barnard, Inc.; Thermal 2-seal tie
      - 2) Or approved equal
  5. Screw attached Masonry-Veneer Anchors for use at CMU:
    - a. Dual diameter single-Barrel stainless steel Screw with single or double Pintle Wingnut:
      - 1) single-barrel screw with thermally resistant wingnut head designed to receive pintle wire tie.
      - 2) Screw has a smooth barrel the same thickness as insulation with factory-installed gasketed washer to seal at face of insulation and additional gasket to seal at weather barrier installed direct to sheathing.
      - 3) Screw to have a coating to reduce thermal conductivity.
      - 4) Pre-drill hole in concrete/CMU construction in accordance with manufacturer requirements.
    - b. Where stack bond masonry: Provide with seismic tie, clip, and continuous stainless steel wire reinforcement in veneer.
    - c. Basis-of-Design, Product: Subject to compliance with requirements, provide the following:

- 1) Hohmann & Barnard, Inc.; Thermal Concrete 2-seal tie
  - 2) Or approved equal
6. Stainless Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 diameter by length required to penetrate steel stud flange with not less than three exposed threads; either made from Type 410 stainless steel or made with a carbon-steel drill point and 300 Series stainless steel shank.

## 2.9 THROUGH-WALL FLASHING

### A. Stainless Steel Flashing Materials

1. Stainless Steel Flashing: ASTM A 240, Type 304, stainless steel, with 2D finish, dead soft temper, fully annealed, as manufactured by International Nickel Co., Republic Steel Corp., United States Steel, or Washington Steel Corp. Thickness of stainless steel shall be as listed below.
  - a. Concealed Flashings: 0.012" thick, thirty (30) gauge (U.S. Standard).
  - b. Exposed Flashings: 0.015" thick, twenty-eight (28) gauge (U.S. Standard).
  - c. Edge Strips: 0.025" thick, twenty-four (24) gauge (U.S. Standard).
2. Through-wall flashing shall have sawtooth ribs at three (3) inch intervals, as manufactured by Keystone Flashing Co., or approved equal.
3. Solder: Composed of sixty (60) percent block tin and forty (40) percent pig lead, except that solder at seams exposed to public view shall be eighty (80) percent tin and twenty (20) percent lead.
4. Flux: An acid type flux manufactured specifically for soldering stainless steel, as approved.

### A. Thru-wall Flashing Accessories:

1. AISI, Types 302 and 304 stainless steel.
2. Termination Bars for Flexible Flashing: Stainless steel bars 1/8 inch by 1 inch, apply continuous sealant at top edge.
3. EndDams: Stainless steel not less than 24ga. with minimum 4" flanges
4. Inside and outside corners: Stainless steel not less than 24ga. with minimum 4" flanges at wall face

## 2.10 ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 or PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

- C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).
- D. Weep/Cavity Vents: Use the following:
  - 1. Cellular Plastic Weep/Vent: One-piece, rectangular vent with honeycomb to restrict insect and debris. Full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard. Tubes or open rectangles will not be accepted
    - a. Products: Subject to compliance with requirements, provide the following:
      - 1) QV Quadro Vent as supplied by Hohmann & Barnard.
      - 2) CellVent by Mortar Net Solutions
      - 3) Or approved equal.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
  - 1. Mortar Deflector: Strips, full depth of cavity and 10 inches high, with dovetail-shaped notches that prevent clogging with mortar droppings.
    - a. Products: Subject to compliance with requirements, provide the following:
      - 1) Mortar Net, as supplied by Mortar Net Solutions.
      - 2) Mortar Trap by Hohmann & Barnard
      - 3) Or approved equal.
- F. Proprietary Acidic Masonry Cleaner: Cleaner recommended in writing by Brick Manufacturer for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

## 2.11 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
  - 1. Do not use calcium chloride in mortar or grout.
  - 2. Use portland cement-lime mortar unless otherwise indicated.
  - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
  - 1. For masonry below grade or in contact with earth, use Type M.
  - 2. For reinforced masonry, use Type S.



3. For exterior, above-grade, load-bearing, nonload-bearing walls, and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, Type S as recommended by brick manufacturer due to low-absorption properties of brick.
  4. For interior nonload-bearing partitions, Type N.
- D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
1. Pigments shall not exceed 10 percent of portland cement by weight.
  2. Mix to match Architect's sample.
  3. Application: Use pigmented mortar for exposed mortar joints at brick, see drawings for basis of design color to match
- E. Grout for Unit Masonry: Comply with ASTM C476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602 for dimensions of grout spaces and pour height.
  2. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.1.2 for specified 28-day compressive strength indicated, but not less than 2500 psi
  3. Provide grout with a slump of 8 to 11 inches as measured in accordance with ASTM C143/C143M.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
- C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

### 3.2 TOLERANCES

- A. Dimensions and Locations of Elements:
  1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch .
  2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.

3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 ft, or 1/2-inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft, or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 ft., or 1/2-inch maximum.

C. Joints:

1. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) from one masonry unit to the next.
2. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 1/2 inch or minus 1/4 inch).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

### 3.3 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Lay exposed masonry in bond indicated on drawings, lay CMU in running bond unless otherwise indicated. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- D. Fill space between steel frames and masonry with mineral wool insulation.
- E. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated. Refer to structural drawings

### 3.4 MORTAR BEDDING AND JOINTING

- A. Lay CMUs as follows:
1. Bed face shells in mortar and make head joints of depth equal to bed joints.
  2. Bed webs in mortar in all courses of piers, columns, and pilasters.
  3. Bed webs in mortar in grouted masonry, including starting course on footings.
  4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
  5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.
  6. Tool joints flush on side of units to receive fluid-applied weather barrier in accordance with weather barrier manufacturer requirements
  7. Tool exposed joints at interior side.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. **At CMU face within wall cavity shall be prepared as follows:**
1. **Strike joints flush, fill all voids with mortar ready to receive fluid applied weather barrier**
  2. **according to air and water membrane manufacturer's written recommendations and free of contaminants such as grease oil and wax, free from projections, all joints struck, all voids filled with mortar. All surface irregularities shall be ground flush or made smooth with all gaps around penetrations filled with mortar and struck flush. Remove any mortar droppings from brick ties, shelf angles, brick shelves or other horizontal obstructions.**
- D. Tool exposed joints at interior side of CMU slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

### 3.5 CAVITY WALLS

- A. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- B. Installing Cavity Wall Insulation: Place small dabs of adhesive compatible with fluid-applied membrane weather barrier as needed until attached with masonry anchored designed for this purpose. Press units firmly against inside wythe of masonry or other construction as indicated.

### 3.6 ANCHORED MASONRY VENEERS

- A. Anchor masonry veneers to wall framing and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:

1. Fasten screw-attached anchors through sheathing to wall framing and to masonry backup with metal fasteners of type indicated.
2. Embed tie sections, and continuous wire in masonry joints.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than 16 inches (457 mm) o.c. vertically and horizontally. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 24 inches (610 mm), around perimeter.

### 3.7 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 8 inches.
  1. Space reinforcement not more than 16 inches o.c.
  2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
  3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.

### 3.8 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
  1. Provide an open space not less than 3/4 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
  2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
  3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

### 3.9 LINTELS

- A. Install steel lintels where indicated, to maintain cavity dimension.
  1. Refer to structural drawings where lintel is to be anchored to supporting steel through structural thermal isolation plate, washers and bushings.
- B. Provide concrete or masonry lintels where shown and where openings of more than 24 inches are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

### 3.10 FLASHING, WEEP HOLES, AND CAVITY VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
  - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
  - 2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches with termination bar installed at top edge.,
  - 3. At lintels and shelf angles, extend flashing 6 inches minimum past at each end. At heads and sills, extend flashing 6 inches minimum, and install with stainless steel end dams not less than 2 inches.
  - 4. Install metal drip edges with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
  - 5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall. Set metal drip flashing in bed of sealant to masonry and adhere flexible flashing to top of metal drip edge.
- C. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
  - 1. Use specified weep/cavity vent products to form weep holes.
  - 2. Space weep holes 16 inches o.c. unless otherwise indicated.
- D. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.
- E. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.

### 3.11 REINFORCED UNIT MASONRY

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
  - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches, 12.67 ft.

### 3.12 CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by methods described in BIA Technical Notes 20.
6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
7. Clean masonry with a proprietary acidic masonry cleaner applied according to manufacturer's written instructions.

### 3.13 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 2000

## SECTION 051200 - STRUCTURAL STEEL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Furnish and erect all structural steel as shown on Drawings. Provide shop painting and galvanizing as specified.

#### 1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Anchor Bolts for Structural Steel for Casting into Concrete - Section 033000

#### 1.4 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Loose Bearing and Base Plates for Structural Steel - Section 055000

#### 1.5 RELATED SECTIONS

- A. Metal Deck – 053000
- B. Painting - 099000

#### 1.6 REFERENCES

- A. References and industry standards listed in this Section are applicable to the Work. Unless more restrictive criteria or differing requirements are explicitly stated in the Specifications, or mandated by governing codes or regulations, the recommendations, suggestions, and requirements described in the referenced standards shall be deemed mandatory and applicable to the Work.

- 1. American Society of Testing and Materials (ASTM) standards, latest editions.

- A6 Standard Specification for General Requirements for Rolled Steel Bars, Plates, Shapes, and Sheet Piling.
- A36 Standard Specification for Carbon Structural Steel.
- A108 Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.



- A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both.
  - A307 Standard Specification for Carbon Steel Bolts and Studs, 60000 psi Tensile Strength.
  - A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
  - A490 Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
  - A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
  - A501 Standard Specification for Hot-Formed Welded Seamless Carbon Steel Structural Tubing.
  - A563 Standard Specification for Carbon and Alloy Steel Nuts.
  - A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coating.
  - A992 Standard Specification for Steel for Structural Shapes for Use in Building Framing
  - F436 Standard Specification for Hardened Steel Washers
  - F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
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- 2. "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings" 9th edition, including supplements - American Institute of Steel Constructors (AISC 335).
  - 3. "Load and Resistance Factor Design Specification for Structural Steel Buildings" 13th edition, including supplements - American Institute of Steel Constructors (AISC LRFD 2005).
  - 4. Seismic Provisions for Structural Steel Buildings (AISC 341-05).
  - 5. "Code of Standard Practice for Steel Buildings and Bridges" (AISC 303).
  - 6. "Standard Welding Symbols - A2.0" - American Welding Society (AWS).
  - 7. "Specification for Mild Steel Covered Arc-Welding Electrodes - A5.1" - AWS.
  - 8. "Specification for Low-Alloy Steel Covered Arc-Welding Electrodes - A5.5" - AWS.
  - 9. "Structural Welding Code - D1.1" - AWS.
  - 10. "Solvent Cleaning - SP1" - Steel Structures Painting Council (SSPC).
  - 11. "Hand Tool Cleaning - SP2" - SSPC.
  - 12. "Power Tool Cleaning - SP3" - SSPC.
  - 13. "Commercial Blast Cleaning - SP6" - SSPC.
  - 14. "Pickling - SP8" - SSPC.
  - 15. "Near-white Blast Cleaning - SP10" - SSPC.

## 1.7 DEFINITIONS

### A. Structural Steel

- 1. Structural Steel consists of the steel elements of the structural steel frame essential to support the design loads. These elements consist of material as shown on the structural

steel plan and listed in Article 2.1 of the AISC "Code of Standard Practice for Steel Buildings and Bridges."

B. Other Steel

1. Structural steel does not apply to those elements listed in Article 2.2 of the AISC "Code of Standard Practice for Steel Buildings and Bridges."

1.8 SUBMITTALS

A. Product Data: Submit manufacturers' specifications for the following products:

1. Primer paints, galvanizing repair paint
2. Stud shear connectors
3. Expansion/adhesive anchors
4. Hot-Dip Galvanizing

B. Shop Drawings

1. Failure to submit legible shop drawings will be cause for return without review.
2. All connections shall be designed by and all drawings shall be prepared under supervision of a Professional Engineer licensed in the State of New Jersey. Do not submit unchecked shop drawings. First submissions of all job standards, shop drawings of connections not shown on, or that are in deviation of, the job standards, and calculations shall have one set sealed and signed by the Engineer. After final approval of all shop drawings, submit a final set sealed and signed by the Professional Engineer.
3. Shear connections (framed beam, seated beam, single plate, etc.) shall be designed by the detailer's licensed engineer and detailed by the structural steel detailer, unless otherwise shown on Drawings. All wind and seismic connections (moment connections, bracing, etc.) are generally detailed on the Drawings. Based on the indicated loads (axial force, moment, etc.), the structural steel detailer's engineer shall design the connections. Those not detailed shall be detailed by the structural steel detailer.
4. Immediately after award of Contract and before preparing steel shop drawings, submit for review a set of job standards showing all necessary joint details with full particulars of connection pieces, shop and field welds, and holes for erection bolts and permanent bolts. These shall include any moment and shear connection designed by the Engineer of Record as well as those designed by the detailer. Appropriate marks for designating all types and sizes of joint details shall be included. Submit all calculations pertaining to the job standards. After approval of these job standards, the erection plans are to be submitted and shall be marked to indicate unmistakably the type and size of joint to be used for every beam connection. Do not order steel in advance of approval of the job standards and the erection plans with joint marks, except at own risk.
5. Prepare remainder of steel shop drawings after approval of job standards and erection plans. Drawings submitted prior to approval of job standards will be returned without review. Submit drawings gradually and not all at the same time so that sufficient time is allowed for checking and approval. No more than 100 drawings are to be submitted within a 14-day period to allow for checking and approval of package before submittal of next package.

6. Steel shop drawings shall include framing plans, bolted and welded work, and details such as camber and other pertinent data not shown on job standards. Detail openings and reinforcement due to other Work. Coordinate with Drawings of other Work.
7. Indicate welds by standard AWS symbols and show size, length, and type of each weld in accordance with AWS A2.0.
8. Identify columns using same identification system shown on Drawings.
9. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed under other Sections.
10. Shop drawings will be checked for size of material and strength of connection by the Engineer of Record, which shall not render the Engineer of Record responsible for any errors in construction dimensions, etc. that have been made in preparation of shop drawings. The Contractor shall assume full responsibility for the correctness of dimensions and fit.
11. Submit calculations for design of connections on job standard and all other connections such as moment, brace, and trusses.
12. After shop drawings are 100% complete and approved and all field changes have been made, a CD rom of the as-built drawings are to be submitted to the Owner in an AutoCad format.

**C. Quality Control Submittals**

1. Certificates and Affidavits
  - a. Furnish notarized Building Department affidavit from steel manufacturer (Form SS24) certifying materials conform to Specification requirements and material was erected as designed.
  - b. Furnish bolt manufacturer's test reports, covering physical and chemical tests, for each lot of high strength bolts submitted.
  - c. Furnish steel manufacturer's certificate certifying welders employed on the Work have met AWS qualifications within the previous twelve months and are NJ licensed welders.
  - d. Furnish complete listing of ASTM's of materials listed in Part 2 of this Section and certification that materials supplied meet those listed.
  - e. For mechanical and adhesive anchors installed in concrete, submit ICC certification for use in cracked concrete.
2. Contractor Qualifications: Provide proof of Fabricator, Erector, Detailer/Engineer, and Hot-Dip galvanization qualifications specified under "Quality Assurance".
  - a. Provide proof of Hot-Dip galvanizer's qualifications specified under "Quality Assurance"; certification of qualifications meeting Military Standard by one of the following:
    - 1) A branch of the U.S. Dept. of Defense (DoD), or
    - 2) A company certified by U.S. Dept. of Defense; submit DoD certification for this company.

**D. Surveys**

1. Submit signed and sealed copies of surveys conducted by a Licensed Land Surveyor of items listed in Part 3 of this Section and the Drawings.

E. Test Reports

1. Submit test reports for hot-dip galvanizing and epoxy coating system as specified herein, paragraph titled "Galvanizing by the Hot-Dip Galvanization Process".

1.9 QUALITY ASSURANCE

A. Qualifications

1. Fabricator: Company specializing in the fabrication of steel products to be used in this Contract shall have a minimum of five years experience. The fabricator is to be AISC certified.
2. Erector: Company specializing in performing the Work of this Section shall have a minimum of three years experience and have done at least three projects with similar quantity of material.
3. Detailer: Company shall be specialized in the detailing and design of structural steel shop drawings with a minimum of three years experience. Connections shall be designed by and shop drawings prepared under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed by the State of New Jersey engaged.
4. Hot-Dip Galvanizing: The company or individual responsible for application of hot-dip galvanizing shall be certified as qualified to perform this process, meeting the requirements of Mil Std 2138 or Mil Std 1687. Certification shall be by a branch of the U.S. Dept. of Defense, or by a company that is certified by the Dept. of Defense in accordance with either one of these military standards.

B. Regulatory Requirements

1. Building Code: Work of this Section shall conform to all requirements of the International Building Code 2021, New Jersey Edition and all applicable regulations of governmental authorities having jurisdiction, including safety, health, noise, and anti-pollution regulations. Where more severe requirements than those contained in the Building Code are given in this Section, the requirements of this Section shall govern.
2. Industry Standards: Standards specified herein apply to Work of this Section. Where more severe requirements than those contained in the Standards are given in this Section or the Building Code, requirements of this Section or the Building Code shall govern.
  - a. "Code of Standard Practice for Steel Buildings and Bridges" – AISC 303-05.
  - b. AISC 335-89 or LRFD (2005) as modified by the International Building Code 2021, New Jersey Edition.
  - c. Seismic Provisions for Structural Steel Buildings AISC 341-05.
  - d. "Specifications for Structural Joints using ASTM A325 or A490 Bolts" approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation (RCRBSJ) – AISC-2005.
  - e. "Structural Welding Code" - AWS.

3. Recommendations or suggestions in the codes and references listed in this Article and under "References" shall be deemed to be mandatory unless they are in violation of the Building Code.

C. Certifications

1. Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the site at such intervals as to insure uninterrupted progress of Work.
- B. Deliver anchor bolts and other anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time so as not to delay Work.
- C. Store materials to permit easy access for inspection and identification.
  1. Shop-primed steel. (Painted or galvanized): Primed steel stored in the field or shop shall be kept off ground (using pallets, platforms, or other supports) and so positioned as to minimize water-holding pockets, dust, and other contamination of the primer. Repair damage to primed surfaces due to improper storage in a manner approved by the Owner.
  2. Unpainted Steel: Steel stored in field or shop shall be kept off ground (using pallets, platforms or other supports), kept clean and in general protected against damage and corrosion.
- D. Do not store materials on erected structure in a manner that might cause distortion or damage to the members or supporting structures. Repair or replace damaged materials or structures as directed by the Owner.

1.11 FIELD MEASUREMENTS

- A. Take field measurements as required by Drawings. Where possible take field measurements of existing conditions prior to fabrication. Verify that field measurements are the same as those shown on Drawings and shop drawings. Report all deviations to the Owner in writing.

**PART 2 -PRODUCTS**

2.1 MANUFACTURERS

- A. Stud Shear Connectors
  1. KSM Products, Inc., or approved equal.
  2. Nelson Stud Welding Co., or approved equal.
- B. Paint

1. Tnemec Co., or approved equal.
2. Carboline, or approved equal.
3. Sherwin Williams, or approved equal.
4. ZRC, or approved equal.

C. Expansion/Screw/Adhesive Anchors, Fasteners

1. Hilti, Inc., or approved equal.
2. ITW Ramset/Redhead, Inc., or approved equal.
3. Simpson Strong-Tie Anchor System, or approved equal.
4. Powers Fasteners, or approved equal.

## 2.2 MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so post-consumer recycled content plus one-half of pre-consumer recycled content is not less than the following:

1. W-Shapes: 60 percent.
2. Channels, Angles: 60 percent.
3. Plate and Bar: 25 percent.
4. Cold-Formed Hollow Structural Sections: 25 percent.
5. Steel Pipe: 25 percent.
6. All Other Steel Materials: 25 percent.

B. Structural Steel Shapes, Plates, and Bars

1. Structural steel W shapes shall have a minimum yield strength of 50 ksi conforming to the provisions of ASTM A992. For other shapes not available in ASTM A992, steel shall have a minimum yield strength of 36 ksi conforming to the provisions of ASTM A36.
2. Tube steel shall conform to the provisions of ASTM A500, Grade B, and pipe steel to the provisions of ASTM A501.

C. Headed Stud-Type Shear Connectors

1. Shall conform to the provisions of ASTM A108, Grade 1015 or 1020, and Articles 4.26 and 4.27 of AWS D1.1.

D. Bolts

1. Anchor Bolts (Anchor Rods): Shall conform to the provisions of ASTM F1554, Grade 36, unless different grade is specified elsewhere. Size and detailing indicated on Drawings.
2. Unfinished Bolts: Shall conform to the provision of ASTM A307.
3. High-Strength Bolts: Shall conform to the requirements of ASTM A325 unless otherwise indicated on Drawings.
4. Expansion/Screw/Adhesive Anchors: Provide types as indicated on Drawings. The anchor specified shall be considered the basis of design.

- a. As a minimum, all anchors exposed to weather or embedded in masonry are to be Type 316 stainless steel.
- b. Anchors installed in concrete shall have current ICC-ES listing for performance in cracked concrete as per International Building Code 2021, New Jersey Edition.
- c. Design and installation provisions shall be based on current ICC-ES ESR report and ACI 318 Appendix D.

**E. Hardware**

1. Nuts for anchor bolts and unfinished bolts shall conform to the requirements of ASTM A563.
2. Nuts for high-strength bolts shall conform to the provisions of ASTM A194 or ASTM A563 as specified in ASTM A325.
3. Washers shall conform to the provisions of ASTM F436.

**F. Filler Metal for Welding**

1. Welding electrode shall conform to E70XX classification of AWS A5.1, except as described below.
2. Welding electrode shall be compatible with existing steel where connections are made to steel of existing building. Electrode shall be E7018 unless determined otherwise. E7018 are low hydrogen electrodes that must be kept extremely dry.

**G. Structural Steel Primer Paint**

1. Provide type of primer indicated on steel under the following application conditions.
  - a. General application: Modified alkyd rust-inhibitive type containing no lead equal to Tnemec Co. No. 10 99 or Carboline Carbocoat 115-SG. Red oxide paint is not acceptable.
  - b. Cavity wall (including steel within the exterior block back-up or not separated from the cavity by a full block), exterior application, and as a primer after hot-dip galvanizing: Epoxy paint equal to Tnemec Co. Series FC27 Typoxy or Carboline Carboguard 888.
  - c. Touch-up primer for cavity wall and exterior application: High adhesion high-solids epoxy coating equal to Tnemec Co. Series 135 Chembuild or Carboline Carboguard.
  - d. For steel to receive 'Intumescent Fireproofing' per specification section 078123, provide and apply primer in conformance with that specification section.
  - e. For steel to receive 'Factory-Applied Metal Coatings' per specification section 050800, provide and apply primer in conformance with that specification section.

**H. Galvanizing by the Hot-dip Method**

1. Galvanize structural shapes in accordance with ASTM 123.
2. Galvanize hardware in accordance with ASTM A153.
3. Galvanizing repair paint for regalvanizing welds and damaged areas shall conform to ASTM A780 and comply with Military Specification MIL-P-21035, such as ZRC Cold Galvanizing Compound.

## 2.3 SHOP ASSEMBLY - FABRICATION

### A. General

1. Do not fabricate until shop drawings have been approved.
2. Fabricate and assemble steel in shop to greatest extent possible. Fabricate items and assemblies in accordance with AISC Specifications and the shop drawings.
3. Properly mark members for field assembly. Fabricate items in order to match delivery sequence that will expedite erection.
4. Mill column ends at base plates, cap plates, and splices to a common plane by means of an approved milling machine.

### B. Shop Connections

1. Weld or high-strength bolt shop connections as indicated on Drawings.
2. High-strength bolt connections are friction (slip-critical) connections. Install high-strength bolts in accordance with "Specification for Structural Joints using ASTM A325 or A490 Bolts" (RCRBSJ).
3. Welding: Comply with "Structural Welding Code" for procedures, appearance, and quality of welds and methods used in correcting welded work.
4. Holes for other Work
  - a. Provide holes and openings required for securing other Work to steel framing and for passage of other Work through framing members. Coordinate with Drawings of other Work.
  - b. Provide threaded nuts welded to framing, and other specialty items as indicated to receive other Work.
  - c. Cut, drill, flame cut, or punch holes perpendicular to metal surfaces. Method of cutting must not produce a roughness of over 1000 microinches. Surfaces exceeding these limits must be repaired by machine grinding.
  - d. Reinforce all openings with steel shapes as shown on shop drawings.

### C. Shear Stud Connectors (Non-Metal Deck Construction)

1. Weld shear studs to beams with automatically timed stud welding equipment at spacing shown on Drawings. Size, type, and length specified on Drawings.
2. Top flanges of beams must be free of paint, heavy rust, mill scale, dirt, ice and/or water, and any other material that will interfere with the welding operation.

## 2.4 SHOP PAINTING

### A. General: Apply one shop coat of primer paint on structural steel except as follows:

1. Structural steel that is encased in concrete.
2. Steelwork or portions of such to receive sprayed fireproofing. Steel that is exposed to the cavity and within the block back-up is to be painted, unless indicated to be galvanized.
3. Top flanges of structural steel members requiring stud shear connectors or supporting metal deck.
4. Contact surfaces of structural steel that are to be bolted or welded together.



5. Surfaces of structural steel within 2" of field welds.
6. Contact milled bearing surfaces.
7. Steel members, hardware, and miscellaneous pieces to be galvanized and not specified or indicated to be painted.

**B. Cleaning and Surface Preparation**

1. Clean all steel first in accordance with SSPC-SP1.
2. Clean steelwork not to be painted (except steel work to be galvanized) in accordance with SSPC SP2.
3. Clean steelwork to be painted within the same day as it will be applied and in accordance with the following methods, determined by location and exposure:
  - a. Interior steel not exposed to view: SSPC-SP2.
  - b. Interior steel exposed to view: SSPC-SP3.
  - c. Cavity wall and exterior steel exposed to weather: SSPC-SP6.

**C. Shop Coat**

1. Apply structural steel primer paint (general application) at a rate to provide dry film thickness of 2.0 to 3.5 mils. Apply primer paint (cavity wall and exterior application) at a rate to provide dry film thickness of 4.0 to 6.0 mils. Provide full coverage of joints, corners, edges, and exposed surfaces.
2. Apply to dry surfaces only, when surface temperatures are above dew-point, by brush, spray, or roller, thoroughly and evenly, in strict accord with manufacturer's instructions for every detail of handling.
3. Apply second coat of the approved primer, in a darker shade, to surfaces inaccessible to painting after assembly or erection.
4. Protect machined surfaces with an approved rust-inhibiting coating that is readily removable prior to erection.

**D. Concrete Contact Surfaces**

1. Paint steelwork at least two inches into the area in contact with concrete, where applicable.

**2.5 GALVANIZING**

**A. General: Galvanize the following members:**

1. All angles supporting exterior masonry or exposed to the weather, including shelf, arch, relieving angles.
2. All connections between the above angles and the supporting structural member, including WT's, hangers, clip angles, hardware, etc.
3. All exterior steel supporting mechanical equipment (dunnage steel) and any other steel members indicated on Drawings.

**B. Cleaning and Surface Preparation**

1. Hardware (bolts, nuts, etc.): Clean and leave free of mill scale before galvanizing.
2. Clean all steel first in accordance with SSPC-SP1 if needed.
3. Steel members: Clean in accordance with SSPC-SP8 before hot-dip galvanizing.
4. Steel members: Clean in accordance with SSPC-SP10 before hot-dip galvanizing. Surface shall have a 3-4 mil anchor pattern. Moisture cannot be present on steel and temperature cannot be less than 50F above the dew point. Thermal spray must be applied within 4 hours of blasting.

C. Shop Coat - Hot-dip Galvanizing – Provide for galvanized items not to have finish paint coat.

1. Galvanize hardware in accordance with ASTM A153.
2. Galvanize steel shapes in accordance with ASTM A123. Apply zinc (hot-dip) coating as per Thickness Grade specified in ASTM A123.

## 2.6 SOURCE QUALITY CONTROL

### A. Testing

#### 1. General

- a. Structural steel work is subject to all tests required by the Special Inspection requirements of the International Building Code 2021, New Jersey Edition.
- b. Cooperate with the Testing Laboratory in making all required tests.

#### 2. Tests: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

- a. Shop bolted connections: Tested in accordance with AISC specifications.
- b. Shop welding: The laboratory will perform the following functions:
  - 1) Certify welders.
  - 2) Visually inspect all welds, record type and locations of defects, and perform tests if necessary. Check all corrected work.
  - 3) Perform following non-destructive tests if necessary or as required by the Special Inspector. Tests used shall be at the Special Inspector's option:
    - a) Liquid Penetrant Inspection: ASTM E165.
    - b) Magnetic Particle Inspection: ASTM E709. Perform on roof pass and on finished weld.
    - c) Radiographic Inspection: ASTM E94 or E149. Minimum quality level 2 2T.
    - d) Ultrasonic Inspection: ASTM E164.

#### 3. Welding of Critical Joints

- a. All welded joints that are critical to the integrity of the structure, and require non-destructive testing to assure the adequacy of the critical weld, are indicated on the Drawings.

- b. To insure general weld quality of less critical groove and butt welds, a quality control program may be required to check the welds by non-destructive testing. The Drawings specify whether non-destructive testing is required and, if necessary, the method of inspection.

**B. Inspection**

**1. Testing Laboratory**

- a. The Owner will engage a Testing Laboratory or Special Inspection Agency to assist in the inspection of steel fabrication and conduct tests at the mill, shop, or foundry. The laboratory will assist in checking erection tolerances and provide shop and field testing required for all structural steel work, including metal deck and studs.
  - b. The Testing Laboratory will be responsible to and under the supervision of a Special Inspector.
- 2. Special Inspector: The Owner will assign a Special Inspector to supervise the Work listed above under "Testing Laboratory".
  - 3. Notification: Notify the Owner before beginning fabrication of the structural steel and supply laboratory with copies of agreements, approved drawings, approved prints of all shop details, etc., and all necessary information relating thereto. Do not ship material to job site until after inspection and approval by the Testing Laboratory.
  - 4. Discretionary Inspections: No mill, shop, foundry, or field inspection, such as is above provided for, shall be held to prohibit or preclude inspection of such materials during delivery and erection at the building by such other persons as the Owner shall direct.
  - 5. Reports: Shop and field reports, including shipments, will be submitted by the Testing Laboratory to the Owner as the work proceeds at the shop or job site. A final report will be submitted by the Testing Laboratory when work is completed at the shop, and again when work is completed in the field. The Special Inspector reserves right to reject material not in compliance with specified requirements at any time.
  - 6. Corrections: Correct deficiencies in work which inspections and tests have indicated to not be in compliance with requirements. Pay for additional tests, at own expense, necessary to reconfirm any non-compliance of original work and as necessary to show compliance of corrected work.
  - 7. Contractor's Responsibility: Inspection and acceptance or failure to inspect shall in no way relieve the Contractor or the mill and shops from their responsibility to furnish satisfactory material strictly in accordance with Drawings and Specifications.

**PART 3 -EXECUTION**

**3.1 EXAMINATION**

- A. Verify that field conditions are acceptable and that erection may proceed. Notify the Owner in writing of conditions that adversely affect the Work. Do not proceed with erection until conditions have been corrected. Beginning of installation means the erector accepts existing conditions.

### 3.2 ERECTION

#### A. General

1. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
2. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
3. All work shall be erected plumb, square, and true to lines and levels in strict accordance with the structural requirements of the building.
4. Provide all machinery, apparatus, and staging required for the erection of steelwork in a thoroughly safe and efficient manner. Install, maintain and remove, without injury to other Work, such temporary bracing, scaffolding, etc. as may be necessary or required. Care shall be taken that no part of the structure is overloaded during construction.
5. Arrange for deliveries of material to facilitate the rapid and continuous progress of operation, but the site or streets adjacent to same shall not be used for the storage of material unless absolutely necessary and then only with special permission of the Owner and other authorities having jurisdiction.
6. Employ a Licensed Professional Engineer and Land Surveyor to ensure accurate erection of the steel.
7. Do not alter or cut structural members without written approval of the Engineer of Record.

#### B. Temporary Shoring and Bracing

1. Provide temporary shoring and bracing members with connections of sufficient strength to bear erection loads and guy wires to maintain structure plumb and in true alignment until completion of erection. Remove temporary work when permanent members and bracing are in place and final connections are made.

#### C. Anchors Bolts

1. Furnish to the concrete and brick masons anchor bolts and other connectors required for securing structural steel to the foundation and other in-place concrete work, together with instructions, templates, etc. necessary for setting them. Anchor bolts are to be surveyed and any approved modifications made prior to placement of columns.
2. Tighten anchor bolts after support members have been positioned and plumbed. Cut off protruding edges of wedges or shims flush with edge of base or bearing plate prior to packing with grout.

#### D. Base and Bearing Plates

1. Clean concrete and masonry bearing surfaces of loose and bond-reducing materials.
2. Set loose and attached base plates and bearing plates for structural members on shims and other adjusting devices, such as leveling plates, within specified tolerances. Elevations of shims and leveling plates shall be surveyed and adjusted to correct elevation prior to placement of column or beam. Plates are to have grout holes.

#### E. Field Assembly

1. Erect structural frames accurately to lines and elevations indicated. Align and adjust members forming a part of a complete frame or structure before permanently fastening.
2. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.
3. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
4. Level and plumb individual members of the structure within specified tolerances. Do not tighten structure until surveys verify that structure is within allowable tolerances.
5. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.
6. Splice members only where indicated and accepted on shop drawings.

**F. Connections**

1. Field connections shall be welded or bolted, except where welding is specifically called for on the Drawing.
  - a. Provide high-strength bolts for bolted connections except where unfinished bolts are indicated on the Drawings. High-strength bolt connections are friction (slip-critical) connections. Install high-strength bolts in accordance with "Specification for Structural Joints using ASTM A325 or A490 Bolts."
  - b. Provide unfinished bolts where indicated on Drawings. Lock nuts by upsetting bolt end or by similar method when unfinished bolts are not encased in concrete. Tighten all bolts and nuts fully.
  - c. Expansion/screw/adhesive anchors shall be installed in accordance with the manufacturer's installation instructions. Holes shall be cleaned completely using wire brush and compressed air following manufacturer's guidelines.
  - d. For ASTM A307 or A325 bolts, hardened washer shall be installed under the turned element. For ASTM A490 bolts, hardened washer shall be installed under the head and nut.
2. Holes
  - a. The size of boltholes shall be in accordance with AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings."
  - b. Ream holes that must be enlarged to admit bolts. Burning or use of drift pins is not permitted.

**G. Erection Holes**

1. Fill erection boltholes on exposed to view members with plug welds and grind smooth.

**H. Lintels and Relieving Angles**

1. Erect all exterior steel lintels and relieving angles connected (by hangers, clips, bolts or otherwise) to the structural steel work.
2. Loose lintels (interior and exterior) and lintels secured to concrete are part of the Work Section 055000.

**I. Flame Cutting**

1. Flame cutting in field of members to correct fabrication errors is to be avoided and to be done only upon approval of the Engineer of Record based on the method proposed. Roughness cannot exceed 1000 microinches. Repair of surfaces shall be by mechanical grinding.

**J. Field Touch-Up**

1. Painted Members: After erection, clean all damaged areas in shop coat, exposed surfaces of bolts, bolt heads, nuts and washers, abrasions, and all field welds and unpainted areas adjacent to field welds to the same standards as the shop coat and paint with primer paint to same thickness as the shop coat. Finish painting is specified in Section 099000.
2. Galvanized Members: After erection, clean and paint all damaged areas to the galvanizing, welds, and areas adjacent to welds with the galvanizing repair paint. For galvanized members to be painted, finish painting is specified in Section 099000 and shall be the final two coats of the epoxy paint system.

**3.3 TOLERANCES**

- A. Erection tolerances shall be in accordance with "Code of Standard Practice for Steel Buildings and Bridges", except as indicated in B below.
- B. The following overall maximum deviations (tolerances) from theoretical are permitted:
  - a. Column location @ base plate: 1/2"
  - b. Base Plate, bearing plate and column splice elevation: +1/8"
  - c. Column Plumbness: in or out 3/4" in column length, 1/4" for total building height
  - d. Beam or girder elevation: +1/2"
  - e. Beam camber: 1/8"
  - f. Lintel elevation: +1/16"
  - g. Lintel location: +1/4"

**3.4 FIELD QUALITY CONTROL**

- A. Cooperate with the Special Inspector and the Testing Laboratory performing Special Inspection testing.
- B. The Special Inspector will inspect erection of the structural framework and test field bolting and welding as listed in Part 2 of this Section. The Special Inspector will also check the welding of deck and metal studs described in Section 053000.
- C. The Contractor shall engage an engineer licensed in the state of New Jersey to check tolerances and inspect the erection.
- D. Contractor's Surveys
  1. Provide surveys of items listed below. Surveys are to indicate the actual location and elevation and the deviation from theoretical. Highlight those numbers that exceed

permissible tolerances. Surveys are to be submitted in a timely manner in order for corrections to be made prior to installation of the next item in sequence (e.g. anchor bolt and base plate survey prior to column installation), including placement of concrete. The following items are to be surveyed:

- a. Anchor bolt location
- b. Elevation of bottom of base plates (top of shims or leveling plate).
- c. Elevation of lowest column splice.
- d. Location (x,y, & radial) and plumbness of columns.
- e. Elevation of steel members taken at approximately 20 members from each floor for those members not cambered.
- f. Elevations of cambered members taken at each end and in center. The average of the two ends subtracted from the center will be the measured camber. Approximately 20 members will be selected by the Engineer of Record to be surveyed. Survey is to be done prior to and after placing concrete.
- g. Elevation and location of lintels prior to installation of masonry.

### 3.5 CLEANING

- A. Structural steel or portions of such to receive sprayed fireproofing shall be clean of dust, grease, oils, loose material, and any other matter which would impair the adhesion of the fireproofing material to the steel.

END OF SECTION 051200

## SECTION 053000 - METAL DECK

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Furnish material, labor, equipment, services necessary to erect all metal deck, including connections, welding and accessories required for installation of Work. Field cut and fit deck as required and cut all openings.
- B. Place edge of deck at proper location to ensure proper placement of masonry. Set deck edge from a survey line based on the theoretical building line.

#### 1.3 RELATED SECTIONS

- A. Cast-in-Place Concrete- Section 033000
- B. Structural Steel - Section 051200

#### 1.4 REFERENCES

- A. References and industry standards listed in this Section are applicable to the Work. Unless more restrictive criteria or differing requirements are explicitly stated in the Specifications, or mandated by governing codes or regulations, the recommendations, suggestions, and requirements described in the referenced standards shall be deemed mandatory and applicable to the Work.

- 1. American Society Testing and Materials (ASTM) standards, latest editions.

A36	Standard Specification for Carbon Structural Steel.
A108	Standard Specification for Steel Bars, Carbon, Cold-finished, Standard Quality.
A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coating.
A992	Standard Specification for Steel for Structural Shapes for Use in Building Framing
B633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel



- B. "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings", 9th edition including supplements. - American Institute of Steel Constructors (AISC 335).
- C. "Load and Resistance Factor Design Specification for Structural Steel Buildings" 13th edition, including supplements. - American Institute of Steel Constructors (AISC LRFD 2005).
- D. Seismic Provisions for Structural Steel Buildings (AISC 341-05).
- E. "North American Specification for the Design of Cold-Formed Steel Structural Members" - American Iron and Steel Institute (AISI).
- F. Safety Requirements for Powder-Actuated Fastening Systems (ANSI A10.3), American National Standard (ANSI).
- G. International Code Council Evaluation Service (ICC-ES):
  - 1. 2021 International Building Code NJ Edition
  - 2. Acceptance Criteria for Steel Deck Roof and Floor Systems (AC43)
  - 3. Steel Deck Diaphragms (ESR-2199)
- H. "Structural Welding Code - AWS D1.1" - American Welding Society (AWS).
- I. "Specifications for Mild Steel Covered Arc - Welding Electrodes - AWS A5.1" - AWS.
- J. "Diaphragm Design Manual for Floor Decks and Roof Decks" 3rd Edition - Steel Deck Institute (SDI).
- K. "Fire Resistance Directory" - Underwriters Laboratory (UL).

## 1.5 DESIGN REQUIREMENTS

- A. Metal deck unit sizes and gages are indicated on the Drawings.
- B. Units shall be of three-span length except where framing layout does not permit. Deck sheets shall be butted over supports.
- C. Provide shoring where required by the deck manufacturer as indicated on the approved shop drawings and where indicated on the Contract Documents.
- D. Use of integral and non-piercing hanger tabs to support ceiling systems is not permitted. Piercing hanger tabs with a safe working loading of 250 lbs or greater are permitted for ceilings weights below the hanger tab capacity. Integral hanger tabs are to be used for venting purposes only.
- E. Units included in a fire rated assembly must be classified in appropriate UL designs.
- F. Use fasteners or welds for decking attachment that provide adequate diaphragm shear strength, uplift resistance and stiffness for imposed load combinations.
- G. Performance Requirements: FM classified Class I-90 minimum for uplift resistance and UL fire

classified for roof deck.

## 1.6 SUBMITTALS

### A. Product Data

1. Submit manufacturer's specifications for
  - a. Shear stud connectors
  - b. Deck Fasteners, if used

### B. Shop Drawings

1. Prepare metal deck shop drawings immediately after award of Contract.
2. Shop drawings shall include, but not be limited to the following:
  - a. Type and gage of metal deck.
  - b. Metal deck layout and orientation, including clear indication where shoring is required.
  - c. Welding or fastener types, sizes and pattern.
  - d. Side and end details of metal deck.
  - e. Supplementary framing details.
  - f. Location of all openings and fittings.
  - g. Shop finish.
  - h. Size, location, and spacing of stud shear connectors, where required, for each beam.
  - i. Designation of welding electrode strength to be used.
3. Shop drawings reviewed by the Engineer of Record for general conformity with the Drawings shall not relieve the Contractor or the metal deck supplier of responsibility for correctness of fit, quantities of materials, and adequacy of attachment details of deck and accessories to the structural steel. Deck must have UL or OTCR approval as part of the fire rated assembly. Approval of shop drawings does not absolve the Contractor of this requirement.
4. Calculations in accordance with ICC-ES AC 43 or SDI Design Method verifying diaphragm shear strength and stiffness: Submit calculations for the load tables of the metal deck supplied. Calculations shall be signed and sealed by a Professional Engineer licensed in the State of New Jersey.

### C. Quality Control Submittals

1. Certificates
  - a. Submit notarized certificates from the manufacturers of the specified materials stating compliance with the applicable requirements set forth for all materials specified in this Section.
  - b. Submit certificate stating welders employed for installation of the metal deck have met AWS qualifications within the previous 12 months.

- c. Furnish proof that deck to be used is part of a UL, approved fire-rated assembly if other than deck shown on Drawings. Refer to Section 078100.
  - d. Submit certificate stating deck manufacturer is a member producer of SDI.
2. Manufacturers' Instructions: Furnish manufacturers' printed material, specifications and installation instructions for each type of decking, accessories, and studs.
3. Contractor Qualifications
  - a. Provide proof of Manufacturer, Erector, welder, and mechanical fastener technician qualifications specified under "Quality Assurance".

**D. Surveys**

1. Submit signed and sealed copies of surveys conducted by a Licensed Land Surveyor showing locations of edge of deck with respect to theoretical edge of deck and building survey line.

**1.7 QUALITY ASSURANCE**

**A. Qualifications**

1. Manufacturer: Company specializing in the manufacture of metal deck as used in this Contract shall have a minimum of five years of experience and is a member producer of SDI.
2. Erector: Company specializing in performing the Work of this Section shall have a minimum of three years of experience and have done at least three projects with similar quantity of material.
3. Welders: All steel roof deck welders shall be AWS certified for welding of sheet steel and must provide all appropriate welding certifications.
4. Mechanical Fastener Installer: Shall be certified or licensed by the fastener and tool system manufacturer on the project site in accordance with ANSI A10.3 requirements. Certification or licensing includes all training necessary for proper tool operation, fastener selection, maintenance and troubleshooting.

**B. Regulatory Requirements**

1. Building Code: Work of this Section shall conform to all requirements of the International Building Code 2021, New Jersey Edition and all applicable regulations of other governmental authorities. Where more severe requirements than those contained in the Building Code are given in this Section, the requirements of this Section shall govern.
2. Industry Standards: Standards specified herein shall apply to Work of this Section. Where more severe requirements than those contained in the standards are given in this section or the Building Code, requirements of this Section or the Building Code shall govern.
  - a. AISC 335-89 or LRFD (1999) as modified by the International Building Code 2021, New Jersey Edition.
  - b. Seismic Provisions for Structural Steel Buildings AISC 341-05.
  - c. "Rules for Design of Composite Construction with Metal Decks or Lightweight Concrete" - Department of Buildings.

d. Fire Resistance Directory - UL.

- 1) Composite metal deck shall have UL approval with respect to the following:
  - a) As a component part of a floor construction of specified fire resistance rating without need for sprayed fireproofing on underside of deck.
  - b) As a component part of a three-hour fire resistive floor construction with use of sprayed fireproofing on underside of deck.
- 2) Roof deck shall have UL approval as a component part of the specified fire resistive roof construction.
3. Recommendations or suggestions in the codes and references listed in this Article and under "References" shall be deemed to be mandatory unless they are in violation of the Building Code.

C. Certifications

1. Structural metal deck and stud shear connectors shall conform to the material acceptance, certification and inspection requirements of the International Building Code 2021, New Jersey Edition.
2. Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver deck to site undamaged. With each deck unit bearing the UL label and marking for specific system detailed.
- B. Store deck units off the ground with one end elevated to provide drainage. Protect units from the elements with a waterproof covering.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Metal Deck and Accessories, or approved equal.
  1. H.H. Robertson Company, or approved equal.
  2. Canam Steel, or approved equal.
  3. Nucor (Vulcraft/Verco Group), or approved equal.
  4. Wheeling Corrugating Co., or approved equal.
  5. United Steel Deck, Inc., or approved equal.
  6. Epic Metals Corporation, or approved equal.

- B. Stud Shear Connectors
  - 1. KSM Products, Inc., or approved equal.
  - 2. Nelson Stud Welding Co., or approved equal.
  - 3. Hilti, Inc., or approved equal.

- C. Mechanical Fasteners
  - 1. Hilti, Inc., or approved equal.
  - 2. ITW Ramset, or approved equal.

- D. Sidelap Connectors
  - 1. Hilti, Inc., or approved equal.
  - 2. Elco Textron, or approved equal.

## 2.2 MATERIALS

- A. Steel for Composite Metal Deck
  - 1. Formed from galvanic steel sheets conforming to ASTM A653. Size of deck is to follow SDI requirements for thickness and tolerances.
  - 2. Minimum yield strength of 40,000 psi.
  - 3. Formed with integral locking lugs.
  - 4. Formed with deformations to provide bond with concrete.
  - 5. Deck to receive sprayed fireproofing shall be free of lubricants or oils that would impair the adhesion of the fireproofing material.
  - 6. Metal deck that is not exposed to view with architectural paint finish shall have integral hanger tabs providing an approximate 0.5% uniformly distributed open area. The hanger tabs are used for venting purposes only.
- B. Steel for Roof Deck
  - 1. Formed from galvanic steel sheets conforming to ASTM A653. Size of deck is to follow SDI requirements for thickness and tolerances.
  - 2. Minimum yield point of 40,000 psi.
  - 3. Deck to receive sprayed fireproofing shall be free of lubricants or oils that would impair the adhesion of the fireproofing material.
- C. Miscellaneous Steel Shapes
  - 1. Shall conform to the requirements of ASTM A36 or A992. Members to receive sprayed fireproofing shall be unprimed and free of lubricants or oils that would impair the adhesion of the fireproofing material.
- D. Shop Finish
  - 1. Metal deck: Steel sheet shall receive before being formed a coating of zinc conforming to ASTM A653 coating class G60 (both sides). Metal deck exposed to view shall be cleaned

and phosphatized prior to priming. Primer shall be applied in the shop (Zinc dust-zinc oxide primer - 2.5 Mils DFT).

2. Steel roof deck: Steel sheet shall receive before being formed a coating of zinc conforming to ASTM A653 coating class G90 (both sides). Roof deck exposed to view shall be cleaned and phosphatized prior to priming. Primer shall be applied in the shop (Zinc dust-zinc oxide primer - 2.5 Mils DFT).

E. Metal Deck Accessories (cants, pour stops, closure pieces, etc.)

1. Shall conform to the requirements of ASTM A653, coating class G90. Unless a thicker gage is required by design considerations, such as at cantilever edge conditions, minimum thickness shall be same gage as metal deck. Accessories to receive sprayed fireproofing shall be free of lubricants and oils that would impair the adhesion of the fireproofing material.

F. Headed Stud Type Shear Connector

1. Welded studs shall conform to the requirements of ASTM A108, Grade 1015 or 1020, and Articles 4.26 and 4.27 of AWS D1.1. Welded studs shown on the Drawing are the Basis of Design.
2. Mechanical Studs of equivalent strength to welded studs. Unless shown on the Contract Drawings, the size, number of and location on the beam shall be in accordance with the manufacturer's published data and supported by test data.
  - a. Mechanical shear connectors shall be Hilti X-HVB Shear Connectors installed with Hilti X-ENP-21 HVB powder-actuated fasteners.

G. Welds and Fasteners

1. Welds:
  - a. No welding (FM Global) permitted of side laps of roof deck 20ga or thinner.
  - b. Material: Welding electrodes shall conform to E70XX classification of AWS A5.1.
  - c. Weld Washers: Use on steel roof deck thinner than 22 gauge
2. Mechanical Fasteners:
  - a. Material: AISI 1070 modified
  - b. Hardness: Minimum Rockwell Hardness C 54.5
  - c. Design and Manufacture: Knurled shank with forged ballistic point. Manufacturing process shall ensure steel ductility and prevent development of hydrogen embrittlement.
  - d. Washers:
    - 1) For structural steel framing: Minimum 15 mm (0.591 in.) steel washers
    - 2) For steel bar joist framing: Minimum 12 mm (0.472 in.) steel washers
  - e. Corrosion Resistance:

- 1) For steel roof decks with waterproofing membrane: 5 micron zinc electroplated in accordance with ASTM B 633 SC1 Type III
- 2) For exposed steel roof decks: Minimum AISI 304 stainless steel sealing caps with bonded neoprene washer shall be installed over each fastener

f. Design Requirements:

- 1) ICC-ES AC43 or SDI method for diaphragm shear strength and stiffness
- 2) FM wind uplift resistance
- 3) UL fire classification

g. Approved Types

- 1) For use with structural steel framing supports with top flange thickness 1/4 in. or thicker:
  - a) Hilti X-ENP-19 L15 (1/4 in. or thicker)
  - b) ITW/Ramset SP
- 2) For use with steel bar joist supports with top chord or flange thickness 1/8 in. to 3/8 in.:
  - a) Hilti X-EDNK22 THQ12 (1/8 in. up to and including 1/4 in.)
  - b) Hilti X-EDN19 THQ12 (3/16 in. up to and including 3/8 in.)
  - c) ITW/Ramset 1500K and 1600WK

H. Sidelap Connectors

1. Acceptable types of sidelap connectors:

a. Top or side seam welds

- 1) 1-1/2 in. long fillet welds in accordance with AWS D1.3 procedures.

b. Mechanical sidelap connectors

- 1) Drive mechanical sidelap connectors completely through adjacent lapped roof deck sheets to achieve positive engagement of adjacent sheets with a minimum of three thread penetration.
- 2) Material: ASTM A 510 Grade 1022
- 3) Hardness: Minimum Vickers Surface Hardness of 450 HV0.3
- 4) Design and Manufacture: Hex washer head undercut with reverse serrations; self-piercing or stitch point at center
- 5) Corrosion Resistance:
  - a) For steel roof decks with waterproofing membrane: 5 micron zinc electroplated in accordance with ASTM B 633 SC1 Type III.
  - b) For exposed steel roof decks: AISI 410 or 304 stainless steel with bonded neoprene washer.

- 6) Design Requirements:
  - a) ICC-ES AC43 or SDI method for diaphragm shear strength and stiffness
  - b) FM wind uplift resistance

- 7) Approved Types
  - a) Hilti S-SLC01 M HWH Sidelap Connector
  - b) Hilti S-SLC02 M HWH Sidelap Connector
  - c) Hilti S-MD 10-16 x 3/4 HWH #3 Stainless Steel Screw
  - d) Elco Textron

c. Button punches

- 1) Standard or proprietary type button punches shall be deep and positively engage the male and female side edges of adjacent interlocking deck sheets in accordance with steel deck manufacturer recommendations
- 2) Approved Types
  - a) Wheeling Corrugating Gator Crimp
  - b) Verco Manufacturing Punchlok

I. Galvanizing Repair Paint

- 1. Shall conform to the requirements of ASTM A780 and comply with Military Specification MIL-P-21035.

J. Deck Fasteners (if used)

- 1. Deck fasteners of a type that will provide equal or greater uplift resistance than a 3/4" puddle weld.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Do not begin placement of metal deck until all surfaces and members are deemed acceptable to receive the deck. Do not proceed with Work until any unsatisfactory conditions have been corrected to the satisfaction of the deck installer.

### **3.2 ERECTION**

A. General

- 1. Care should be taken to avoid overloading the supporting structural elements when placing bundles of metal deck or other construction loads on floors and roof.



2. Do not use floor deck units for storage or working platforms until they are permanently secured.
3. Employ a Licensed Professional Engineer or Land Surveyor to ensure accurate erection of the deck and end closures.

**B. Metal Deck and Accessories Installation**

1. Lay units in strict accordance with manufacturer's instructions and requirements and as shown on Drawings.
2. Adjust units in place before permanent fastening and accurately align end to end. Rectify inaccuracies in alignment and level of bearing before units are finally placed.
3. Provide proper bearing at all supports. Metal deck must be placed to bear fully on surface of beam flanges.
4. Provide angle and channel supports for metal deck at locations where deck cannot be properly seated due to obstructions by structural connections and as shown on Drawings. Coordinate with mechanical trades to adjust supports at columns if required to permit items to pass adjacent to column.
5. Anchor deck to steel member by welding directly through the bottom of the rib at all structural supports by welds not less than 3/4" in diameter or by using powder driven fasteners of equivalent strength, spaced not more than 12" across the width of the unit. All welds shall be of uniform size and appearance and free of pinholes, porosity, undercutting or other defects. Welds shall be free of sharp points or edges. Mechanical fasteners shall be fully engaged and washer snug and holding deck without damage. Where two units abut, each unit shall be so fastened to the steel framing. Add additional welds or fasteners where found defective.
6. Fasten side laps of adjacent units between supports by crimping or mechanically fastening with sheet metal screws of size and spacing required by manufacturer or as indicated on the Drawings to provide diaphragm strength required by seismic design. In no case shall fasteners exceed two feet. Fasteners for exposed to view roof deck shall be the minimum length possible to ensure an aesthetic appearance.
7. Furnish, install, and weld in position all accessories, including pour stops, closures, cant strips, etc., where required.
  - a. Furnish sheet metal pour stops and closures for open ends of all cell raceways at columns, walls, and openings shown on Drawings. Pour stop gage is to be selected by manufacturer based on overhang. Revise gage if survey shows overhang exceeds that designed. Provide additional supports to strengthen pour stop at wedge inserts if required.
  - b. Provide sheet steel cover plate (or closure tape) as required to close panel end conditions where panels change direction or abut.
  - c. Furnish material for column closures to close openings between panels and structural columns.
  - d. Provide welding hole cover, with friction fastening, to close welding access holes when required.
  - e. Provide smooth form wood edge at locations where edge of deck will be exposed to view, such as at stairwells.

**C. Stud Shear Connector Welding**

1. Weld studs to steel beams through the steel deck with automatically-timed stud welding equipment.
2. Stud welding shall conform to the requirements of AWS D1.1 with respect to workmanship, quality control, and field inspection.
3. Manufacturer shall supply guidance and instruction in proper installation method
4. Additional requirements for stud welding with metal deck:
  - a. Top flanges of beams must be free of paint, heavy rust, millscale, dirt, ice and water, and any other material that will interfere with the welding operation.
  - b. Metal deck must be free of dirt, ice, water, and other foreign materials that will interfere with the welding operation.

**D. Cutting, Drilling, and Reinforcing of Openings**

1. Where predetermined openings (such as stairs, elevators, etc.) are framed by structural steel beams on all sides (shown on the Drawings), the metal deck shall be engineered by the manufacturer to fit these conditions.
2. Any opening which is not framed by structural steel beams on all sides, and which is required in steel decking, shall be cut by the respective trades requiring it.
3. Reinforcing of Openings in Steel Deck
  - a. Holes 6" or less in dimension need not be reinforced.
  - b. Holes greater than 6" but less than 30" in any dimension shall be reinforced by the General Contractor as shown on the Structural Contract Drawings.

**E. Field Touch Up**

1. Clean scarred and rusted areas in galvanizing after deck installation is completed and paint welds and the scarred and rusted areas with the galvanizing repair paint. Apply in accordance with the manufacturer's instructions.

**3.3 TOLERANCES**

- A. Edge of metal deck is to be within a tolerance of 1/4" of theoretical, set to a survey line, to ensure proper installation of masonry and installation of relieving angles.

**3.4 FIELD QUALITY CONTROL**

- A. Welding/fastening of metal deck and shear studs is subject to Special Inspection and Testing and is included as part of the Quality Control Work of Section 051200 and includes, but is not limited to.
1. Weld sizes and pattern.
  2. Mechanical fastener placement location and washer condition.
  3. Clamping of steel roof deck to supporting steel framing
- B. The Contractor shall engage an engineer licensed in the state of New Jersey to check tolerances and inspect the erection.

C. Contractors Surveys

1. Provide survey of locations of edge of deck with respect to theoretical edge of deck and building survey line. Indicate discrepancies between actual installation and Contract Documents. Surveys are to be submitted in a timely manner such that corrections can be made prior to placement of concrete. Do not proceed with placing concrete until the pour stop locations are corrected.

3.5 CLEANING

- A. Metal deck and accessories to receive sprayed fireproofing shall be clean of dust, grease, excessive oils, loose materials, and any other matter which would impair the adhesion of the fireproofing material to the deck and accessories.

END OF SECTION 053000

## **SECTION 05 4000 - COLD-FORMED METAL FRAMING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Exterior non-load-bearing wall framing
  - 2. Any location in plans identified as using cold-formed metal framing (CFMF)

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of cold-formed steel framing product and accessory.
- B. Shop Drawings:
  - 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
  - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
  - 3. Include signed and sealed calculations by a licensed New Jersey Professional Engineer.
- C. Delegated-Design Submittal: For cold-formed steel framing.
  - 1. Submit shop drawings and comprehensive engineering calculations which have been signed and sealed by a Professional Engineer, indicating that cold formed metal framing complies with performance requirements and support imposed loads.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.
- B. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.
  - 1. Steel sheet.
  - 2. Expansion anchors.
  - 3. Power-actuated anchors.
  - 4. Mechanical fasteners.
  - 5. Vertical deflection clips.
  - 6. Horizontal drift deflection clips
  - 7. Miscellaneous structural clips and accessories.
- C. Research Reports:
  - 1. For cold-formed steel framing.

2. Steel framing manufacturer to have a third-party evaluation report for its products that are reviewed to the local building code or its model code (IBC 2018 and AISI S100).

## 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Member in good standing of the Steel Framing Industry Association (SFIA) or be a part of a similar organization that provides verifiable code compliance program.
  1. Products to be certified under an independent third-party inspection program administered by an agency accredited by IAS to ICC-ES AC98 IAS Accreditation Criteria for Inspection Agencies.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-steel thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
  1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- D. Comply with the following AISI Specifications and standards:
  1. AISI S100, "North American Specification for the Design of Cold-Formed Steel Structural Members."

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202, "Code of Standard Practice for Cold-Formed Steel Framing."

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
  1. ClarkDietrich.
  2. MarinoWARE.
  3. Super Stud Building Products, Inc.
  4. United Metal Products, Inc.
  5. Craco Mfg., Inc.
  6. Or approved equal

### 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Division 1 Section "Quality Requirements" and "Submittal Procedures," to design cold-formed steel framing.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads

within limits and under conditions indicated according to the 2021 new jersey edition of the IBC, ASCE 7-16.

1. Design Loads: See structural drawings.
    - a. risk category 2, exposure B, basic wind speed 121 mph.
  2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
    - a. Exterior Non-Load-Bearing Framing where masonry veneer braced/attached: Horizontal deflection of  $L/600$  of the wall height
    - b. Exterior non-load bearing framing without masonry veneer: Horizontal deflection of  $L/360$  of the wall height
  3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
  4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
    - a. Upward and downward movement of 1 inch.
  5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
  6. Design soffit framing to accommodate a positive and negative pressure as determined by engineering analysis based on design loads but in no case shall be less than  $\pm 30$  psf.
- C. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S240.

## 2.3 COLD-FORMED STEEL FRAMING MATERIALS

- A. Framing Members, General: Comply with AISI S240 for conditions indicated.
- B. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
  1. Grade:
    - a. ST33H (33KSI) where studs are 0.0428 in (18 gauge) and lighter
    - b. ST50H (50KSI) where studs are 0.0538 in (16 gauge) and heavier.
  2. Coating: **CP 90: G90 , AZ50 , or GF45.**

## 2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
  1. Minimum Base-Steel Thickness: Determined by Contractor's Delegated Design Engineer but not less than 0.0428 in. (18 gauge).
  2. Flange Width: 1-5/8 inches minimum.
  3. Section Properties: Determined by Contractor's Delegated Design Engineer.

- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges. Material thickness to match studs.
- C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
  - 1. Minimum Base-Steel Thickness: as required by engineering calculations but not less than thickness of the studs.
- D. Slotted Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; punched with vertical slots in both legs. Studs should be positively attached to deep-leg track using vertical slots while allowing free vertical movement. Legs designed to support horizontal and lateral loads and transfer them to the primary structure.
  - 1. Depth of legs as required to accommodate specified movement
- E. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure and with length sufficient to allow specified movement, and as follows:
  - 1. Minimum Base-Steel Thickness: Determined by Contractor's Delegated Design Engineer.
  - 2. Flange Width: Determined by Contractor's Delegated Design Engineer.

## 2.5 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
  - 1. Supplementary framing.
  - 2. Bracing, bridging, and solid blocking.
  - 3. Web stiffeners.
  - 4. Anchor clips.
  - 5. End clips.
  - 6. Foundation clips.
  - 7. Stud kickers and knee braces.
  - 8. Hole reinforcing plates.
  - 9. Backer plates.

## 2.6 ANCHORS, CLIPS, AND FASTENERS

- A. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.
- B. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a

qualified testing agency.

- C. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

- 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

- D. Welding Electrodes: Comply with AWS standards.

## 2.7 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780.
- B. Shims: Load bearing, high-density multi-monomer plastic, and non-leaching; or of cold-formed steel of same grade and coating as framing members supported by shims.
- C. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

## 2.8 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
  - 1. Fabricate framing assemblies using jigs or templates.
  - 2. Cut framing members by sawing or shearing; do not torch cut.
  - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
    - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
  - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
  - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
  - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.



## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

### 3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to ASTM C1007, AISI S240 and to manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
  - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
  - 1. Cut framing members by sawing or shearing; do not torch cut.
  - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
    - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    - b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Install insulation, specified in Division 7 Section "Building Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

- H. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.
- I. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
  - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

### 3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
  - 1. Stud Spacing: 16 inches, unless otherwise determined by the delegated design engineer.
- C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
  - 1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
    - a. Install solid blocking at 96-inch centers.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall- framing system.

### 3.5 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace work where test results indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine

compliance of replaced or additional work with specified requirements.

**3.6 REPAIRS AND PROTECTION**

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 4000

## SECTION 05 5000 - METAL FABRICATIONS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Metal ladders including attachment brackets.
2. Steel bollards, galvanized
3. Galvanized steel lintels.
4. Thermal break plates with bushings and washers for use at steel lintels where indicated
5. Miscellaneous steel framing and supports.
6. Counter support brackets for built-in counters and benches.
7. Miscellaneous metal framing and supports not furnished as structural steel components.
8. Other metal items indicated on the drawings but not specified elsewhere, and those metal items not indicated but required to complete the work.

#### 1.2 SUBMITTALS

A. Product Data: For the following:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Fasteners.
3. Shop primers.
4. Shrinkage-resisting grout.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

C. Engineering Data

1. Before any ladders or railings are fabricated, submit engineering data drawings to the Architect for review indicating how performance standards specified here shall be met. The Contractor is responsible for the structural design and supports for these systems and must show his proposed systems on these drawings.
2. These drawings must show all load conditions and design calculations relative to connections, fastening devices and anchorage, as well as size and gauge of members. Calculations and drawings must be prepared by a Structural Engineer licensed in the State of New Jersey and shall be signed and sealed by this Engineer.

D. Welding certificates.

E. Qualification Data: For professional engineer.

### 1.3 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1, "Structural Welding Code--Steel."
  - 2. AWS D1.3, "Structural Welding Code--Sheet Steel."
- B. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

### 1.4 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Coordinate installation of metal fabrications, such as steel weld plates and angles for casting into concrete, that are specified in this Section but required for work of another Section. Deliver such items to Project site to not delay their installation.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Galvanized Metal Ladders: Ladders shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
  - 1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces.

### 2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

- C. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304 or Type 316L as indicated.
- D. Rolled-Stainless Steel Floor Plate: ASTM A793.
- E. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- F. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
  - 1. Provide Schedule 80 pipe for bollards.
  - 2. Where to be installed at exterior location and where indicated: Galvanized steel, ASTM A653/A653M, structural steel, Grade 33, with G90 coating; hot-dip galvanized after fabrication
- G. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.
- H. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.
- I. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.
- J. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.
- K. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).
- L. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (lead red brass) or UNS No. C84400 (lead semired brass).
- M. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent lead nickel bronze).

## 2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
  - 1. Provide stainless steel fasteners for fastening aluminum, stainless steel, or nickel silver.
- B. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

## 2.4 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide shop primers compatible with topcoats, Refer to Section 099000 Painting and Coatings and Section 099600 "High-Performance Coatings".
- B. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat, refer to section 099600 high-performance coating.

- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint (isolating coating): Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- E. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- F. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 4500 psi

## 2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 8 inches from ends and corners of units and 24 inches o.c.

## 2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

## 2.7 COUNTERTOP SUPPORT BRACKETS

- A. Description: For built-in counters, surface- mounted and inside- wall brackets made manufacturers standard aluminum, with holes for wall mounting and fastening to countertop.
  - 1. Model # and Size: As indicated on drawings to suit project application or approved equal.
  - 2. Weight Capacity: As indicated or required to suit project application
  - 3. Finish: Clear anodized.
  - 4. Mounting Hardware: #14 x 2 ½ inch Phillips flat-head screw with color-matched finish washer, unless otherwise required to suit project application
  - 5. Basis-of-Design, Product: Subject to compliance with requirement, provide 'EH-series' as supplied by Rakks or approved equal.

## 2.8 STRUCTURAL THERMAL ISOLATING MATERIALS

- A. Products: Subject to compliance with requirements, provide the following:
  - 1. Fabreeka-TIM.
  - 2. Armatherm
  - 3. Or approved equal
- B. Description:
  - 1. Provide Load-bearing, structural thermal break/insulation material to prevent thermal bridging between flanged, bolted, structural steel framing members at connections. And include thermal material washers and bushings
  - 2. Maintains structural integrity of connections while reducing energy loss.
- C. Material: Fiberglass-reinforced laminate composite.
- D. ICC Certified
- E. Thickness: 1" or as indicated by structural engineer.
- F. Ultimate Mechanical Properties, Nominal:
  - 1. Tensile Strength, ASTM D 638: 11,000 psi.
  - 2. Flexural Strength, ASTM D 790: 25,000 psi.
  - 3. Compressive Strength, ASTM D 695: 38,900 psi.
  - 4. Compressive Modulus, ASTM D 695:
    - a. 1/2-Inch (12.7 mm) Thickness: 291,194 psi .
    - b. 1-Inch (25.4 mm) Thickness: 519,531 psi
  - 5. Shear Strength, ASTM D 732: 15,000 psi.
  - 6. Operating Temperature Range: Minus 20 degrees F to 250 degrees F
    - a. Loss in Ultimate Strength at 250 degrees F: 30 percent.
- G. Thermal Properties, Nominal:



1. Thermal Conductivity, ASTM C 177: 1.8 BTU/hr/ft<sup>2</sup>/in/degree F
  2. Heat Flow Resistance, R-Value:
    - a. 1/2-Inch (12.7 mm) Thickness: 0.28.
    - b. 1-Inch (25.4 mm) Thickness: 0.56.
- H. Thermal Break Washers: Same material as structural thermal break plates, 1/4" minimum thickness or as recommended by manufacturers with outside and inside diameters determined by structural bolt.
1. Provide at each bolt where plates are noted to be used
- I. Thermal Break Bushings: As recommended by thermal break plate manufacturer, made of Elastomeric material length determined by thickness of steel end plate and having outside and inside diameters determined by structural bolt.
1. Provide at each bolt where plates are noted to be used.

## 2.9 METAL LADDERS

### A. General:

1. Comply with ANSI A14.3.

### B. Steel Ladders:

1. Space siderails 16 inches apart unless otherwise indicated.
2. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
3. Rungs:
  - a. At interior locations: 3/4-inch- diameter, steel bars
  - b. At exterior locations: 1-inch- diameter, steel bars..
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout
6. Where crossover platform indicated, fabricate form galv. 1-1/2" deep Grip-strut flooring and 4" high toe-guards. Railings to return each side of cross-over and provide with mid-rail.
7. Provide attachment brackets of 1/2" thick galv. steel anchored to structure prior to installation of façade. Ladder to bolt to brackets with galv. steel bolts.
8. Galvanize and prime ladders, including brackets.
9. Prime ladders, including brackets and fasteners, with
  - a. Interior locations: Comply with 099000 Painting and Coatings
  - b. Exterior Locations: Comply with 099600 High performance coatings

## 2.10 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize bearing and leveling plates.

- C. Prime plates with primer compatible with topcoats
  - 1. Where high-performance coating indicated, refer to section 099600 High-performance coatings
  - 2. Where noted to be painted, refer to section 099000 Painting and Coatings

## 2.11 STEEL BOLLARDS

- A. Provide Galvanized schedule 80 steel pipe filled with concrete in height indicated with cast-in-place concrete footing. Minimum 6" diameter and extending 48" above grade unless otherwise noted on the drawings.
- B. Prime and Paint with high-performance coating, refer to specification 099600 high-performance coating.

## 2.12 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Galvanize and prime loose steel lintels located in exterior walls.
- C. Prime loose steel lintels located in exterior walls with primer compatible with topcoats, refer to section 099000 Painting and Coating

## 2.13 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.

## 2.14 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
  - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
  - 1. Shop prime with primers specified in Section 099000 painting and coatings indicated.
- C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
  - 1. Items Indicated to Receive Zinc-Rich Primer and non-galvanized exterior items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."
  3. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
- D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, GENERAL**

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  2. Obtain fusion without undercut or overlap.
  3. Remove welding flux immediately.
  4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

### **3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS**

- A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.
- C. Anchor shelf angles securely to existing construction with anchor bolts or welds as indicated on structural drawings

- D. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

### 3.3 INSTALLATION OF METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
- B. Anchor bollards in concrete, wrap embedded length with 2 turns of #30 roofing felt. Slope concrete around bollard away from pipe, Fill annular space around bollard with urethane sealant as required.
- C. Fill bollards solidly with concrete, mounding top surface to shed water.
- D. Unless otherwise detailed on the drawings, Bollard pipe to extend 42inches minimum below grade with 18inch diameter concrete footing of 4000psi concrete minimum.
- E. Prime and paint bollard and concrete top mount with high-performance coating, refer to specification 099600 high-performance coating.

### 3.4 INSTALLATION OF BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

### 3.5 REPAIRS

- A. Touchup Painting:
  - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 5000

## **SECTION 055100 - STEEL PAN STAIRS**

### **PART 1 GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### **1.2 SECTION INCLUDES**

- A. Work of this Section includes all labor, materials, equipment and services necessary to complete the steel pan stairs as indicated on the drawings and specified herein, including but not limited to, the following:
  - 1. Steel pan stairs, including all clips, hangers, inserts, braces and other supports.

#### **1.3 RELATED SECTIONS**

- A. Ornamental Handrails and railings – Section 05 5200
- B. Miscellaneous metals - Section 055000.
- C. Finish painting - Section 099000 and Section 099600

#### **1.4 QUALITY ASSURANCE**

- A. Qualification of Welders: Use only certified welders and the shielded arc process for all welding performed in connection with the work of this Section. Protect adjacent surfaces when field welding to prevent damage or stain. Welders and welding operators must be qualified by tests as provided by AWS.
- B. Codes and Standards: In addition to complying with all pertinent codes and regulations, comply with:
  - 1. "Specifications for Design, Fabrication and Erection of Structural Steel for Buildings" of the American Institute of Steel Construction.
  - 2. "Code for Welding in Building Construction" of the American Welding Society.
  - 3. "Metal Stairs Manual" of the National Association of Architectural Metal Manufacturers.
- C. Conflicting Requirements: In the event of conflict between pertinent codes and regulations and the requirements of the referenced standards of these specifications, the provisions of the more stringent shall govern.
- D. Field Measurements: If construction process permits, take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress. Allow for trimming and fitting wherever taking field measurements before fabrication might delay work.
- E. Tolerances: Allow for construction tolerances as required.
- F. Coordination: Coordinate this work with the work of all other trades interfacing with metal pan stairs, such as structural openings, sprinklers and standpipes, and other trades as required.

## 1.5 DRAWING SUBMISSION

- A. General: It is the intent of the Working Drawings to display the layouts and general design parameters upon which the Shop Drawings shall be developed. Detail development and all connections shall be part of Shop Drawing Development.
- B. Shop Drawings
  - 1. Before any steel stairs are fabricated, submit shop drawings to the Architect for approval.
  - 2. Show all locations, markings, quantities, materials, sizes and shapes, and indicate all methods of connecting, anchoring, fastening, bracing, for the stair construction, support and attachment to the work of other trades.
- C. Delegated Design & Engineering Data
  - 1. Before any metal pan stairs or railings are fabricated, submit engineering data drawings to the Architect for review. The Contractor is responsible for the structural design and supports for the stair system and railings and must show his proposed system on these drawings.
  - 2. These drawings must show all load conditions and design calculations relative to connections, fastening devices and anchorage, as well as size and gauge of stair members. Calculations and drawings must be prepared by a Structural Engineer licensed in the State of New Jersey and shall be signed and sealed by this Engineer.

## 1.6 SAMPLES SUBMISSION

- A. Submit the following listed samples and other samples as may be requested by the Architect, to show the quality standards:
  - 1. Exposed weld.
  - 2. Exposed bolted connection.
- B. Samples shall be submitted cleaned and shop primed and shall represent standards to which all respective materials used in the Project shall meet.

## 1.7 PERFORMANCE STANDARDS

- A. Stairs and railings shall be constructed to conform to the following performance standards, unless greater required by Code:
  - 1. Stairs and platforms shall support a live load of one hundred (100) psf and a concentrated live load of three hundred (300) lbs. and shall have a live load deflection limited to 1/360 of the span. Loads shall not apply simultaneously.

## 1.8 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect steel pan stair before, during and after installation and to protect the installed work and materials of all other trades.
- B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- A. Structural Steel: ASTM A 36.
- B. Steel Sheets: ASTM A 245, Grade C, minimum ten (10) gauge for platforms, twelve (12) gauge minimum for treads and risers.
- C. Stainless Steel
  - 1. Comply with the following standards for the forms and types of stainless steel for the required items of work.
    - a. Castings: ASTM A 743, Grade CF 8 or CF 20 for interior, Grade CF 8M or CF 3M for exterior.
    - b. Sheet, Strip, Flat Bar and Plate: ASTM A 666, Type 304 for interior, Type 316L for exterior.
    - c. Bars and Shapes: ASTM A 276, Type 304 for interior, Type 316L for exterior.
- D. Malleable Iron Castings: ASTM A 47, Grade 35018.
- E. Bolts and Nuts: ASTM A 307, Grade A bolts.
- F. Machine Screws: ASME B 18.6.3.
- G. Expansion Bolts: "Cinch" type, galvanized, of approved manufacture.
- H. Threaded End Hanger Rods: Minimum 3/4" diameter, ASTM A 36.
- I. Shop Paint: Shop prime all stairs and railings using Series 88 Azerox Primer made by Tnemec, ICI Devco "Rust Guard" quick dry alkyd shop coat No. 41403, or "Interlac 393" by International Protection Coatings or approved equal.
- J. Bituminous Paint: Cold applied asphalt emulsion complying with ASTM D1187.
- K. Concrete Fill and Reinforcing Materials
  - 1. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of 3000 psi.
  - 2. Nonslip-Aggregate Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.
  - 3. Welded Wire Fabric: ASTM A 185, 6 by 6 inches – W1.4 by W1.4, unless otherwise indicated.

### **2.2 FABRICATION**

- A. General
  - 1. Steel pan stair work shall be fabricated by an experienced manufacturer in accordance with approved shop drawings and best practices of the industry, using new and clean materials as specified, having structural properties sufficient to safely sustain or withstand strains and stresses to which material will be subjected.

2. Fabricate shop assemblies in largest practical sizes to minimize field work. All exposed surfaces shall be clean and free from all dirt, stains, grease marks, scratches, waves, dents, buckles, tool marks, rattles, and other objectionable defects which mar appearance or use of finished work.
3. Cutting: Cut materials by sawing, shearing, or blanking. Flame cutting will be permitted when ground back to clean edges. Cuts shall be made accurately, clean, sharp and free of burrs, without deforming adjacent metals.
4. Connections: Make connections with tight joints, capable of developing full strength of the members, flush. Locate joints where least conspicuous. Use concealed fasteners where possible. Weld or rivet shop connections; bolt, screw or weld field connections.
  - a. Welding: Welds shall be continuous, except where spot welding is specifically permitted. Welding shall conform to the Standard Code of the American Welding Society. Exposed welds are required to be ground flush.
  - b. Bolts and Screws: Make threaded connections tight with threads entirely concealed. Use lock nuts, or upset thread ends. Exposed bolts and screw head shall be flat and countersunk, unless otherwise indicated on drawings. Remove projecting ends of bolts and screws. Punch or drill holes; do not burn.

**B. Stairs and Platforms**

1. Provide stringers, risers, sub-treads and platforms matching profiles as shown. Form tread pan and riser in a continuous piece to receive the finished tread; tread shall be a minimum of twelve (12) gauge. Weld risers and treads to carrier angles which shall be welded to the structural steel stringers. Fasten countersunk bolts or stud welded clips through mesh for cement fill. Provide welded-on clips for the support of gypsum drywall soffits.
2. On intermediate platforms, provide metal bases formed of stringers. Miter and weld and grind smooth internal and external corners of metal bases. Form platform runs of minimum ten (10) gauge steel.
3. Countersink bolt heads and screws on finished surfaces or cut off flush with such surfaces.
4. Properly fit and securely fasten together all parts making exposed joints close fitting. Cut, drill, punch and tap as required for installation.
5. Make joints as strong and rigid as adjoining sections. Weld continuously along entire line of contact except where spot welding is indicated.
6. Separate dissimilar metals in or adjacent to work of this Section with a coat of bituminous paint on each surface prior to installation.
7. Closure and Filler Plates: Where indicated on drawings or as required, at least twelve (12) gauge sheet steel, securely fastened to top and bottom of stringer and adjacent wall, by welding or screws.
8. Struts, Hangers, Platform Headers and Subframing
  - a. Provide supports as detailed and required, including all struts, clip angles, angles or hangers which are required and necessary for support of stair construction.
  - b. Supports shall be of size suitable for the support load, as required. Struts, angles and hangers shall be supported by and directly connected to the structural framing. Struts and hangers, with their connections, shall be concealed.



- c. Provide other inserts, anchors and/or other subframing as may be required to complete the stair construction and properly support it on the structural framing.

## **2.3 SHOP PAINTING**

- A. Scope: All ferrous metal shall be cleaned and shop painted with one coat of specified ferrous metal primer.
- B. Cleaning: Conform to Steel Structures Painting Council Surface Preparation Specification SP 3 (latest edition) "Power Tool Cleaning" for cleaning of ferrous metals which are to receive shop prime coat.
- C. Application
  - 1. Apply shop prime coat immediately after cleaning metal. Apply paint in dry weather or under cover. Metal surfaces shall be free from frost or moisture when painted. Paint all metal surfaces including edges, joints, holes, corners, etc.
  - 2. Paint surfaces which will be concealed after shop assembly prior to such assembly. Apply paint in accordance with approved paint manufacturer's printed instructions, and the use of any thinners, adulterants or admixtures shall be only as stated in said instructions.
  - 3. Paint shall uniformly and completely cover the metal surfaces, 2.0 mils minimum dry film thickness. No work shall be shipped until the shop prime coat thereon has dried.
- D. Touch-Up: In the shop, after assembly and in the field, after installation of work of this Section, touch-up damaged or abraded portions of shop prime paint with specified ferrous metal primer.
- E. Apply one shop coat to fabricated metal items, except apply two (2) coats of paint to surfaces inaccessible after assembly or erection. Change color of second coat to distinguish it from the first.

## **PART 3 EXECUTION**

### **3.1 INSPECTION**

- A. Examine the areas and conditions where steel pan stairs are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

### **3.2 INSTALLATION**

- A. Work in the field shall comply with the same requirements as specified for shop work above.
- B. Except where otherwise shown or specified for a particular item of work or for built-in work, fasten metal work to solid masonry with expansion bolts. Fastenings to wood plugs in masonry will not be accepted. Drill holes to the exact diameter of the bolts using a rotary drill for concrete and a percussion drill for other masonry. Thread screws full length to the head of the screw.
- C. Provide connecting members needed for properly securing the work to masonry, drywall and structural framing, including bolts, machine screws, rods, hangers, inserts, sleeves, plates, anchors, expansion bolts, washers and other items as required. Furnish built-in items to drywall trades as required for proper anchorage.

- D. Leave work exposed to view, including stair soffits, clean, smooth and neatly finished. All exposed welds shall be dressed smooth.
- E. Include supplementary parts necessary to complete each item even though such work is not definitively shown or specified.
- F. Coordinate and schedule the work of this Section with the work of other trades. Furnish anchors, sockets, fastenings and other miscellaneous items to be embedded in concrete or masonry, or required for securing metal work to other construction so as not to delay job progress.
- G. Attach wall railings to the wall construction, using appropriate bolts and anchors to meet performance standards.
- H. Install work plumb and true to the exact lines and levels, in the correct location and in proper relation to adjoining work.
- I. Touch up marred and abraded shop paint of exposed surfaces after erection in the field.
- J. Posts shall be set plumb within 1/8" vertical tolerance. Longitudinal members shall be parallel with each other and with floor surface or slope of stair to a tolerance of 1/8" in ten (10) linear feet. Center lines of members within each run of railing shall lie in the same vertical plane. Field joints of connecting sections shall be hairline.

### 3.3 TOUCH-UP PAINTING

- A. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop coat, and paint exposed areas with same material used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

END OF SECTION

## SECTION 05 5200 ORNAMENTAL HANDRAILS AND RAILINGS

### PART 1 GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### 1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment and services necessary to complete the interior and exterior ornamental handrails and railings as shown on the drawings and/or specified herein.
  - 1. Painted steel guardrails and railings.
    - a. Exterior – hot dip galvanized and painted.
    - b. Interior – Primed and painted.

#### 1.3 RELATED SECTIONS

- A. Concrete work - Section 033000.
- B. Masonry construction- Section 042000.

#### 1.4 QUALITY ASSURANCE

- A. General: Work of this Section shall be fabricated and installed by an experienced fabricator or manufacturer who has been engaged in work of equivalent scope and fabrication standards for at least 5 years. Materials, methods of fabrication, fitting, assembly, bracing, supporting, fastening, operating devices and erection shall be in accordance with drawings, specifications, and approved shop drawings, and be of highest quality practices of the industry, using new and clean materials as specified, having structural properties sufficient to safely sustain or withstand stresses and strains to which materials and assembled work will be subjected. All work shall be accurately and neatly fabricated, assembled, and erected.
- B. Single-Source Responsibility: Obtain handrails and railing systems of each type and material from a single manufacturer.
- C. Engineer Qualifications: Professional engineer legally authorized to practice in the State of New Jersey and experienced in providing engineering services of the kind indicated for handrails and railing systems similar to this Project in material, design, and extent, and that have a record of successful in-service performance.

#### 1.5 SUBMITTALS

- A. Shop Drawings: Submit for all items of work, at full scale as far as practical, showing metal thicknesses, arrangement of components, of joining, of jointing, details of all field connections and anchorages, diagrams and details explaining provisions for thermal movement, fastening and sealing methods, and support methods, metal finishes and all other pertinent information.

1. Engineering design and calculations for handrails and railing assemblies - see Article 1.7 herein.
- B. Samples for Verification: For each type of exposed finish required, prepared on components indicated below and of same thickness and metal indicated for the work.
  1. 6" long sections of each different linear railing member, including handrails, top rails, posts, and balusters.
  2. Fittings and brackets.
  3. Perforated steel guard.
  4. Welded connections.
  5. Assembled samples of railings, made from full size components, including top rail, post and handrail. Show method of finishing members at intersections. Samples need not be full height.

#### 1.6 PRODUCT HANDLING

- A. Finished Materials: Protect finishes against soiling, staining or damage from scratches and abrasion. Maintain protection during construction until project completion or as otherwise directed by Architect.
  1. Provide wrappings, strippable coatings or other means approved by Architect.
  2. During construction, remove protection for visual observation of finish as directed by Architect and replace to maintain protection.

#### 1.7 PERFORMANCE STANDARDS

- A. Structural Performance of Handrails and Railing Systems: Engineer, fabricate, and install handrails and railing systems to withstand the structural loads indicated in the State of New Jersey Building Code, without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each of the respective components of each metal fabrication. Provide stamped and sealed drawings by Professional Engineer licensed in the State of New Jersey.
- B. Structural Performance of Guard Rail Systems: Engineer, fabricate, and install railing guards at vehicular areas to withstand the following structural loads, as indicated in the State of New Jersey Building Code 2021 Edition without exceeding the allowable design working stress of the guard assembly materials, anchors and connections.
  1. Infill of Guards:
    - a. Concentrated load of 200 lbf applied horizontally on an area of 1 sq. ft.
    - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in engineering, fabricating, and installing handrails and railing systems to prevent buckling, opening of joints, overstressing of components and connections, damage to adjoining construction, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

1. Temperature Change (Range): 120 deg F ambient, 180 deg F material surfaces.
- D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Provide materials which have been selected for their surface flatness, smoothness and freedom from surface blemishes where exposed to view in the finished unit. Surfaces exposed to view that exhibit pitting, seam marks, roller marks, "oil-canning," stains, discoloration's or other imperfections on the finished units will not be acceptable.
- B. Exposed Steel (cold rolled)
  1. Structural Shapes and Sheets: ASTM A 1008.
  2. Strip: ASTM A109
- C. Protection for Metals: Bituminous paint; cold applied asphalt mastic complying with SSPC - Part 12, but containing no asbestos fibers.
- D. Welding Electrodes and Filler Metal: Type and alloy of filler metal and electrodes as recommended by producer of the metal to be welded, and as required for color match, strength and compatibility in the fabricated items.
- E. Fasteners for Interconnecting Handrails and Railing Components: Furnish of basic metal and alloy, matching finished color and texture as the metal being fastened, unless otherwise indicated. Unless otherwise shown, provide Phillips flat-head screws for exposed fasteners.
- F. Fasteners for Anchoring Handrails and Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring handrails and railings to other types of construction indicated and capable of withstanding design loads. Fasteners shall be fabricated from Type 304 or 316 stainless steel.
- G. Erosion-Resistant Anchoring Cement: Factory packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with water at project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

### 2.2 FABRICATION

- A. General: Fabricate handrails and railing systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of hollow members, post spacings, and anchorage, but not less than those required to support structural loads.
- B. Assemble handrails and railings in shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use

connections that maintain structural value of joined pieces. . Clearly mark units for reassembly and coordinated installation.

- C. Form changes in direction of members as detailed or, if not detailed, by either of the following methods:
  - 1. By radius bends of radius indicated.
  - 2. By flush radius bends.
  - 3. By bending.
  - 4. By insertion of prefabricated flush elbow fittings.
- D. Welded Connections: Fabricate steel handrails and railing systems for connection of members by welding, except as otherwise indicated. Limit non-welded connections to connections that cannot be made in the factory due to size or handling limitations and similar considerations. For connections made during fabrication, weld corners and seams continuously to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At tee and cross intersections, cope ends of intersecting members to fit contour of pipe or tube to which end is joined, and weld all around.
  - 5. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- E. Brackets, Flanges, Fittings and Anchors: Provide manufacturer's standard wall brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing system members to other construction.
- F. Provide inserts and other anchorage devices to connect handrails and railing systems to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railing systems. Coordinate anchorage devices with supporting structure.
- G. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.
- H. Ease exposed edges to a radius of approximately 1/32", unless otherwise indicated. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing work.
- I. Cut, reinforce, drill and tap components, as indicated, to receive finish hardware, screws, and similar items.
- J. Provide weepholes, or another means to evacuate entrapped water, in hollow sections of railing members that are exposed to exterior or to moisture from condensation or other sources.

- K. Fabricate joints that will be exposed to weather in a manner to exclude water.
- L. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.
- M. Close exposed ends of pipe by welding 3/16 inch-thick steel plate in place or with prefabricated fittings, except where clearance of end of pipe and adjoining wall surface is 1/4 inch or less.
- N. Fillers: Provide steel sheet or plate fillers, of thickness and size indicated or required to support structural loads of handrails, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses to produce adequate bearing to prevent bracket rotation and overstressing substrate.

### 2.3 PRIME PAINTING (INTERIOR RAILINGS)

- A. Scope: All ferrous metal (except galvanized steel) shall be cleaned and shop painted with one coat of specified ferrous metal primer. No shop prime paint required on galvanized steel or aluminum work.
- B. Cleaning: Conform to Steel Structures Painting Council Surface Preparation Specification SP 3 (latest edition) "Power Tool Cleaning" for cleaning of ferrous metals which are to receive shop prime coat.
  - 1. Steel to get high performance coating as noted in Section 099000 shall be cleaned as per SSPC SP.6 "Commercial Blast Cleaning."
- C. Application
  - 1. Apply shop prime coat immediately after cleaning metal. Apply paint in dry weather or under cover. Metal surfaces shall be free from frost or moisture when painted. Paint all metal surfaces including edges, joints, holes, corners, etc.
  - 2. Paint surfaces which will be concealed after shop assembly prior to such assembly. Apply paint in accordance with approved paint manufacturer's printed instructions, and the use of any thinners, adulterants or admixtures shall be only as stated in said instructions.
  - 3. Paint shall uniformly and completely cover the metal surfaces, 2.0 mils minimum dry film thickness. No work shall be shipped until the shop prime coat thereon has dried.
- D. Touch-Up: In the shop, after assembly and in the field, after installation of work of this Section, touch-up damaged or abraded portions of shop prime paint with specified ferrous metal primer.
- E. Apply one shop coat to fabricated metal items, except apply two (2) coats of paint to surfaces inaccessible after assembly or erection. Change color of second coat to distinguish it from the first.
- F. Shop Paint: Shop prime all non-galvanized miscellaneous metal items using Series 88 Azeron Primer made by Tnemec, ICI Devco "Rust Guard" quick dry alkyd shop coat No. 41403, or "Interlac 393" by International Protection Coatings, or approved equal.
  - 1. Finish Paint see drawings

## 2.4 GALVANIZING (EXTERIOR RAILINGS)

- A. Scope: All ferrous metal exposed to the weather, and all ferrous metals indicated on drawings or in specifications to be galvanized, shall be cleaned and then hot-dipped galvanized after fabrication as provided by Duncan Galvanizing or approved equal.
- B. Avoid fabrication techniques that could cause distortion or embrittlement of steel items to be hot-dip galvanized. Fabricator shall consult with hot-dip galvanizer regarding potential warpage problems or handling problems during the galvanizing process that may require adjustment of fabrication techniques or design before finalizing shop drawings and beginning of fabrication.
- C. Cleaning: Thoroughly clean metal surfaces of all mill scale, rust, dirt, grease, oil, moisture and other contaminants prior to galvanizing.
- D. Application: Hot-dip galvanizing shall conform to the following:
  - 1. ASTM A 143: Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel.
  - 2. ASTM A 123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 3. ASTM A 153: Galvanized Coating on Iron and Steel Hardware - Table 1.
  - 4. ASTM A 384: Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
  - 5. ASTM A 385: Practice for Providing High Quality Zinc Coatings.
  - 6. ASTM A 924: Galvanized Coating on Steel Sheets.
  - 7. Minimum weight of galvanized coating shall be two (2) oz. per square foot of surface.
- E. Fabricate joints which will be exposed to weather in a manner to exclude water or provide weep holes where water may accumulate.
- F. All galvanized materials must be inspected for compliance with these specifications and marked with a stamp indicating the name of the galvanizer, the weight of the coating, and the appropriate ASTM number.
- G. To minimize surface imperfection (e.g.: flux inclusions), material to be galvanized shall be dipped into a solution of Zinc Ammonium Chloride (pre-flux) immediately prior to galvanizing. The type of galvanizing process utilizing a flux blanket overlaying the molten zinc will not be permitted.
- H. After galvanizing all materials not exposed to view must be chromated by dipping material in a 0.2% chromic acid solution.
- I. Galvanized surfaces, where exposed to view, must have a smooth, level surface finish. Where this does not occur, piece shall be rejected and replaced to the acceptance of the Architect.
- J. Painted see drawings



## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions and directions for installing anchorages, such as sleeves, concrete inserts, anchor bolts, and miscellaneous items having integral anchors, that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

### 3.2 INSTALLATION - GENERAL

- A. Fit exposed connections accurately together to form tight, hairline joints.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling and fitting required for installing handrails and railing systems. Set handrails and railing systems accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.
  - 1. Do not weld, cut, or abrade surfaces of handrails and railing components that have been coated or finished after fabrication and are intended for field connection by mechanical or other means without further cutting or fitting.
  - 2. Set posts plumb within a tolerance of 1/4 inch in 12 feet.
  - 3. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
  - 4. Adjust handrails and railing systems prior to anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated but not less than that required by design loadings.
  - 5. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing handrails and railing systems and for properly transferring loads to in-place construction.

### 3.3 RAILING CONNECTIONS

- A. Non-Welded Connections: Use mechanical joints for permanently connecting railing components in the field. Locate exposed fasteners in least conspicuous locations. Seal recessed holes of exposed locking screws with plastic filler, cement colored to match finish of handrails and railing systems.
  - 1. Welded Connections: Fully welded joints for permanently connecting steel railing components may be used where unavoidable. Cope or butt components to provide 100 percent contact, or use fittings designed for this purpose.
- B. Expansion Joints: Install expansion joints at locations indicated but not further apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side; fasten internal sleeve securely to one side; locate joint within 6 inches of post.

### 3.4 ANCHORING POSTS

- A. Attach posts to wall with custom wall brackets as indicated on drawings. Secure wall brackets to building construction as follows:

1. Use type of bracket with predrilled hole for exposed bolt anchorage.
  2. For solid masonry anchorage, use drilled-in expansion shield and either concealed hanger bolt or exposed lag bolt, as applicable.
  3. For hollow masonry anchorage, use toggle bolts with square heads.
- B. Anchor posts in concrete by forming or core-drilling holes not less than 5 inches deep and 3/4 inch greater than outside diameter of post. Clean holes of all loose material, insert posts, and fill annular space between post and concrete with the following anchoring material, mixed and placed to comply with anchoring material manufacturer's directions.
1. Non-shrink, non-metallic grout, or, for interior applications only, anchoring cement.
  2. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave 1/8 inch buildup, sloped away from post.

- C. Anchor posts to metal surfaces by direct welding unless otherwise indicated.

### 3.5 ANCHORING RAIL ENDS

- A. Anchor rail ends into concrete and masonry with round flanges connected to rail ends and anchored into wall construction with post installed anchors and bolts.

### 3.6 ATTACHING HANDRAILS TO WALLS

- A. Attach handrails to wall with wall brackets and end fittings. Provide bracket with 1-1/2 inch clearance from inside face of handrail to finished wall surface.
- B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- C. Secure wall brackets and wall return fittings to building construction as follows:
1. Use type of bracket with predrilled hole for exposed bolt anchorage.
  2. For concrete and solid masonry anchorage, use drilled-in expansion shield and either concealed hanger bolt or exposed lag bolt, as applicable.
  3. For hollow masonry anchorage, use toggle bolts with square heads.
  4. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed anchors using self-tapping screws of size and type required to support structural loads.

### 3.7 CLEANING, PROTECTION AND ADJUSTMENT

- A. Cleaning and Protection: Protect work from misuse or damage after installation has been completed. Work which is scratched, etched or damaged will not be accepted by Owner, and shall be replaced with acceptable work. Protect work shall against soiling, etching or other contamination. This work shall be done at no additional cost to Owner.
- B. Touchup Steel Finishes: Immediately after erection, clean bolted connections, and abraded areas of shop paint, and paint exposed areas with same material.

- C. Protect shop-applied steel finishes of handrails and railing systems from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
  - 1. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

## SECTION 06 1000 - ROUGH CARPENTRY

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Rooftop equipment bases and support curbs.
  2. Wood blocking and nailers.
  3. Plywood backing panels.
  4. Exterior Wood posts

#### 1.2 ACTION SUBMITTALS

- A. Product Data:
1. For each type of process and factory-fabricated product.
  2. For preservative-treated wood products.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Material Certificates:
1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
  2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.
- B. Evaluation Reports: For the following, from ICC-ES:
1. Wood-preservative-treated wood.
  2. Fire-retardant-treated wood.
  3. Power-driven fasteners.
  4. Post-installed anchors.
  5. Metal framing anchors.

### PART 2 - PRODUCTS

#### 2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency

certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Dress lumber, S4S, unless otherwise indicated.

**B. Maximum Moisture Content:**

1. Boards: 19 percent.
2. Dimension Lumber: 19 percent unless otherwise indicated.

**C. Dimension Lumber Items: Construction or No. 2 grade lumber or better.**

1. Species: Douglas fir or Southern yellow pine.

**D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used if it is cut and selected to eliminate defects that will interfere with its attachment and purpose.**

## **2.2 PRESERVATIVE TREATMENT**

**A. Where pressure treated wood products are specified, the following shall apply: Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with ground, and Use Category UC4a for items in contact with ground and exterior construction.**

**1. Preservative Chemicals:**

- a. Locations other than within roofing assembly: Pressure-treated with chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium meeting criteria above.
- b. Locations within roofing assembly: shall use inorganic boron (SBX), decay-resistant Douglas fir, or other treatment recommended by roofing manufacturer and approved by architect.

**B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.**

**C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.**

**D. Application: Treat items as indicated on Drawings and at the following locations:**

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing and roof perimeter nailers. Preservative treatment type at these locations limited to salt-based methods SBX/DOT, decay-resistant Douglas Fir or other approved type recommended by roofing manufacturer and approved by architect.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.

3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood floor plates that are installed over concrete slabs-on-grade.
5. Exterior wood posts in contact with the ground.

## 2.3 FIRE-RETARDANT-TREATMENT

- A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
  1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
  2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
- C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- E. Application: Treat items indicated on Drawings, and the following:
  1. Concealed blocking.
  2. Plywood backing panels.

## 2.4 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

## 2.5 FASTENERS AND ANCHORS

- A. Provide size, type, material and finish complying with applicable Federal Specifications for nails, staples, screws, bolts, nuts, washers and anchoring devices. Provide metal hangers, anchors and connectors of the size and type recommended by the manufacturer for each use indicated, including recommended nails. Fasteners shall be of sufficient length to penetrate not less than 1-1/2 inches into wood substrate

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M
  2. Provide galvanized steel connectors, minimum 16 gage, of type and size as recommended by manufacturer for uses indicated.
    - a. Connectors shall be G185 where used at exterior or in contact with pressure treated lumber and G60 interior locations unless otherwise indicated.
- B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC58, ICC-ES AC193, or ICC-ES AC308 as appropriate for the substrate.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- C. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- D. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- E. Do not splice structural members between supports unless otherwise indicated.
- F. Comply with AWWA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- G. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
  2. ICC-ES evaluation report for fastener.
- H. Do not paint over or conceal stamps, registrations or markings identifying classification of treated lumber or panels.

3.2 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 1000



## **SECTION 0 61600 - SHEATHING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Gypsum sheathing for exterior walls and parapets.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data:** For each type of process and factory-fabricated product.

#### **1.3 INFORMATIONAL SUBMITTALS**

- A. Evaluation Reports:** For the following, from ICC-ES:

#### **1.4 QUALITY ASSURANCE**

- A. Source Limitations:** Obtain each gypsum sheathing product through one source from a single manufacturer.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials in original packages, containers, or bundles, each bearing brand name and identification of manufacturer.**
- B. Store materials protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, or other causes. Neatly stack gypsum sheathing board flat on leveled supports off the ground, under cover, and fully protected from weather.**

#### **1.6 SEQUENCING AND SCHEDULING**

- A. Sequence installing sheathing with installing exterior cladding to comply with requirements indicated below:**
1. Do not leave glass-mat gypsum sheathing board exposed to weather for more than 180 days or maximum length of time recommended in writing by manufacturer.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

### 2.2 WALL SHEATHING

#### A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Georgia-Pacific Gypsum LLC; Dens-Glass Gold.
  - b. National Gypsum Company; Gold Bond, e<sup>2</sup>XP.
  - c. USG Corporation; Securock.
  - d. CertainTeed Corp.; GlasRoc.
  - e. Or approved equal
2. Type and Thickness: 5/8 inch thick.
3. Size: 48" minimum width, 96" minimum length
4. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - a. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
5. Mold Resistance (ASTM D3273): 10, in a test as manufactured.
6. Microbial Resistance (ASTM D6329, UL Environmental GREENGUARD 3-week protocol): Will not support microbial growth.

### 2.3 FASTENERS

- #### A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
1. For sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117.
  2. For steel framing from 0.033 to 0.112 inch thick, attach sheathing to comply with ASTM C 954.

### 2.4 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- #### A. Refer to specification 072726 fluid applied membrane air barrier manufacturer.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
  - 1. ICC-ES evaluation report for fastener.
- D. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

### 3.2 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
  - 1. Fasten gypsum sheathing to cold-formed metal framing with screws.
  - 2. Install panels with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
  - 3. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
  - 4. Outside corners to be tight 90degrees

END OF SECTION 06 1600

## SECTION 06 4020 - INTERIOR ARCHITECTURAL WOODWORK

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Work Included: The Work of this Section shall include:
  - 1. Plastic laminate-clad cabinets.
  - 2. Shop finishing of interior woodwork
  - 3. Closet & utility shelving
  - 4. Solid Surface countertops
- B. Products installed but not furnished, under this Section include the following:
  - 1. Countertop support brackets.

#### 1.2 DEFINITIONS

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
  - 1. Show details full size.
  - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
  - 3. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
  - 4. Show locations and sizes of cutouts and holes for plumbing fixtures faucets soap dispensers and other items installed in architectural woodwork.
  - 5. Apply AWI -certified compliance label to first page of shop drawings.
- C. Samples for Verification:
  - 1. Lumber and panel products with shop-applied opaque finish, 50 sq. in. for lumber and 8 by 10 inches for panels, for each finish system and color, with 1/2 of exposed surface finished.
  - 2. Lumber with or for transparent finish, 5 inches wide by 24 inches long, for each species and cut, finished on 1 side and 1 edge.
  - 3. Veneer leaves representative of and selected from flitches to be used for transparent-finished woodwork.
  - 4. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish, with 1

- sample applied to core material.
- 5. Solid-surfacing materials, 6 inch square.
- 6. Exposed cabinet hardware and accessories, one unit for each type and finish.

- D. Product Certificates: For each type of product, signed by product manufacturer.
- E. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.
  - 1. This project has not been registered with AWI as AWI Quality Certification Program but shall be by the contractor.
- F. Qualification Data: For Installer.

#### 1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.
- B. Installer Qualifications: Certified participant in AWI's Quality Certification Program.
- C. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers and wood doors with face veneers that are sequence matched with woodwork.
- D. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.
- E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Laminate clad cabinets with hardware and other items as selected by the Architect.
  - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- F. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

#### 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and

90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.

- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
  - 2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

## 1.7 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

## PART 2 - PRODUCTS

- A. Use composite wood and agrifiber building products on the interior of the building only that contains no added urea-formaldehyde resins. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies shall contain no added urea-formaldehyde resins.

## 2.2 INTERIOR ARCHITECTURAL WOODWORK, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

## 2.3 MATERIALS

- A. Wood Products: Comply with the following:
  - 1. Medium-Density Fiberboard: ANSI A208.2, Grade MD and formaldehyde-free.
  - 2. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density and formaldehyde-free.
  - 3. Softwood Plywood: DOC PS 1, Medium Density Overlay.
  - 4. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.
  - 5. Countertop and Work surface substrate: DOC PS 1, Exterior or marine- grade plywood.
- B. High- Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard. (PLAM1 as listed on the finish schedule)
  - 1. Manufacturers: Subject to compliance with requirements, provide products as listed in the finish schedule or approved equal.

C. SOLID- SURFACING MATERIAL:

1. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
  - a. Integral Sink Bowls, where specified: Comply with CSA B45.5/IAPMO Z124
2. Manufacturers: Subject to compliance with requirements, provide products as listed in the finish schedule or approved equal.
3. General: Use only adhesives formulated for simulated stone or solid- surfacing material and that are recommended by the manufacturer for the application indicated.
  - a. Water- Cleanable Epoxy Adhesive: ANSI A118.3, with a VOC content of 65 g/L or less.

2.4 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section "Door Hardware."
- B. Hinges: Overlay quiet self- closing hinge wing base plate; as supplied by Grass or approved equal.
- C. Strike Plates: Nickel plated; #239.40.703 as supplied by Hafele or approved equal.
- D. Wire Pulls:
  1. Type 304 stainless steel; #3096 as supplied by Sugatsune America, Inc. or approved equal.
  2. Finish: No. 4 satin.
- E. Catches: #36752G as supplied by Richelieu; zinc finish or approved equal.
- F. Shelf Standards and Supports: #2552G96 with 2562G shelf clip as supplied by Richelieu or approved equal; zinc finish.
- G. Drawer Slides: BHMA A156.9, B05091 with soft-close feature.
  1. Full Extension soft-close Drawer Slides:
    - a. 100 lb. as supplied by Accuride or approved equal.
  2. Heavy Duty Grade 1HD-200): Side mounted; full-overtravel-extension type; zinc-plated steel ball-bearing slides.
  3. Box Drawer Slides: Grade 1HD-100]; for drawers, not more than 6 inches high and 24 inches wide.
  4. File Drawer Slides: Grade 1HD-200; for drawers, more than 6 inches high or 24 inch wide.
  5. Pencil Drawer Slides: Grade 1; for drawers, not more than 3 inches high and 24 inches wide.
  6. Keyboard Slides: Grade 1HD-100; for computer keyboard shelves.
  7. Trash Bin Slides: Grade 1HD-200]; for trash bins, not more than 20 inches high and 16 inches wide.
- H. Locks
  1. Door: BHMA A156.11, E07121.

2. Drawer: BHMA A156.11, E07041.
  3. Product: #3310-cylinder lock as supplied by Sugatsune America, Inc. or approved equal
  4. Coordinate keying with Owner.
- I. Grommets for Cable Passage through Countertops:
1. 2 1/4inch OD, solid brass grommet cap and liner with nickel satin finish.
    - a. Model 20692170 by Richlieu or approved equal
- J. Metal Backing Plates: Refer to Division 05 Section – “Metal Fabrications” for requirements.
- K. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
1. Satin Stainless Steel: BHMA 630, unless otherwise indicated or not available for specific product.
  2. Satin Castings, Nickel Silver: ASTM B 584, Alloy UNS No. C97300 (12 percent leaded nickel silver).
  3. Satin Extruded Shapes, Nickel Silver: ASTM B 249/B 249M, Alloy UNS No. C79600.
- L. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.
- M. Countertop Supports Brackets: Refer to Section 055000 – Metal Fabrications.

## 2.5 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- C. VOC Limits for Installation Adhesives and Glues, and used in particleboard and MDF: Use installation adhesives that comply with the following limits for VOC content when calculated per 40 CFR 59, Subpart D (EPA Method 24):
1. Wood Glues: 30 g/L.
  2. Contact Adhesive: 250 g/L.
- D. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.
1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

## 2.6 FABRICATION, GENERAL

- A. Interior Woodwork Grade: Unless otherwise indicated, provide Custom-grade interior woodwork complying with referenced quality standard.
- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.



- C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- D. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
  - 1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members 3/4-Inch-thick or Less: 1/16 inch.
  - 2. Edges of Rails and Similar Members More Than 3/4-Inch-Thick: 1/8 inch.
  - 3. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch.
- E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
  - 1. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
  - 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
- F. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
  - 1. Seal edges of openings in countertop subbases and wood supports with a coat of varnish.

## 2.7 CLOSET AND UTILITY SHELVING

- A. Grade: Custom.
- B. Shelf Material: 3/4-inch solid lumber MDF or particleboard with solid-lumber edge and plastic laminate finish where indicated on drawings.
- C. Cleats: 3/4-inch solid lumber.
- D. Wood Species: Any closed-grain hardwood for opaque finishes. Match species indicated for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated.
- E. Closet Rods: 1-5/16-inch- diameter, chrome-plated-steel tubes complying with BHMA A156.16, L03131.
- F. Rod Flanges: Chrome-plated steel.
- G. Wood Finish: As indicated on Drawings or in schedules.

## 2.8 PLASTIC- LAMINATE CLAD CABINETS

- A. AWI Grade: Custom.
- B. AWI Type of Cabinet Construction: Type A, Flush Overlay.
- C. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
  - 1. Horizontal Surfaces Other Than Tops: Grade HGS.
  - 2. Postformed Surfaces: Grade HGP.
  - 3. Vertical Surfaces: Grade VGS.
  - 4. Edges: Grade HGS.
- D. Materials for Semiexposed Surfaces:
  - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade VGS.
    - a. Edges of Plastic-Laminate Shelves: PVC tape, 0.018-inch minimum thickness, matching laminate in color, pattern, and finish.
    - b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, Grade VGS.
  - 2. Drawer Sides and Backs: Solid-hardwood lumber.
  - 3. Drawer Bottoms: Hardwood plywood.
- E. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.
- F. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
  - 1. As indicated in drawings Finish Schedules or selected by the Architect.
- G. Provide dust panels of 1/4-inch plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

## 2.9 SOLID SURFACE COUNTERTOPS

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
  - 1. Grade: Custom
- B. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material complying with the following requirements:
  - 1. As indicated in drawings Finish Schedules or selected by the Architect.
- C. Configuration:
  - 1. Front: built-up edge as indicated on the drawings
  - 2. Backsplash: Radius edge with 3/8-inch radius.
  - 3. End Splash: Matching backsplash

- D. Countertops: 1/2-inch thick, solid surface material with front edge built up with same material.
- E. Backsplashes: 1/2-inch thick, solid surface material.
- F. Joints: Fabricate countertops without joints to extend possible
  - 1. Where joints required due to countertop length, fabricate in sections for joining in field, all joints to be clearly labeled on shop drawings.
- G. Cutouts and Holes:
  - 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves. Finish exposed cut edges
- H. Adhesive: Product recommended by solid surface material manufacturer.

## 2.10 SHOP FINISHING

- A. Grade: Provide finishes of same grades as items to be finished.
- B. General: Drawings indicate items that are required to be shop finished. Finish such items at fabrication shop as specified in this Section. Refer to Division 9 painting Sections for finishing architectural woodwork not indicated to be shop finished.
- C. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
  - 1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require backpriming when surfaced with plastic laminate, backing paper, or thermoset decorative panels.
- D. Transparent Finish: Comply with requirements indicated below for grade, finish system, staining, and sheen, with sheen measured on 60-degree gloss meter per ASTM D 523:
  - 1. Grade: Same as item to be finished.
  - 2. AWI Finish System: Conversion Varnish TR- 4; 35 percent sheen to match existing building sample.
  - 3. Staining: Matching Architect's samples.
  - 4. Wash Coat for Stained Finish: Apply a vinyl wash coat to woodwork made from closed-grain wood before staining and finishing.
  - 5. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
  - 6. Filled Finish for Open-Grain Woods: After staining (if any), apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.
    - a. Apply vinyl wash coat sealer after staining and before filling.
  - 7. Sheen: Rubbed semi-gloss finish matching the Architect's samples.
- E. Opaque Finish:
  - 1. Grade: Same as item to be finished.
  - 2. Finish: Provide one of the following as indicated or selected by the Architect:

- a. System - 4, water-based latex acrylic
  - b. System - 5, conversion varnish
  - c. System - 7, catalyzed vinyl
  - d. System - 12, water-based polyurethane.
3. Color: Match Architect's sample As selected by Architect from manufacturer's full range.
4. Sheen: Provide one of the following as indicated or selected by the Architect:
- a. Flat, 15-30
  - b. Satin, 31-45
  - c. Semigloss, 46-60
  - d. Gloss, 61-100
  - e. Gloss units measured on 60-degree gloss meter per ASTM D 523.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

#### **3.2 INSTALLATION**

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
- F. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
- G. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 60 inches long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.
  - 1. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base if finished.

2. Install wall railings on indicated metal brackets securely fastened to wall framing.
  3. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.
- H. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
  2. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.
- I. Countertops: Anchor securely by screwing through corner blocks of base cabinets or to support brackets from underside of countertop, in accordance with approved shop drawings. Or where quartz, secure to subtops with adhesive according to quartz agglomerate manufacturer's written instructions.
1. Align adjacent solid- surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
  2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
  3. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
  4. Calk space between backsplash and wall with sealant specified in Division 7 Section "Joint Sealants."
  5. Grommets: Drill and install in countertops at each device location, where indicated or as directed by Architect.
  6. Drill holes in countertops for plumbing fittings and soap dispensers in shop.
- J. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.
- K. Apply sealant to gaps at walls and between backsplash and endsplash to countertop.

### 3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06 4020

## **SECTION 06 8200 – FIBER- REINFORCED PLASTIC PANELS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

A. Work Included: The Work of this Section shall include but not be limited to the following:

1. Glass-fiber reinforced plastic (FRP) wall paneling and trim.
2. Installation accessories.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Color samples for initial selection: Provide a full set of manufacturer's available standard color chips for plastic panels.
- C. Samples for Verification:
1. 12-inch square of each type and of each color of panels.
  2. 12-inch-long sample of each type of trim and accessories.

#### **1.3 QUALITY ASSURANCE**

- A. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.
- B. Surface-Burning Characteristics: As determined by testing identical products per ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Class A
    - a. Flame-Spread Index: 25 or less.
    - b. Smoke Development of 450 or less

#### **1.4 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

### **PART 2 - PRODUCTS**

#### **2.1 PLASTIC SHEET PANELING**

- A. Materials: Gelcoat-finished, glass-fiber reinforced plastic panels complying with ASTM D 5319.
- B. Nominal Thickness: Not less than 0.090 inch
- C. Surface Finish: as indicated on the drawings, see finish schedule, Class A
- D. Color: as indicated on the drawings, see finish schedule
- E. Attachment Method: Adhesive only, with trim and sealant in joints.

## 2.2 MANUFACTURERS

- A. Product: Subject to compliance with requirements, provide manufacturer's standard product,
  - 1. Marlite, Inc (basis of design);
  - 2. Crane Composites
  - 3. Nudo Products, Inc
  - 4. Panolam Industries International, Inc;
  - 5. Or approved equal.

## 2.3 ACCESSORIES

- A. Trim Accessories:
  - a. Where patterned FRP specified, designated as FRP 2 on the finish schedule:
    - i. Anodized Aluminum extrusions designed to retain and cover edges of panels, at top, bottom and corners of panels. Provide inside corners, outside corners, and caps as needed to conceal edges. Intermediate joints between panels shall be silicone- type adhesive only
  - b. In utility rooms, storage rooms and janitor closets:
    - i. Manufacturer's standard one-piece vinyl extrusions designed to retain and cover edges of panels, at top, bottom and corners of panels. Provide inside corners, outside corners, and caps as needed to conceal edges. Intermediate joints between panels shall be silicone- type adhesive only
      - 1. Color: To match the panels unless otherwise indicated.
- B. Exposed Fasteners: not acceptable
- C. Adhesive: As recommended by plastic paneling manufacturer.
- D. Sealant: Single-component, mildew-resistant, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Division 07 Section "Interior Joint Sealants."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Remove any material that might interfere with adhesive bond.
- B. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.
- C. Clean substrates of substances that could impair bond of adhesive, including oil, grease, dirt, and dust.
- D. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
  - 1. Mark plumb lines on substrate at panel joint locations for accurate installation.

### 3.3 INSTALLATION

- A. Install plastic paneling per manufacturer's written instructions.
- B. Install panels in a full spread of adhesive.
- C. Install trim accessories with adhesive.
- D. Fill grooves in trim accessories with sealant before installing panels and bed inside corner trim in a bead of sealant.
- E. Maintain uniform space between panels and wall fixtures. Fill space with sealant.

### 3.4 CLEANING

- A. Remove excess sealant and smears as paneling is installed.
- B. Clean with panels with solution as recommended by manufacturer and wipe with clean dry cloth.

END OF SECTION 06 8200



## SECTION 071326 - SHEET MEMBRANE WATERPROOFING

### PART 1 GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### 1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the sheet membrane waterproofing as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:
  - 1. Self-adhered waterproofing membrane.

#### 1.3 QUALITY ASSURANCE

- A. Preinstallation Conference: Approximately 2 weeks prior to scheduled commencement of waterproofing installation, meet at Project site with Waterproofing Installer; preparer of substrate to receive waterproofing; installers of other work in and around waterproofing that must precede, follow, or penetrate waterproofing (including Mechanical and Electrical Installers as applicable); Architect; Owner; and waterproofing manufacturer's representative to review materials, procedures, schedules, and other requirements and conditions related to installing waterproofing.
- B. Qualifications of Subcontractors
  - 1. Subcontractors: All work of this Section shall be performed by a subcontractor who is approved by the manufacturer of the waterproofing material.
  - 2. Qualifications of Subcontractors: Subcontractors shall submit evidence of being bona fide waterproofing subcontractors, for a period of not less than five (5) years, and that they are approved by the manufacturer of the waterproofing material for the installation of the manufacturer's material in accordance with the requirements of this Section.
    - a. Subcontractor shall submit a letter from manufacturer of waterproofing material stating that subcontractor is approved by the manufacturer for the application of the waterproofing systems specified and accepted for use on the Project.
    - b. Letter shall certify that the subcontractor has previously and satisfactorily applied the waterproofing systems specified herein on jobs of similar size and scope, under manufacturer's supervision.
    - c. Letter shall be on manufacturer's letterhead and shall be signed by an officer of the company, not by a local sales representative.

C. Manufacturer's Representative/Contractor's Certification

1. Representative of the waterproofing material manufacturer shall be required to provide field instructions and supervision for the installation of the waterproofing systems at the start of the work of this Section.
2. The manufacturer's representative shall be required to make sure that the workmen for waterproofing systems on the site of the Project are fully instructed and trained in the handling and application of all the materials and shall see that all the materials are correctly installed.
3. Upon completion of the Installation, submit to the Architect written certification that the representative of the manufacturer of the waterproofing material has supervised the work of this Section and that all materials were correctly installed.

1.4 SUBMITTALS

- A. Shop Drawings: Typical installation details, showing details at flashings, at terminations, at joints, at intersection of horizontal and vertical surfaces, and at penetrations in membrane system.
- B. Manufacturer's Literature: Submit manufacturer's technical, safety data sheets, and installation literature for all materials of this Section. Submit Independent Test data indicating that membrane meets properties specified herein.
- C. General Contractor's Certification: Submit per Article 1.3.

1.5 STORAGE OF MATERIALS

- A. All materials shall be stored in their original tightly sealed containers or unopened packages; shall be clearly labeled with the manufacturer's name, brand name and number, and batch number of the material with expiration date where appropriate.
- B. Materials shall be stored in a neat and safe manner so as not to exceed the allowable live load of the storage area.
- C. Material shall be stored out of the weather in a clean, dry area.
- D. Liquid materials, such as adhesives, thinners and primers, shall be stored in areas away from sparks, open flames and excessive heat.

1.6 JOB CONDITIONS

- A. No application of waterproofing shall commence or proceed during inclement weather, or the threat of imminent precipitation.
- B. All surfaces to receive the system shall be thoroughly dry and free of dew or frost.
- C. Materials shall be stored until time of mixing at temperatures above 60 deg. F. to maintain a consistency suitable for mixing. Do no work below 40 deg. F.

- D. Prior to and during application, all dirt and dust shall be removed from surfaces either by vacuuming, sweeping, blowing with compressed air, or similar methods.
- E. Surfaces not designated to receive the system shall be properly masked or otherwise protected against accidental spillage or application of the material to those areas.

#### 1.7 PROTECTION

- A. Against Loads: Protect work of this Section against concentrated loads and any other loads or equipment that would damage the materials or work.
- B. Against Damage: Protect vertically installed work of this section from damage by reinforcing and placement.
  - 1. Take and maintain necessary preventative measures to protect work of this Section from damage until Project is accepted.
  - 2. Rejection of Damaged Work: Damaged materials or work will be rejected. Rejected materials or work must be immediately removed and replaced with new materials.

#### 1.8 FIELD QUALITY CONTROL

- A. Inform Architect in writing on a daily basis of any of the following events. State specific location of each occurrence.
  - 1. Buckling to the Waterproofing and other deformations as a result of ground water events.
  - 2. Leakage through the finished waterproofing installation.
  - 3. Damage by other trades.
- B. Provide Manufacturer's Representative's report (prior to backfill) stating that the waterproofing has been inspected and is acceptable and eligible for manufacturer's warranty.

#### 1.9 WARRANTY - SELF ADHERED MEMBRANE

- A. Contractor hereby warrants that the waterproofing membrane will stay in place and remain leakproof for a period of 2 years.
- B. Waterproofing membrane manufacturer hereby warrants that the waterproofing membrane will remain in a watertight condition and will not leak as a result of faulty materials for a period of 5 years.

### PART 2 PRODUCTS

#### 2.1 SELF-ADHERED WATERPROOFING MEMBRANE

- A. Basis of Design Manufacturer: Henry Company
  - 1. Other manufacturers: Carlisle Coatings & waterproofing incorp, GCP applied technologies, or approved equal

- B. Primary Waterproofing Membrane: Provide "Henry Blueskin WP200" or approved equal SBS-modified bitumen, self-adhering type waterproofing, integrally laminated to a high-density, cross-laminated polyethylene film, and having the following physical properties:
  - 1. Thickness: 1.5 mm (60 mils) min.
  - 2. Flexibility: Pass @ -40 deg F to ASTM D 1970.
  - 3. Vapor Permeance: 0.05 perms (2.8 ng/Pa.s.m<sup>2</sup>) to ASTM E 96.
  - 4. Tensile Strength (Membrane): 325 psi to ASTM D 412.
  - 5. Tensile Strength (Film): 5000 psi to ASTM D 882.
  - 6. Elongation: 300% to ASTM D 412.
  - 7. Puncture Resistance: 50 lbs. min. to ASTM E 154.
- C. Accessories to Primary Waterproofing Membrane
  - 1. Aquatac Primer by Henry or approved equal .
  - 2. BES 925 Sealant by Henry or approved equal.
  - 3. Polybitume Polymer Modified Sealing Compound (Mastic) by Henry or approved equal.
- D. Adhesive: Blueskin LVC Adhesive or approved equal.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that surfaces and conditions are ready to accept the work of this Section. Commencement of the work or any parts thereof shall mean acceptance of the prepared substrate.

#### 3.2 PREPARATION

- A. All surfaces must be sound, dry, clean and free of oil, grease, dirt, excess mortar, frost or other contaminants. Fill spalled areas in substrate to provide an even plane.
- B. Concrete should be cured for a minimum of 7 days and must be dry before waterproofing membranes are applied.
- C. Use appropriate waterproofing membrane as recommended by manufacturer based on air and surface temperature at time of application.
- D. Coat penetrations, such as brackets, clips, braces, etc. that are set into the concrete with a 90 mil coating of liquid membrane to the height of the wearing course and around projections to ensure a complete seal prior to coating the entire area.

### 3.3 INSTALLATION - GENERAL

- A. General: Conform to recommendations and published specifications of the manufacturer, including environmental requirements and preparation requirements to receive waterproofing.

### 3.4 INSTALLATION - SELF-ADHERED MEMBRANE

- A. Primer: Apply primer for self-adhered membrane by roller or spray at rate recommended by manufacturer. Allow minimum 30-minute open time. Primed surfaces not covered by waterproofing membrane during the same working day must be re-primed.
- B. Joint and Crack Treatment
  - 1. All cracks in concrete 1/16" to 1/4" wide are to be pre-treated with a 6" wide strip of membrane centered over crack. Provide 3" end laps.
  - 2. Horizontal to vertical inside corner transition areas are to be pre-treated with an manufacturers recommended sealant fillet extending 3/4" vertically and horizontally from the corner. Apply a minimum 9" strip of membrane centered at the joint.
  - 3. All outside corners are to be pre-treated with a minimum 9" strip of membrane centered at the joint.
- C. Expansion Joints: Where required provide expansion joint treatment as per membrane manufacturer's standard details.
- D. Projections: Extend primary membrane tight to projection and seal with second layer of membrane extending 2-1/2" along projection and 2-1/2" onto primary membrane.
- E. Waterproofing Membrane Application
  - 1. Apply waterproofing membrane to prepared substrate in lengths of 8 feet or less. Provide 2-1/2" laps at both sides and ends. Position for alignment and remove protective film. Press firmly into place. Promptly roll all laps with a countertop roller to effect seal. If more than one length is required on a vertical surface, apply in a shingle fashion.
  - 2. Terminate membrane using manufacturer's recommended mastic and termination bar, reglet or counter flashing as indicated. Refer to manufacturer's standard details.
  - 3. All laps within 12" of a 90-degree change in plane are to be sealed with manufacturer's recommend mastic.

### 3.5 CLEANING AND PROTECTION

- A. Protect membrane from job site abuse as soon as possible following membrane application.

END OF SECTION

## SECTION 071616 - CAPILLARY WATERPROOFING

### PART 1 GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### 1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment and services necessary to complete the capillary waterproofing as shown on the drawings and/or specified herein, including but not necessarily limited to the following:
  - 1. Capillary waterproofing system for interior surfaces of backwash basin, surge tank and elevator pit.

#### 1.3 RELATED SECTIONS

- A. Concrete - Section 033000.

#### 1.4 SUBMITTALS

- A. Shop Drawings: Submit shop drawings showing details at terminations, at joints, at intersection of horizontal and vertical surfaces, and at penetrations in waterproofing system.
- B. Product Data: Submit manufacturer's technical information and installation instructions for all materials of this Section.
- C. Contractor's Certification: Submit per Article 1.6.
- D. Subcontractor's Qualifications: Submit per Article 1.7.

#### 1.5 STORAGE OF MATERIALS

- A. All materials shall be stored in their original tightly sealed containers or unopened packages; shall be clearly labeled with the manufacturer's name, brand name and number, and batch number of the material where appropriate.
- B. Materials shall be stored in a neat and safe manner so as not to exceed the allowable live load of the storage area.
- C. Material shall be stored out of the weather in a clean, dry area.

#### 1.6 MANUFACTURER'S REPRESENTATIVE

- A. Contractor shall require representative of manufacturer of the waterproofing material to provide field instructions and supervision of the installation of the complete waterproofing system.

- B. Contractor shall require the manufacturer's representative to make sure that the subcontractor's workmen are fully instructed and trained in the handling and application of all the materials, and shall see that all the materials are correctly installed.
- C. Upon completion of the installation, the Contractor shall submit to the Architect a written certification that the representative of the manufacturer of the waterproofing material has supervised the work of this Section and that all materials are correctly installed.

#### 1.7 QUALIFICATIONS OF SUBCONTRACTORS

- A. Subcontractors: All work of this Section shall be performed by a subcontractor who is approved by the manufacturer of the waterproofing material.
- B. Qualifications of Subcontractors: Subcontractors, in order to obtain Architect's acceptance for doing work of this Section, shall submit evidence of being bona fide waterproofing subcontractors, and that they are approved by the manufacturers of the waterproofing material for the installation of their material in accordance with the requirements of this Section. Subcontractor shall submit letter from manufacturer of waterproofing material stating that the subcontractor is approved by the manufacturer for the application of the waterproofing system specified for the Project. Letter shall certify that the subcontractor has satisfactorily applied the waterproofing system specified herein under manufacturer's supervision. Letter shall be on manufacturer's letterhead and shall be signed by an officer of the company.

#### 1.8 WARRANTY

- A. The Contractor and manufacturer shall jointly warrant the waterproofing system executed under this Section to be watertight and free from defects in materials and workmanship for a period of ten (10) year from date of acceptance of this Contract, and that he, at his own expense, repair and/or replace all other work which may be damaged as a result of such defective work, and which becomes defective during the warranty period.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Waterproofing materials shall be a cement bond compound, free from chloride and iron oxide, which waterproofs by crystalline growth through the capillary tracts and shrinkage cracks in the concrete substrate
  - 1. Basis of design: "Aqua-Fin IC" manufactured by Aqua-Fin inc.
  - 2. Other Manufacturers:
    - a. Xypex Chemical Corp.
    - b. Anti-Hydro Co.
    - c. or approved equal.

- B. Mixing Water: Potable.

### **PART 3 EXECUTION**

#### **3.1 INSPECTION**

- A. Examine the areas and conditions where capillary waterproofing is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

#### **3.2 INSTALLATION**

- A. Temperature Requirements: Surrounding temperatures shall be a minimum thirty-five (35) degrees F. for forty-eight (48) hours before, during and after installation.
- B. Preparation of Surfaces
  - 1. Surfaces to be waterproofed shall be clean and free of form scale, mold, laitance, oil, form release agents, curing compounds, hardeners, and any other materials likely to affect the bond penetration or performance of the waterproofing materials.
  - 2. Materials shall not be applied to frozen or frosted surfaces, nor during rain or snow.
  - 3. The presence of moisture in the concrete substrates is essential at the time of the waterproofing application. Should this not be the case, soak thoroughly all surfaces with water a day prior to the waterproofing, and remove all free laying water.
  - 4. All cracks in the concrete structure exceeding .01" in width and construction joints which have not been treated before with capillary waterproofing, shall be routed out to a minimum depth of 3/4".
  - 5. Areas that have become dirty and concrete pours which have resulted in an extremely smooth surface shall be acid etched or, at the Contractor's option, may be sand blasted. Surfaces to be acid etched shall be dampened with clean water. Etching shall be done with a fifteen (15) percent hydrochloric (muriatic) acid. One gallon of acid should cover about fifty (50) to seventy-nine (79) square feet. Allow the acid to stand at least three (3) minutes and when bubbling ceases, flush off with water immediately. Do not let the acid stay on the surface for a prolonged period. When completed, the surface shall have a finish similar to fine or medium sandpaper. Surfaces which retain a smoothness or dirty condition shall be re-etched until the desired effect is obtained.
  - 6. Fill Form: Tie holes with "Aqua-Fin Mortar" or approved equal of mortar consistency.
  - 7. Vertical Concrete Surfaces
    - a. Grind off all fins and other projections.



- b. Extremely smooth surfaces must be etched or sand blasted.
- c. Form ties with insets shall be removed. Chip back concrete approximately one (1) inch where form ties are without insets.
- d. Honeycombed Pockets and Faulty Construction Joints: Rout out all faulty materials back to sound concrete; clean and rinse thoroughly with water all surfaces to be treated; check by rubbing hand over the surfaces. Hand should not become wet.

**C. Mixing of Capillary Waterproofing Materials**

- 1. Slurry Consistency: The capillary waterproofing materials shall be delivered in powder consistency in original undamaged containers with manufacturer's labels and seals intact.
  - a. Separate container shall be used for measuring by volume the powdery capillary waterproofing and the water.
  - b. Measure two (2) parts of capillary waterproofing and 0.7 - 0.9 parts of water (depending on water or absorption of concrete).
- 2. Mortar Consistency for Seal Strips and Coves
  - a. Add water to capillary waterproofing and/or capillary waterproofing reinforcing proportion 1:2 and/or 1:3 and mix thoroughly until stiff consistency is reached.
  - b. Prepare only as much mortar as can be applied within ten (10) minutes.

**D. Installation of Capillary Waterproofing Materials**

- 1. Slurry Application
  - a. Concrete surfaces to be treated with capillary waterproofing shall be moist, not wet.
  - b. Capillary waterproofing slurry coatings shall be applied with a stiff masonry brush or stiff broom and worked into every irregularity of the concrete surfaces.
  - c. Prior to the specified final application of capillary waterproofing slurry coatings on the concrete surface, the following initial applications and repairs to the concrete structure have to be completed.
- 2. Construction Joints
  - a. Construction joints shall receive a slurry coating of capillary waterproofing 2.5 lbs. per square yard immediately prior to each concrete pour. In areas where inaccessibility is difficult, apply 2.5 lbs. per square yard of capillary waterproofing by dry sprinkle method immediately prior to the following pour or rout out to a minimum depth of 3/4".

- b. Apply slurry coating of capillary waterproofing 1.5 lbs. per square yard to routed out areas of cracks and construction joints and fill remaining depth with capillary waterproofing and capillary waterproofing reinforcing 1:6 in mortar consistency in two (2) laminating layers after each layer has reached its initial set (approximately 20-30 minutes).
  3. Installation of Capillary Waterproofing Coves (Junction Horizontal Surfaces and Walls)
    - a. Apply slurry coating of capillary waterproofing 1.5 - 2.0 lbs. per square yard, six (6) inches in width, and install a cove with capillary waterproofing and capillary waterproofing reinforcing 1:3 in mortar consistency.
  4. Honeycombed Pockets in Wall Areas
    - a. Rout out all faulty materials back to sound concrete. Apply slurry coating of capillary waterproofing 1.5 lbs. per square yard over routed out area and fill with sand and cement mortar 1:3. If necessary (owing to depth) apply layers of mortar not exceeding 5/8" in thickness after each layer has hardened and repeat capillary waterproofing slurry coating.
  5. Pit Walls - Interior Face
    - a. Moisture treat vertical concrete surfaces thoroughly one day prior to application. Construction joints and form tie holes shall be filled with capillary waterproofing and capillary waterproofing reinforcing 1:6 in mortar consistency.
    - b. Apply two (2) slurry coatings on entire surface, consisting of capillary waterproofing at rate of 1.25 to 1.4 lbs. per square yard per coating, to levels and on surfaces indicated. The second coating shall be applied while the first coating is green, normally within an hour or the application of first coating.
  6. Concrete Slabs - Pits
    - a. Apply capillary waterproofing at the rate of 2.5 lbs./sq. yd. in slurry consistency to concrete slab surfaces in one coat.
- E. Curing of Capillary Waterproofing Application
  1. Capillary waterproofing applications while setting shall be protected from rain, frost and from drying out. During extreme hot weather, light water fog spraying may be necessary during time of application.
  2. Moisture treat capillary waterproofing treated areas for minimum period of three (3) days starting the day following the completion of the capillary waterproofing application with fog water spray. Surfaces shall have moist and later wet appearance for the duration of the curing period.
  3. Treated surfaces shall not be exposed to aggressive water, chemicals or acids until the applications have reached full strength (normally after 14 days).

- F. Adjusting: Following application and completion of related work, as required, but well prior to completion of entire project, fill surge tank and backwash tank to capacity and allow to stand not less than 1 week. Fill structures at a uniform rate not greater than 6.5 feet (2 m) in 24 hours or slower for minimum a minimum of three days to fill any tank. Should leakage occur after this period due to initial loading forces or thermal stress (i.e. cold water contacting warmer concrete), drain tanks to perform repairs. Notify Owner and architect prior to draining tanks.
1. Stop leakage due to curing and shrinkage cracks in concrete, which can develop during this period by installing plugs, seal-strips and additional surface treatment at no additional cost to the Owner. Following all required repairs, re-test by refilling tank and allow to stand not less than 1 week. Follow this procedure until all leakage is eliminated.
- G. Preparation for coating: Surge tanks and Backwash tanks shall have all surfaces treated with Capillary/Crystalline Waterproofing which are to be coated or painted shall be left to cure for 4 weeks after adjusting procedures above. At the end of the curing period, the surfaces shall be saturated with water and neutralized with a 1:8 solution of muriatic acid. Rinse waterproofed areas thoroughly with clean water.

END OF SECTION

## **SECTION 07 2100 - THERMAL INSULATION**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation (class A).
3. Mineral-wool blanket insulation for installation in stud cavities
4. Rigid mineral wool board insulation for installation as continuous cavity insulation
5. Spray foam insulation for voids and closure at parapet

**B. Reference:**

1. See specification 092900 Gypsum board for Acoustical Batt (SAFB) insulation.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data:** provide manufacturer data sheets showing compliance with performance requirements.
- B. Schedule:** Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.
- C. Product test reports.**

#### **1.3 INFORMATIONAL SUBMITTALS**

- A. Installer's Certification:** Listing each type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.
1. Sign, date, and post the certification in a conspicuous location on Project site as agreed to by architect and owner.

### **PART 2 - PRODUCTS**

#### **2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION (FOUNDATION INSULATION)**

- A. Extruded Polystyrene Board Insulation, Type IV: ASTM C578, Type IV, 25-psi minimum compressive strength; unfaced.**
1. Location: perimeter foundation insulation and locations indicated as XPS insulation
  2. Manufacturers:

- a. Owens Corning, product line: Foamular NGX
    - b. Kingspan, product line: Greenguard LG
    - c. Dupont, product line: Styrofoam
    - d. Or approved equal
  3. Zero ozone depleting blowing agent compliant with New Jersey law.
  4. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
  5. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
  6. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.
  7. Water absorption: 1.0% by volume max
  8. Thermal resistance, R value = 5 per inch
  9. Thermal conductivity, K value = .2
- B. Extruded Polystyrene Board Insulation, Type VII: ASTM C578, Type VII, 60-psi minimum compressive strength.
1. Location used: under slab where noted on structural drawings and locations indicated as XPS insulation with high compressive strength.
  2. Manufacturers:
    - a. Owens Corning, product line: Foamular NGX
    - b. Kingspan, product line: Greenguard LG
    - c. Dupont, product line: Styrofoam
    - d. Or approved equal
  3. Zero ozone depleting blowing agent compliant with New Jersey law.
  4. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
  5. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
  6. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.
  7. Water absorption: 0.3% by volume max
  8. Thermal resistance, R value = 5 per inch
  9. Thermal conductivity, K value = .2

## 2.2 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

- A. Polyisocyanurate Board Insulation, Foil Faced : ASTM C1289, foil faced, Type I, Class 1 or 2 meeting NFPA285 compliance as part of a complete system including weather resistive barrier
1. Location: Continuous insulation at exterior walls at locations indicated
  2. Manufacturers:
    - a. Hunter panels – Xci Foil(class A)
    - b. Atlas - Energyshield Pro2
    - c. Or approved equal
  3. Thickness: 1-1/2” or as indicated on the drawings
  4. Thermal resistance, R value = 9.5 minimum total for 1-1/2” thickness per ASTM C518 test method
  5. Compressive Strength: 25psi
  6. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.
  7. Faces: 1.25 mil thick white embossed aluminum facer one side, and a 1.25 mil thick plain embossed aluminum facer on the other side.

8. Water absorption: less than 1% by volume max
9. Fire-rating classification: Class A
10. Flame Spread: <75
11. Smoke development <450
12. UV resistance, Days: 180

## 2.3 RIGID MINERAL-WOOL BOARD INSULATION

- A. Provide Mineral-wool board insulation: ASTM C612, Typbe IVB, with a maximum flamespread index of 0 and smoke developed index of 0 per ASTM E84
  1. Location: Continuous insulation at exterior walls at locations indicated
  2. Basis of Design Manufacturers:
    - a. Roxul Inc; Comfortboard 110
  3. Other manufacturers:
    - a. John Mansville,
    - b. Thermafiber, Inc.; an Owens Corning company,
    - c. Or approved equal
  4. Flame-Spread Index: Not more than 0 when tested in accordance with ASTM E84.
  5. Smoke-Developed Index: Not more than 0 when tested in accordance with ASTM E84.  
Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.
  6. Density: 11 lbs per cubic foot
  7. Thickness: 1 layer of 3-inch thickness providing an overall nominal R-value at 75degreeF equal to R-12 or as indicated on the drawings.
  8. Board Size: 48inches x 72 inches
- B. Insulation board attachment fasteners: Corrosion resistant steel screws, #10 minimum diameter x length appropriate for substrate. Use four (4) screws minimum per insulation board.

## 2.4 MINERAL-WOOL BLANKET INSULATION

- A. Mineral-Wool Blanket Insulation, Unfaced : ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.
  1. Location: stud cavities in exterior walls and where labeled.
  2. Manufacturers:
    - a. Roxul Inc; COMFORTBATT
    - b. John Mansville, TempControl
    - c. Thermafiber, Inc.; an Owens Corning company, Ultrabatt
    - d. Or approved equal
  3. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
  4. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.  
Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.
  5. Thermal Resistance, R-value = 15, min or as indicated on drawings.
  6. Fungi Resistance = ASTM C1338, pass

## 2.5 SPRAY FOAM INSULATION FOR VOIDS AND CLOSURE AT PARAPET:

- A. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
  - 1. Manufacturers:
    - a. Icynene, ProSeal HFO
    - b. Thermoseal 2000
    - c. BASF Spraytite
    - d. Or approved equal
  - 2. Zero ozone depleting blowing agent compliant with New Jersey law.
  - 3. Minimum density = 2.0pcf

## 2.6 ACCESSORIES

- A. Insulation Anchors, Spindles, and Standoffs:
  - 1. Plate: Perforated galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square or as recommended by manufacturer.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Install insulation with manufacturer's R-value label exposed after insulation is installed.
- D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

### 3.2 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

### 3.3 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.
- B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors.
- C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

### 3.4 INSTALLATION OF CAVITY-WALL INSULATION

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches (610 mm) o.c. both ways on inside face and as recommended by manufacturer.
  - 1. Fit courses of insulation between obstructions, with edges butted tightly in both directions, and with faces flush.
  - 2. Press units firmly against inside substrates.
  - 3. Supplement adhesive attachment of insulation by securing boards with wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

### 3.5 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
  - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
  - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
  - 3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
  - 4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
  - 5. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
    - a. Exterior Walls: Set units with facing placed toward interior of construction.
- B. Miscellaneous Voids and where indicated on drawings: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
  - 1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.



END OF SECTION 07 2100

## **SECTION 07 2726 - FLUID-APPLIED MEMBRANE AIR AND WATER RESISTIVE BARRIER (WRB)**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Vapor-permeable, fluid-applied air and water resistive barriers. (abbreviated WRB)

#### **1.2 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site minimum two weeks prior to start of work under this section.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product including accessories to be used as part of complete system.
- B. Shop Drawings: For air and water-barrier assembly.
  - 1. Include project specific details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
- C. Proof that the air barrier is part of an NFPA 285 approved wall assembly intended to be installed by the General Contractor including insulation and cladding materials.
- D. Samples:
  - 1. Free film sample of product at representative cured thickness, minimum 2 inch by 3 inch size.
  - 2. Sample of sheet detail flashing and transition membrane, minimum 2 inch by 3 inch size.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Product certificates.
- B. Product test reports.
- C. Field quality-control reports.

#### **1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Single source responsibility: provide products and accessories from a single manufacturer

- C. Mockups: Build mockups to set quality standards for materials and execution.
  - 1. Build integrated mockups of exterior wall assembly 6ft x 6ft minimum at each substrate type, incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
    - a. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.
    - b. Include junction with roofing membrane, and building corner condition.
- D. DELIVERY, STORAGE AND HANDLING
  - 1. Deliver materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product, lot number and directions for storage.
  - 2. Store materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by manufacturer.
  - 3. During cold weather, protect product in containers and spray equipment from freezing. Maintain product temperature within acceptable range for spray application, as required by air barrier manufacturer.
  - 4. Avoid spillage. Immediately notify Owner, Architect if spillage occurs and start clean up procedures. Clean spills and leave area as it was prior to spill.
- E. PROJECT CONDITIONS
  - 1. Do not apply product or accessories during rain or accumulating snowfall.
  - 2. Apply product and accessories within approved ambient and substrate temperature range stated in manufacturer's literature.
  - 3. Do not apply product or accessories over incompatible materials, refer to manufacturers list of approved substrates and common building materials.
  - 4. Observe safety and environmental measures indicated in manufacturer's SDS, and mandated by federal, state and local regulations.
- F. WARRANTY
  - 1. Provide the manufacturer's minimum five year material warranty

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction shall be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

- B. Air and water-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. when tested according to ASTM E2357.

## 2.2 HIGH-BUILD AIR BARRIERS, VAPOR PERMEABLE

- A. High-Build, Vapor-Permeable Air and Water Resistive Barrier: synthetic polymer membrane with an installed dry film thickness, according to manufacturer's written instructions, of 35 mils or thicker over smooth, void-free substrates.
1. Basis of design Manufacturer and product:
    - a. Henry Company
      - 1) Air-bloc 17MR, for installation at 20 degrees F and above
  2. Other Manufacturers:
    - a. Carlisle Coatings & Waterproofing, Incorporated.
      - 1) Fire Resist Barritech VP, for installation at 40 degrees F and above
      - 2) Fire Resist Barritech VP LT, for installation at 15 degrees F and above
    - b. GCP applied Tehnologies
      - 1) PERM-A-BARRIER VPL, for installation at 40 degrees F and above
      - 2) PERM-A-BARRIER VPL LT, for installation at 20 degrees F and above
    - c. Or approved equal
  3. Physical and Performance Properties:
    - a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference; ASTM E2178.
    - b. Vapor Permeance: Minimum 10 perms ASTM E96/E96M, Method B
    - c. Ultimate Elongation: Minimum 250 percent; ASTM D412, Die C.
    - d. Adhesion to Substrate: Minimum 16 lbf/sq. in. when tested according to ASTM D4541.
    - e. UV Resistance: Can be exposed to sunlight for 180 days according to manufacturer's written instructions.
    - f. Water Resistance: Product spray-applied to CMU and gypsum sheathing with joint shall resist a 55 cm (22 inch) column of water for 5 hours, no leaking or wet through. According to AATCC-127 - mod, static head generated with 5" diameter PVC pipe sealed to specimen
    - g. Fastener Sealability: No water leaking through nail penetration after 24 h. ASTM D 1970
    - h. Low-Temperature Crack Bridging: No cracking after 10 cycles at minus 15 deg FASTM C 1305, mod 40 mil membrane thickness
    - i. Long-Term Aging/ Flexibility: No cracking or tearing after aging ASTM C 1522, mod 40 mil membrane thickness or CGSB 71-GP-24M
    - j. Surface Burning Characteristics. Flame Spread Index: Not more than 25 Smoke Generation Index: not more than 450 according to ASTM E84
    - k. Upper operational temperature of membrane and accessories: 180 degrees
    - l. Minimum installation temperature: 25 degrees and lower

## 2.3 ACCESSORY MATERIALS

- A. Requirement: Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to

produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions affecting installation of the air & water barrier and accessory products for compliance with requirements. Verify that surfaces and conditions are suitable prior to commencing Work of this section. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Verify that wall assemblies are dried in, such that water intrusion will not occur from above, behind or around the air barrier installation.
- C. Concrete shall be cured for a minimum of seven days. It shall be smooth, with sharp protrusions such as form joints or fins removed and ground flush. Honeycomb and holes/cracks shall be filled with grout or mortar.
- D. Surfaces shall be sound, dry and free of oil, grease, dirt, excess mortar or other contaminants.
- E. Surfaces shall be supported and flush at joints without large voids or sharp protrusions.
- F. Mortar joints shall be struck flush and shall be free of voids. Mortar droppings shall be removed from brick ties and all other surfaces accepting air barrier.
- G. Sheathing boards shall be flush at joints, with gaps between boards according to building code and sheathing manufacturer's requirements. Sheathing boards shall also be securely fastened to the structure with proper fastener type, technique and spacing according to building code and sheathing manufacturer's requirements. Sheathing boards shall be repaired or replaced if inspection reveals moisture damage, mechanical damage or if sheathing boards have exceeded the exposure duration or exposure conditions as required by the sheathing manufacturer.
- H. Plywood, OSB, lumber or pressure-treated wood moisture content, measured with a wood moisture meter in the core of the substrate, shall be below 20%.
- I. Concrete Masonry units (CMU) shall be prepared according to air and water membrane manufacturer's written recommendations and free of contaminants such as grease oil and wax, free from projections, all joints struck, all voids filled with mortar, sealant or other approved material. All surface irregularities shall be ground flush or made smooth with all gaps around penetrations filled with mortar or sealant and struck flush. Remove any mortar droppings from brick ties, shelf angles, brick shelves or other horizontal obstructions.
- J. Inform Architect and Owner in writing of
  1. Unsatisfactory substrates
  2. Cracks in concrete and masonry.
  3. Gaps or obstructions such as steel beams, angles, plates and projections which cannot be spanned or covered by Product or Accessories.
  4. Anticipated problems applying product and accessories over substrate.

### 3.2 SURFACE PREPARATION

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate according to manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.
- D. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- E. At changes in substrate plane, apply 3/4" sealant cant beads at sharp corners and edges to form a smooth transition from one plane to another.
- F. Bridge isolation joints, expansion joints, and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement according to manufacturer's written instructions and details.

### 3.3 DETAILING

- A. Additional materials and installation are required at joints, transitions, openings, terminations, penetrations and similar surface irregularities. Perform detailing before or after product installation.
- B. Install product and accessories in details as directed in manufacturer's literature.
- C. Sheathing joints, use one of the following methods:
  - 1. 4 inch reinforcing fabric imbedded in product and centered over joint.
  - 2. 2" width liquid flashing centered over joint.
- D. Fastener Heads: troweled sealant with feathered edges over each fastener. Sealant type as recommended in writing by manufacturer.
- E. Sheathing inside and outside corners. Flashing or reinforcement shall bear 3 inches minimum onto either side of angle change. Use any of the following methods:
  - 1. Sheet detail flashing
- F. Window openings. Flashing or reinforcement shall bear onto wall 3 inches minimum and shall return into window opening according to Project drawings. Use any of the following materials:
  - 1. Sheet detail flashing
- G. Pipe or duct penetrations. Flashing or reinforcement shall bear onto wall 3 inches minimum and shall bear onto pipe or duct 3 inches, or according to Project drawings. Select any:
  - 1. Sheet detail flashing
  - 2. Glass mat imbedded in product
- H. Expansion or deflection joints. Flashing shall bear 3 inches minimum onto either side of joint. Select any:
  - 1. Sheet detail flashing bellows or expansion bulb
  - 2. Transition membrane expansion bulb

- I. Interface of dissimilar substrates: Flashing or reinforcement shall bear 3 inches minimum onto either side of joint. Select any:
  - 1. Sheet detail flashing
  - 2. Reinforcing fabric imbedded in product
  - 3. Glass mat imbedded in product
- J. Seal all terminations of sheet detail flashing with a 1 inch width X 0.040 inch (40 mils) thick ribbon of detail sealant, centered over termination.

### 3.4 INSTALLATION

- A. Apply product and accessories over opaque wall surfaces as indicated in Project drawings.
- B. Use the manufacturer's standard or low temperature formula product as required by the project conditions.
- C. Apply product by spray, roller, brush or other method as recommended by air barrier manufacturer. Apply product at specified wet mil thickness in accordance with air barrier manufacturer's requirements.
- D. Verify compliance with air barrier manufacturer's minimum required thickness by documenting product use per area. Perform and document wet mil thickness measurements every 100 square feet, or more frequently if required, to establish uniform and adequate coverage.
- E. Installation shall produce complete coverage of opaque substrates as indicated in Drawings.
- F. Product and accessories shall be fully-adhered to substrates. Defects such as holes, fishmouths, blistering, de-lamination, bridging or thin spots shall be repaired according to air barrier manufacturer's instructions.

### 3.5 SCHEDULE

- A. Wall substrates and roof or temporary roof shall be in place, effectively enclosing interior space, before proceeding with air barrier installation.
- B. Seal penetrations made through installed product according to manufacturer's instructions and drawings.
- C. Seal fenestration to product with detail membrane, transition membrane, detail sealant, silicone sealant or polyurethane foam sealant according to Project drawings
- D. Through-wall flashing may be installed before or after product. Seal termination of through-wall flashing to product according product manufacturer's instructions.
- E. Exterior cladding shall be installed after product within exposure timeframe.
- F. Rigid or semi-rigid insulation installed over product shall be attached with mechanical fastening, insulation adhesive or a combination of these techniques, according to insulation manufacturer and air barrier manufacturer's instructions.

- G. Sequence Work to enable air barrier continuity at wall-to-foundation, shelf angle, wall-to-roof, fenestration, different wall assemblies and other conditions as indicated in Project drawings.

### 3.6 FIELD QUALITY CONTROL

- A. Manufacturer Representative Inspection: the contractor shall coordinate and be responsible for all costs to and have manufacturer representative inspect and report on installation methods and quality to confirm in writing installation meets warranty requirements or corrections that are needed to meet warranty requirements.
  - 1. Inspections shall occur a minimum of (2) times at each structure, with the first inspection occurring at the start of installation and the second when installation is complete prior to installation of any cladding that would conceal the work.
  - 2. Report requirement: written, signed report to be provided to owner and architect following each site inspection.
- B. Testing Agency: Owner may engage a qualified testing agency to perform tests and inspections.
- C. Tests: As determined by testing agency from among the following tests:
  - 1. Air-barrier dry film thickness.
  - 2. Air-Leakage-Location Testing
  - 3. Air-Leakage-Volume Testing
  - 4. Adhesion Testing
- D. Air barriers will be considered defective if they do not pass tests and inspections.
  - 1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
  - 2. Remove and replace deficient air-barrier components for retesting as specified above.
- E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

### 3.7 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
- B. Remove masking materials after installation.

END OF SECTION 07 2726



## SECTION 074100 STANDING SEAM METAL ROOF PANELS

### PART 1 - GENERAL

#### 1.01 SECTION INCLUDES

- A. Work described in this section includes installation of new insulation system, new specified underlayment and specified pre-formed metal roofing system complete with clips, perimeter and penetration flashing, pre-finished coil stock metal fascia, closures, gutters and downspouts.
- B. FM approval of roof system required.

#### 1.02 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General Supplementary Conditions apply to this section.

#### 1.04 SUBMITTALS

- A. Shop Drawings
  - 1. Show roofing system including fascia and soffit, with flashings and accessories in plan, sections and details. Include metal thickness' and finishes, panel lengths, joining details, anchorage details, flashings, insulation and special fabrication provisions for termination and penetrations; thermal expansion provisions and special supports.
  - 2. Indicate relationships with adjacent and interfacing work. Indicate fastener types and spacing; and provide fastener pullout values.
  - 3. Shop drawings must be specific to this project and completed by the metal panel manufacturer's engineering department. Any and/or all changes recommended by the successful bidder must be approved by the manufacturer in writing prior to submittal.
- B. Product Data: Include manufacturer's detailed material and system description, sealant and closure installation instructions, engineering performance data and finish specifications. Indicate fastener types and spacing; and required fastener pullout values.
- C. Design Loads: Submit copy of manufacturer's minimum design load calculations according to ASCE 7-16, Method 2 for Components and Cladding, prepared by a an engineer employed by the system manufacturer as a full-time staff engineer. In no case shall the design loads be taken to be less than those detailed in article 1.9 of this specification.

- D. Design Test Reports: Provide certified test reports from an independent testing laboratory that bear the seal of a registered professional engineer to show compliance with the performance criteria specified in article 1.9. Each of the following test reports must be submitted:
1. ASTM E1592-95: Test results must clearly demonstrate compliance with the following requirements:
    - a. The ultimate test failure load shall be reduced by the safety factor specified in article 1.9 to determine the **allowable working load** for the panel system.
    - b. The proposed system has been tested to insure that the **allowable working load** of the panel system meets or exceeds the specified negative wind uplift pressures listed in article 1.9 of this specification for all roof zones.
    - c. The test results are applicable for the panel material, grade, thickness, width, and profile specified. Results are not applicable for systems that are thinner, wider, lower grade, or different material/profile than the system which was tested.
    - d. The results must clearly show that the allowable clip spacing meets or exceeds the requirements specified in article 3.03 E for all roof areas. Clip spacing shall not be increased for any roof zone from that which is specified.
  2. ASTM E283-93 and E331-86: Test results must clearly demonstrate compliance with the performance requirements specified in article 1.9.
  3. ASTM E1646-95 and E1680-95: Test results must clearly demonstrate compliance with the performance requirements specified in article 1.9. Results are not applicable for systems that are thinner, wider, lower grade, or different material/profile than the system which was tested. The differential test pressures must be equal to those specified in article 1.9.
  4. UL 790: The proposed roof panel shall be listed as a non-combustible roof covering material and be approved for use in a UL classification assembly.
  5. UL 263: The panel system shall clearly be shown as approved for use in an UL Construction Assembly which conforms to the construction of this project
  6. Completed form FM GLOBAL FORM X2688 Checklist for roofing system.

- E. Samples: Provide full scale samples of the following materials and system components. Samples shall be of identical material type, thickness, panel width, and material grade/alloy/temper as the system specified for this project.
1. Submit a twelve (12) inch long by actual width sample of panel showing seam profile and stiffening mesas across the flat pan of the panel. Also include separate snap-on cap with factory applied hot melt sealant beads.
  2. Provide a three by five (3 x 5) inch sample of the color selected for this project. The sample shall be the actual specified coating system on a metal substrate.
  3. Provide samples of actual system components, including: each type of anchor/clip required, head closure assembly, roll goods, bearing plates and/or framing.
- F. Manufacturer's Certificate: Certify that the standing seam metal roof panels are physically manufactured by the distributing manufacturer/organization in the United States and conform to requirements specified herein, are chemically and physically compatible with each other, and are suitable for inclusion within the total roof system specified herein.

#### 1.05 DISCLOSURE OF MATERIALS/ALTERNATE MANUFACTURERS

- A. The materials outlined herein are the basis of design and the type of materials that must be used in this project. When a particular make or trade name is specified, it shall be indicative of the minimum standard required.
1. Submit each item listed in article 1.4 (A through F) for evaluation of the proposed system.
  2. Tests shall have been made for identical systems within the ranges of specified performance criteria.
  3. Empirical calculations for roof performance shall only be acceptable for positive loads.
  4. A list of a minimum of five (5) jobs where the proposed alternate material was used under similar conditions. .
  5. Manufacturer's Certificate: The manufacturer must also have current ISO 9001:2008 certification for the manufacturing of the products to be utilized on this project.
  6. A written statement from the manufacturer stating that they will provide the building owner with a **site inspections a minimum of three (3) times per week** by an experienced, full time employee of the company.

7. A written statement from a corporate officer of the manufacturing company stating that he or she has reviewed the specifications and confirms that the proposed system meets or exceeds all performance requirements listed as well as meets the panel size, gauge, weight, clip design, sealant design, uplift pressures and height of the vertical seam.
9. A copy of manufacturer's thirty-five (35) year No Dollar Limit Watertight warranty. Warranty must be a single-source manufacturer's warranty and must include coverage for all trim, flashing, and penetrations associated with this roof.
10. Proof that the manufacturer has been in business for a minimum number of years equal to the warranty period required for this project.
11. Proof that the materials for the standing seam metal roof system are physically manufactured and guaranteed by the material supplier.
12. Submit a certified copy of the roofing manufacturer's ISO 9001:2008 compliance certificate.
13. In making a request for submission, Bidder/Contractor represents:
  - 0) He/she has personally investigated the proposed product or method, and determined that it is equal or superior in all respects to that specified.
  - 1) He/she will provide the same guarantee for substitution as for the product and method specified.
  - 2) He/she will coordinate installation of accepted substitution in work, making such changes as may be required for work to be completed in all respects.
  - 3) He/she waives all claims for additional cost related to substitution, which consequently become apparent.
  - 4) Cost data is complete and includes all related cost under his/her contract or other contracts, which may be affected by the substitution.
  - 5) He will reimburse the Owner for all redesign cost by the Architect for accommodation of the substitute.
14. The Architect reserves the right to be the final authority on the acceptance or rejection of any or all bids, proposed alternate roofing systems or materials.

- B. Site Formed Panels: Panels must be factory pre-manufactured and engineered for this project unless the panels cannot be shipped. Panels in excess of shippable length shall be formed on-site and engineered for this project. Site formed panels shall meet each of the following requirements:
1. Panels shall be formed on heavy duty factory type rollformers. Rollformers shall gradually form the panel profile utilizing no fewer than twelve (12) forming stations to improve quality and minimize oil canning.
  2. All tooling shall be polished and tempered to a minimum hardness of Rockwell C - 52. Tooling shall be maintained clean and in good working condition. Tooling repairs or modifications made by means of welding, sawing, grinding or the like are unacceptable, as they may contribute to poor quality, aesthetics, and performance of the end product.
  3. Panels shall be of identical profile and characteristics as factory formed panels and specimens used as the basis of performance tests.
  4. Sealant shall be factory applied in a separate factory formed snap on cap. Site/field applied seam sealant is unacceptable. Seam caps may be shipped in forty-five (45') or less length and lap spliced over full length panels in accordance with manufacturer's system details.
  5. Site rollforming equipment shall be operated by a trained full time experienced technician. The installer must provide additional personnel to handle raw materials and finished product as necessary.
- C. Panel Length: Panels shall be one piece from ridge/head to eave with NO splices between. Spliced panels will not be acceptable.

#### 1.06 INSTALLER QUALIFICATIONS

- A. Engage an experienced metal roofing contractor (erector) to install standing seam system who has a minimum of five (5) years experience specializing in the installation of structural standing seam metal roof systems.
- B. Contractor must be certified by manufacturer specified as supplier of structural standing seam system and obtain written certification from manufacturer that installer is approved for installation of specified system. If requested, contractor must supply owner with a copy of this certification.
- C. Successful contractor is required to maintain a full-time supervisor/foreman who is on the job-site at all times during installation of new roof system. Foreman must have a minimum of five (5) years experience with the installation of system similar to that specified.
- D. Successful contractor must obtain all components of roof system from a single manufacturer, including any roll good materials if required. Any secondary products that are required which cannot be supplied by the specified manufacturer must be recommended and approved in writing by primary manufacturer prior to bidding.

- E. If required, fabricator/installer shall submit work experience and evidence of adequate financial responsibility. The owners representative reserves the right to inspect fabrication facilities in determining qualifications.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's responsibility:

- 1. Protect components during fabrication and packing from mechanical abuse, stains, discoloration, and corrosion.
- 2. Provide protective interleaving between contact areas of exposed surfaces to prevent abrasion during shipment, storage, and handling.

B. Installer's responsibility:

- 1. Store materials off ground providing for drainage; under cover providing for air circulation; and protected from wind movement, foreign material contamination, mechanical damage, cement, lime or other corrosive substances.
- 2. Stack pre-finished materials to prevent twisting, bending, abrasion and denting and elevate one end to facilitate moisture run-off.
- 3. Handle materials to prevent damage to surfaces, edges and ends of panels and sheet metal items. Damaged material shall be rejected and removed from the site.
- 4. Unload panels using a boom or crane, supporting the panels in at least two (2) locations during lifting.
- 5. Protect panels from wind-related damages.
- 6. Protect moisture-sensitive materials from the weather.
- 7. Inspect materials upon delivery. Reject and remove physically damaged or marred material from project site.

#### 1.08 JOB CONDITIONS

- A. Determine that work of other trades will not hamper or conflict with necessary fabrication and storage requirements for pre-formed metal roofing system.

B. Protection:

- 1. Provide protection or avoid traffic on completed roof surfaces.
- 2. Do not overload roof with stored materials.
- 3. Support no roof-mounted equipment directly on roofing system.

- C. Ascertain that work of other trades which penetrates the roof or is to be made watertight by the roof is in place and approved prior to installation of roofing.

#### 1.09 DESIGN AND PERFORMANCE CRITERIA

##### A. Thermal Expansion and Contraction.

1. Completed metal roofing and flashing system shall be capable of withstanding expansion and contraction of components caused by changes in temperature without buckling, producing excess stress on structure, anchors or fasteners, or reducing performance ability.
2. The design temperature differential shall be not less than 200 degrees F.
3. Interface between panel and clip shall provide for **unlimited** thermal movement in each direction along the longitudinal direction.
4. Location of metal roofing rigid connector shall be at roof ridge unless otherwise approved by the Manufacturer. Metal ridge connector may require design as per job conditions by specified manufacturer.

##### B. Uniform Wind Uplift Load Capacity.

1. Installed roof system shall withstand negative (uplift) design wind loading pressures complying with the following criteria.
  - a. Design Code: FM 1-28.
  - b. Panel Safety Factor: 1.67
  - c. Building with an Importance Factor of III.
  - d. Wind Speed: 90 mph.
  - e. Ultimate Pullout Value: 431 psf.
  - f. Exposure Category: C
  - g. Design Roof Height: (30 feet)
  - h. Minimum Building Width: (59 feet)

<u><b>Canopy Roof Areas</b></u>	<u><b>Design Uplift Pressure:</b></u>
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Zone 1 – Mid Roof	34.0 psf
Zone 2 – Eaves, Rake & Ridge	45.0 psf
Zone 3 – Corners	61.0 psf

2. Capacity shall be determined using pleated airbag method in accordance with ASTM E 1592, testing of sheet metal roof panels. Allowable safe working loads shall be determined by dividing the ultimate test load by the safety factor specified above.

C. Uniform Positive Load Capacity.

1. The installed roof system shall be capable of resisting the following positive uniform roof loads: Roof Live Load of 35 psf; Ground Snow Load of 20 psf; Balanced Uniform Roof Snow Load of 22 psf; and Maximum Unbalanced Surcharged Load of 10.7 psf; and an Unbalanced Width of 4.3 feet.
2. Capacity to resist positive loads shall be determined by empirical calculations in accordance with AISI. Calculation shall be sealed by a registered professional engineer.
3. Installed roof system shall carry positive uniform design loads with a maximum system deflection of L/180 as measured at the rib (web) of the panel.

- C. Underwriters' Laboratories, Inc., (UL) fire resistance P ratings for roof assemblies: If applicable, panel system shall be approved for use in an appropriate Construction Assembly, as defined by UL 263.

- D. Underwriters' Laboratories, Inc., (UL) fire rating per UL 790.

- E. ASTM E283: **Static pressure air infiltration (doors, windows, curtain walls):**

<u><b>Pressure</b></u>	<u><b>Leakage Rate</b></u>
1.57 PSF	0.0007 cfm/sq.ft.
6.24 PSF	0.0002 cfm/sq.ft.
20.0 PSF	0.0036 cfm/sq.ft.

- F. ASTM E331: **Static pressure water infiltration (doors, windows, curtain walls):**

<u><b>Pressure</b></u>	<u><b>Result</b></u>
5 Gal/Hr Per S.F. and Static Pressure Of 20.0 Psf for 15 minutes	No Leakage



G. ASTM E1680: **Static pressure air infiltration (roof panels):**

<u>Pressure</u>	<u>Leakage Rate</u>
1.57 PSF	0.0012 cfm/sq.ft.
6.24 PSF	0.0001 cfm/sq.ft.
20.0 PSF	0.0011 cfm/sq.ft.

H. ASTM E1646: **Static pressure water infiltration (roof panels):**

<u>Pressure</u>	<u>Result</u>
5 Gal/Hr Per S.F. and Static Pressure Of 20.0 Psf for 15 minutes	No Leakage

- I. Water penetration (dynamic pressure): No water penetration, other than condensation, when exposed to dynamic rain and 70 mph wind velocities for not less than five minutes duration, when tested in accord with principles of AAMA 501.1.
- J. Capacities for gauge, span or loading other than those tested may be determined by interpolation of test results within the range of test data. Extrapolation for conditions outside test range are not acceptable.

1.10 **WARRANTY**

- A. Owner shall receive one (1) warranty from one manufacturer of the manufactured standing seam metal roof panels covering all of the following criteria.
1. Upon completion of installation, and acceptance by the Owner and Architect, the manufacturer will supply to the Owner a single-source, thirty five (35) year No Dollar Limit (NDL), watertight warranty, including coverage for all trim, flashings, and penetrations associated with the standing seam roof system.
  2. 30 year coverage on finish including checking, crazing, peeling, chalking, fading and/or adhesion.
  3. Installer shall provide manufacturer with three (3) year warranty covering roofing system installation and watertightness. A copy shall be provided directly to the Owner.
  4. Warranty shall commence on the date of substantial completion.
  5. This warranty shall be part of a single-source manufacturer's warranty by ONE manufacturer covering the standing seam metal roof panels. This warranty will include all systems and flashings.
  6. At the request of the Owner, the Manufacturer will provide an annual inspection of the roof. These inspection request can occur for the life of the warranty.

## 1.11 MANUFACTURER'S INSPECTIONS

- A. When the project is in progress, the roofing system manufacturer will provide the following:
  - 1. Keep the Architect informed as to the progress and quality of the work as observed.
  - 2. Provide job site inspections a **minimum of three (3) days a week with reports to the Architect.**
  - 3. Report to the Architect in writing any failure or refusal of the Contractor to correct unacceptable practices called to the Contractor's attention.
  - 4. Confirm after completion that manufacturer has observed no applications procedures in conflict with the specifications other than those that may have been previously reported and corrected.

## PART 2 - PRODUCTS

### 2.01 STANDING SEAM ROOFING SYSTEM

- A. FM GLOBAL **ROOFNAV #: 240874-0-0** Rated 1-28
- B. General.
  - 1. Whenever a particular make of material, trade name and/or manufacturer's name is specified herein, it shall be regarded as being indicative of the minimum standard of quality required. A bidding Contractor who proposes to quote on the basis of an alternate material and/or system will only be considered if the proposed alternate is equivalent or superior in quality to the specified system in accordance with article 1.5. Additionally, all manufacturer and contractor/fabricator guidelines, performance criteria and warranty criteria must be met as specified in article 1.4, 1.5, 1.6, 1.9, and 1.10.
  - 2. Product names for the metal roof panel system and waterproofing materials used in this section shall be based on performance characteristics of the R-MER Span System manufactured by The Garland Company and shall form the basis of the contract documents or approved equal
    - a. Approved equal manufacturers to meet or exceed the following listed characteristics and all performance requirements listed in "Design Criteria" (article 1.9) and Warranty Criteria (article 1.10) must be met and submitted as well as all items listed in the Disclosure of Materials/Alternate Manufacturers (article 1.5).
  - 3. This specification is based on the performance characteristics of the system identified herein. Any proposed alternate systems, specified or not, must meet or exceed the following listed characteristics and be submitted for approval. Additionally, all Warranty Criteria (Section 1.10) and Design and Performance Criteria (Section 1.9) must be met and submitted, FM global rated, as well as all items listed in the Disclosure of Materials and

Substitutions (Section 1.5) must be submitted. Failure of a system to meet all requirements of this specification will result in forfeiture of the bid award.

4. Manufacturers: The following manufacturers are acceptable, providing they meet these specifications and the minimum standards stated.

- a. The Garland Company, Inc. (Basis of Design)
- b. Approved Equal

C. Materials.

1. Panel material: 0.040" thickness aluminum, 3105-H14 alloy, smooth as per ASTM B209-96.
2. Flashing and flat stock material: Unless noted otherwise, fabricate in profiles indicated on approved manufacturer's shop drawings of same material, thickness, and finish as roof system, unless indicated otherwise. Gutters and leaders shall be fabricated as specified in 0.040" aluminum with a kynar paint finish to match the roof panel.

D. Finish on surfaces:

1. Exposed surfaces for coated panels:
  - a. Two coat coil applied, baked-on full-strength (70% resin) fluorocarbon coating system (polyvinylidene fluoride, PVF2), applied by manufacturer's approved applicator.
  - b. Coating system shall provide nominal 1.0 mil dry film thickness, consisting of primer and color coat.
  - c. Color: Custom Orange color to match architect's sample and university's standards.
2. Unexposed surfaces for coated panels shall be baked-on polyester coating with .20 - .30 dry film thickness (DFT).

E. Characteristics:

1. Provide the same panel profile from a single manufacturer for ALL standing seam roof areas.

2. Configuration: Provide standing seam panels incorporating mechanically interlocked, concealed anchor clips allowing unlimited thermal movement, and of configuration which will prevent entrance or passage of water.
  - a. Panel/Cap configuration must have a total of four (4) layers of steel surrounding anchor clip for prevention of water infiltration and increased system strength designed to limit potential for panel blow-off.
  - b. Profile of panel shall have mesa's every two (2) inches on center continuous throughout panel which are a minimum of one point five (1.5) inches wide. These will absorb thermal stresses, reduce oil canning, and increase load carrying capacity.
  - c. Exposed fasteners, screws and/or roof mastic are unacceptable and will be rejected. System configuration only allows for exposed fasteners at trim details (as per manufacturer's guidelines).
  - d. Panels must be fabricated and furnished in continuous lengths from ridge/hip to eave with no joints/splices/overlaps.
  - e. Panels lengths which exceed maximum shipping lengths shall be field rolled on equipment owned by the panel manufacturer. Contractor rolling equipment is NOT allowed. Equipment shall have at least 12 rolling stations and provide a product identical to factory manufactured product. The equipment shall be operated by a trained full time experienced technician.
  - f. Seam caps shall be manufactured in the factory and shall be installed with NO endlaps. Seam sealant must be factory applied.
3. Seam must be two and three-eighths (2-3/8) inches minimum height for added upward pressures and aesthetic appeal. Seam shall have continuous anchor reveals to allow anchor clips to resist positive and negative loading and allow unlimited expansion and contraction of panels due to thermal changes. Integral (not mechanically sealed) seams are NOT acceptable.
4. Concealed Standard Anchor Clips: Clips must be sixteen (16) gauge galvanized steel, ONE (1) piece clip with projecting legs for additional panel alignment and provision for unlimited thermal movement in each direction along the longitudinal dimension.
  - a. Two-piece (2) clips are NOT acceptable.
  - b. Sealant applied in panel cap must be isolated from clip to insure that no sealant damage occurs from the movement of the panel during expansion and contraction.

- c. Clip must maintain a clearance of a minimum of three-eighths (3/8) inches between panel and substrate for proper ventilation to help prevent condensation on underside of panel and eliminate the contact of panel fastener head to panel.
  - 5. Seam cap: Snap-on cap shall be a minimum of 1" wide "T" shaped of continuous length up to forty-five (45) feet according to job conditions and field seamed by means of manufacturer's standard seaming machine.
    - a. Cap shall be designed to receive two (2) beads of continuous hot applied gasketing sealant which will be applied independent of anchor clip to allow unlimited thermal movement of panel without damage to cap sealant.
    - b. Sealant shall be a SIS (Styrene-Isoprene-Styrene) block copolymer type thermoplastic rubber adhesive, non-fatigue water barrier.
  - 6. Standing Seam Panel Width: 16"
  - 7. Stiffening ribs: Located in flat of panel to minimize oil canning and telegraphing of structural members.
  - 8. Replaceability: Panels shall be of a symmetrical design with snap on cap configuration such that individual panels may be removable for replacement without removing adjacent panels.
  - 9. Panel ends shall be panned at ridge or where applicable per the manufacturer's approved shop drawings.
  - 10. Panel length: Panels must be full length without joints.
- F. Accessories.
- 1. Gable anchor clips: Standing Seam style, galvanized steel, minimum thickness 16 gauge.
  - 2. Concealed Z clips: Standing Seam style, galvanized steel, minimum thickness 16 gauge.
  - 3. Fasteners:
    - a. Concealed fasteners: Corrosion resistant steel fasteners (zinc plated, stainless steel or equal) designed to meet structural loading requirements and in accordance with recommendations from the manufacturer of the plywood decking. Provide OMG Standard as the minimum fastener size.

- b. Metal deck has exposed underside to the interior, the fastener shall penetrate only the top flange of the metal roof deck, spacing is to be increased from maximum spacing to align with spacing of decking flutes. Length of fastener shall be selected to prevent possibility of penetrating the lower flange of exposed metal decking while achieving required pull out value and minimum one (1) inch.
- c. Exposed fasteners: Series 410 stainless steel fasteners or one-eighth (1/8) inch diameter stainless steel waterproof rivets. All exposed fasteners shall be factory painted to match the color of the standing seam panels.
- 3. Closures: Factory precut closed cell foam meeting ASTM D1056 or ASTM D3575, enclosed in metal channel matching panels when used at ridge, rake, and jamb.
- 4. Provide all miscellaneous accessories for complete installation.

## 2.02 ACCESSORY PRODUCTS

### A. Sealant:

- 1. Acceptable product:
  - a. Concealed Application : Garland Butyl Sealant or approved equal.
  - b. Exposed Application : Garland Tripolymer Sealant or approved equal.
- 2. Colors: As selected by Architect from sealant manufacturer's standard selection.

### B. Insulation Boards: Flat Polyisocyanurate Roof Insulation; ASTM C-1289. Install two layers of (2.6) inches of polyisocyanurate insulation over metal deck.

Qualities: Rigid, closed cell polyisocyanurate foam core bonded to heavy duty glass fiber mat facers.

Thickness: 2.6" (2 layers of 2.6" thickness)

R-Value: Min. 15.0 (2.6" thickness)

Board Size: Four feet by eight feet (4' x 4')

Compressive Strength: Minimum 25 psi

Source of Supply: Hunter Panels - H-Shield; or Approved equal

Insulation board shall meet the following requirements:

UL, WH or FM listed under Roofing Systems  
Federal Specification HH-I-1972, Class 1

C. Metal Roof Deck Fasteners:

1. OMG Heavy Duty or approved equal corrosion resistant roofing screw fastener with a corrosion resistant coating as recommended by roof membrane manufacturer or approved equal .
2. Approved fasteners with three (3) inch coated disc to meet or exceed the specific project wind uplift requirements Length as required to penetrate roof deck per the screw manufacturers recommendation.

D. Prefabricated Shims:

1. Install prefabricated high density polyethylene plastic shims under the roof panel clip and over the bearing plates to maintain a level/plumb plane to prevent buckling of the roof panel.

E. Snow Retention System:

1. Shall be S-5 Snow Retention System or approved equal as supplied by the standing seam panel manufacturer designed for the appropriate local code ground snow load of 20 psf resulting in the required balanced and unbalanced snow loads, specified roof slopes and lengths, and an 16 inch wide panel. One (1) row of the S-5 Color Guard snow retention system will be required. An S-5 Clip shall be installed at each panel seam, and one (1) Snow Clips between each panel. Color shall match standing seam roof panel color.

F. Gutters and Downspouts:

1. Gutters: Fabricate 5" X 5" box gutters to match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required from .040 Aluminum. Fabricate in minimum 10-foot long sections. Furnish gutter supports spaced per SMACNA's recommendation based on gauge and stretch-out, fabricated from same metal as gutters. Finish gutters to match standing seam metal roof panels.
2. Gutter Brackets: External gutter bracket supports shall be 2-inch wide x 1/4-inch thick formed aluminum, and shall be spaced at no greater than 30" on center. Stagger external gutter bracket supports with internal gutter straps. External supports shall be post-painted with a matching full-strength 70 percent PVDF finish and warranted by the panel manufacturer for same term as specified for material finishes.

3. Gutter Straps: Internal gutter straps shall be 2-inch wide x 1/8-inch thick formed aluminum, and shall be spaced at no greater than 30" on center. Stagger internal gutter straps with gutter external bracket supports. Internal straps shall be post-painted with a matching full-strength 70 percent PVDF finish and warranted by the panel manufacturer for same term as specified for material finishes.
4. Downspouts: Formed from .040 Aluminum and of 4"x5" in size with curved corners. Fabricate in 10-foot long sections, complete with curved corners/elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual".
5. Downspout Brackets: Surface mounted downspout protection guards shall be fabricated from 2" wide x double folded .040 Aluminum. Install straps at five (5) feet on center maximum.

G. Underlayment:

1. Underlayment shall be R-Mer Seal or approved equal as part of a tested assembly,
  - . 45 mil self-adhering, high temperature underlayment. Install in accordance with manufacturer's recommendations.

2.03 FABRICATION

- A. Shop fabricate metal roofing and flashing components to the maximum extent possible, forming metal work with clear, sharp, straight, and uniform bends and rises. Hem exposed edges of flashings.
- B. Form flashing components from full single width sheet in minimum ten (10'-0") foot lengths. Provide mitered corners, joined using closed end pop rivets and joint sealant.
- C. Provide splice plates of same material and finish as metal flashing and closures minimum 4" width. Lap each end of abutting metal flashing min 2" onto splice plate and bed in continuous sealant
- C. Fabricate roofing and related sheet metal work in accord with approved shop drawings and applicable standards.

**PART 3 - EXECUTION**

3.01 PREPARATION

- A. Inspection: Examine the alignment and placement of the building structure and substrate. Correct any objectionable warp, waves or buckles in the substrate before proceeding with installation of the pre-formed metal roofing. The installed roof panels will follow the contour of the structure and may appear irregular if not corrected.
- B. Establish straight side and crosswise benchmarks.



- C. Use proper size and length fastener for strength requirements. Approximately five-sixteenths (5/16) inch is allowable for maximum fastener head size beneath the panel.
- D. Rectangular shaped roofs shall be checked for square and straightness. Gable ends may require setting a true line for the gable clips and setting with string line.
- E. Measure the roof lengthwise to confirm panel lengths, overhangs, coverage of flashings at eaves and ridges and verify clearances for thermal movement.
- F. Pre-roofing conference:
  - 1. Prior to beginning metal roofing work, a pre-roofing conference shall be held to review work to be accomplished.
  - 2. Owner, contractor, metal roofing subcontractor, metal roofing system manufacturer's representative and all other subcontractors who have equipment penetrating roof or whose work involves access to roof shall be present.

### 3.02 METAL FABRICATION AND EQUIPMENT

- E. Mechanical panel fabrication for field panels shall be operated by a trained full time experienced technician.
- F. Mechanical equipment shall have a least twelve (12) rolling stations and provide a product identical to factory manufactured product.

### 3.03 ROOFING AND FLASHING INSTALLATION

- A. Details on the project documents are provided for bidding purposes. All details will be shown on manufacturer's shop drawings to successful bidder. Comply with all details and install roofing materials and flashings in accordance with approved manufacturer's shop drawings and manufacturer's product data, within specified erection tolerances.
- B. Mechanically Fastened Polyisocyanurate Insulation System to Metal Roof Deck
  - 1. Approved polyisocyanurate insulation boards, shall be installed with joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. All board joints shall be staggered between layers. Tightly butt substrate boards together. Substrate boards shall be fully attached to the deck with an approved mechanical fastening system. As a minimum, the number of fasteners shall be in accordance with the following:

sixteen (8) fasteners per 4' x 4' board;
  - 2. Filler pieces of insulation require at least two fasteners per piece if size of insulation is less than four square feet.
  - 3. Placement of any fastener from edge of insulation board shall be a minimum of three inches, and a maximum of six (6) inches.

- C. Standing Seam Metal Roof Panel Underlayment Installation
  - 1. Underlayment shall be applied over entire roof areas having rigid insulation.
  - 2. Underlayment shall be applied over entire roof area and turned down over the perimeter edge blocking in accordance with the manufacturer's approved shop drawings.
- D. Prepare roof for the installation of standing seam panels, including:
  - 1. Install insulation in accordance with specifications and manufacturer's recommendations. All joints between the layers of insulation shall be staggered in all directions to provide a thermal break.
  - 2. Install the specified and approved underlayment as required in this specification over the installed insulation system. The specified underlayment shall be applied over the entire roof area.
- E. Install Z-girts directly over first layer of insulation mechanically fastened to metal deck. Z-girts will be nestled between the first and second layer of insulation. All anchor clips will be set on sixteen (16) gauge galvanized pre-punched Z-girts and fastened with two (2) approved fasteners into the top flange of architectural dove-tail metal roof deck. Length of fasteners shall prevent penetration of lower flange of architectural decking. As required, install prefabricated high density polyethylene plastic shims to maintain a level/plumb surface/plane for the standing seam panel to prevent buckling.
- F. Canopy Roof Areas:
  - 1. Clip spacing must be 2 ft. o.c max increased as needed to fasten into top flange of decking for Zone 1 (Mid Roof).
  - 2. Clip spacing must be 2 ft. o.c max increased as needed to fasten into top flange of decking for Zone 2 (Eaves, Rake and Ridge).
  - 3. Clip spacing must be 1 ft. o.c max increased as needed to fasten into top flange of decking for Zone 3 (Corners).

- G. Installation of Roof Panels: Roof panels can be installed by starting from either end and working towards the opposite end. Due to the symmetrical design of the specified panel system, it is also acceptable to start from the middle of the roof and work toward each end.
  - 1. Stainless steel pop rivets shall be secured through the anchor reveal of the panel leg and extend into the arms of the panel clip located at each clip on either side of the top of the curved panel. The panel is then anchored at both sides of each of the clip. Three (3) rivets per panel are required and shall be installed.
    - a. Be sure to capture all drilling debris during this operation with a rag or cloth placed on the panels at the drilling operation.
    - b. Panels are not securely attached to the roof until fixed to the anchor clip. To avoid damage and injury, all panels shall be fixed to the anchor clip immediately as they are installed.
  - 2. The seam caps are shipped with two (2) beads of factory applied hot melt sealant located inside the caps. To install the caps, hook one side of the cap over the panel edge and rotate over the opposite panel leg. For ease of installation, start at one end of the panel and work toward the opposite end.
  - 3. A hand crimping tool is used to crimp the cap around the top of two adjacent panels
  - 4. Caps shall then be permanently seamed with manufacturers mechanical seamer.
  - 5. At the end of each day's work, seam caps shall be mechanically seamed or hand crimped (crimp 4 inches every 8 feet) to reduce the possibility of wind damage prior to completion of the project.
  - 6. Un-installed panels which are temporarily stored on the ground or roof shall be secured in place at the end of each day's work to prevent possible damage or injury.
- H. Isolate dissimilar metals and masonry or concrete from metals with bituminous coating. Use gasketed fasteners where required to prevent corrosive action between fastener, substrate, and panels.
- I. Limit exposed fasteners to extent indicated on shop drawings.
- J. Anchorage shall allow for temperature expansion/contraction movement without stress or elongation of panels, clips, or anchors. Attach clips to structural substrate using fasteners of size and spacing as determined by manufacturer's design analysis to resist specified uplift and thermal movement forces.
- K. Seal laps and joints in accordance with roofing system manufacturer's product data.

- L. Coordinate flashing and sheet metal work to provide weathertight conditions at roof terminations. Fabricate and install in accordance with standards of SMACNA Manual.
- M. Provide for temperature expansion/contraction movement of panels at roof penetrations and roof mounted equipment in accordance with system manufacturer's product data and design calculations.
- N. Installed system shall be true to line and plane and free of dents, and physical defects. In light gauge panels with wide flat surfaces, some oil canning may be present. Oil canning does not affect the finish or structural integrity of the panel and is therefore not cause for rejection.
- O. Maximum variation from true planes or lines shall be one-fourth (1/4) inch in twenty (20) feet and three-eighth (3/8) inch in forty (40) feet or more.
- P. Form joints in linear sheet metal to allow for one-fourth (1/4) inch minimum expansion at twenty (20) feet on center maximum and eight (8) feet from corners.
- Q. At joints in linear sheet metal items, set sheet metal items in two(2), one-fourth (1/4) inch beads of butyl sealant. Extend sealant over all metal surfaces. Mate components for positive seal. Allow no sealant to migrate onto exposed surfaces.
- R. Remove damaged work and replace with new, undamaged components.
- S. Touch up exposed fasteners using paint furnished by roofing panel manufacturer and matching exposed panel surface finish.
- T. Clean exposed surfaces of roofing and accessories after completion of installation. Leave in clean condition at date of substantial completion. Touch up minor abrasions and scratches in finish.
- U. Snow Retention System
  - 2. Shall be S-5 Snow Retention System or approved equal as supplied by the standing seam panel manufacturer designed for the appropriate local code ground snow load of 30 psf resulting in the required balanced and unbalanced snow loads, specified roof slopes and lengths, and an 16 inch wide panel. One (1) row of the S-5 Color Guard snow retention system will be required. An S-5 Clip shall be installed at each panel seam, and one (1) Snow Clips between each panel. Color shall match standing seam roof panel color.



## CHECKLIST FOR ROOFING SYSTEM

FM Global Clients: submit completed form and completed RoofNav Contractor Package to local FM Global field office for review.

### CONTACT INFORMATION:

### FM GLOBAL INDEX NUMBER:

ROOFING CONTRACTOR (NAME, ADDRESS, PROJECT NO.)	TELEPHONE NO.:	CONTACT:
	E-MAIL ADDRESS:	FAX:
CLIENT SITE (NAME & ADDRESS)	TELEPHONE NO.:	CONTACT:
	E-MAIL ADDRESS:	FAX:

### OVERVIEW OF WORK: (Submit 1 form per roof area)

Building Name & Number (provide building diagram as appropriate):			
Type of Work:	<input type="checkbox"/> New Construction <input type="checkbox"/> Recover (New roof over existing Roofing System) <input type="checkbox"/> Reroof (New cover/remove existing roofing system to deck) <input type="checkbox"/> Other (describe)		
Building Dimensions: Length:	ft/m;	Width:	ft/m.;    Height    ft/m.
Roof Slope:	in. per ft. / degrees		
Parapet Height, max (in./m):	Parapet Height, min (in./m): (enter "0" if not always present)		
Roof Zone Width/Dimension*:			
Zone 1:	Zone 1:	Zone 2:	Zone 3:
FM Approved RoofNav Assembly Numbers (provide Assembly Number for individual roof zones as appropriate):			

\*Refer to FM Global Property Loss Prevention Data Sheet 1-28, *Wind Design* or RoofNav for determination of various zone dimensions.

### ROOF SURFACING:

<input type="checkbox"/> None			
<input type="checkbox"/> Coating (Trade Name/Application Rate)			
<input type="checkbox"/> Granules (Application Rate)			
<input type="checkbox"/> Gravel/Slag (Application Rate)			
<input type="checkbox"/> Ballast: <input type="checkbox"/> Stone Size <input type="checkbox"/> Pavers (Beveled, strapped or square edge); <input type="checkbox"/> Other:			
Ballast Weight (psf):	Zone 1:	Zone 2:	Zone 3:
Additional Detail:			

### ROOF COVER / MEMBRANE:

(Provide ALL applicable details including trade name, type, number of plies, thickness, reinforced, adhesive, etc.)

Roof Cover: Trade Name:			
Hail Rating Provided:			
<input type="checkbox"/> Single Ply: <input type="checkbox"/> Reinforced <input type="checkbox"/> Unreinforced <input type="checkbox"/> Adhered <input type="checkbox"/> Fastened <input type="checkbox"/> Ballasted			
<input type="checkbox"/> Multi-Ply <input type="checkbox"/> Built Up Roofing (BUR) <input type="checkbox"/> Modified Bitumen			
Number of Plies:			
<input type="checkbox"/> Lap Width    in/mm <input type="checkbox"/> Lap Adhesion Type			
<input type="checkbox"/> Panel: <input type="checkbox"/> Through Fastened Metal <input type="checkbox"/> Standing Seam metal <input type="checkbox"/> Steel <input type="checkbox"/> Aluminum <input type="checkbox"/> Copper    Thickness:			
Rib Spacing:    Clip Model: <input type="checkbox"/> 1- Piece <input type="checkbox"/> 2-Piece			
<input type="checkbox"/> Insulated Metal Panel Roof:    Bottom facer: Metal type:    Thickness:			
Top facer: Material:    Thickness:			
<input type="checkbox"/> Fiber Reinforced Plastic (FRP)			
<input type="checkbox"/> Other:			
<input type="checkbox"/> Spray Applied <input type="checkbox"/> Other:			
Additional Detail:			
<input type="checkbox"/> Asphalt Shingles <input type="checkbox"/> Metal Shingles: Manufacturer:    Model: <input type="checkbox"/> Ring Shank Nails			
<input type="checkbox"/> Smooth Shank Nails <input type="checkbox"/> Screws    Size    Number per shingle:			
<input type="checkbox"/> Concrete Tile <input type="checkbox"/> Clay Tile: Manufacturer    Model: <input type="checkbox"/> Ring Shank Nails			
<input type="checkbox"/> Smooth Shank Nails <input type="checkbox"/> Screws    Size    Number <input type="checkbox"/> Mortar or urethane at lower end of tile			
<input type="checkbox"/> Only mortar or urethane adhesive at top and bottom (No fasteners)			
<input type="checkbox"/> Slate tile: Width:    Thickness    Length of reveal: <input type="checkbox"/> Ring Shanks Nails <input type="checkbox"/> Smooth Shank Nails			
Number per tile:			
<input type="checkbox"/> Self-Adhering modified bitumen underlayment Trade Name:			

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## CHECKLIST FOR ROOFING SYSTEM

### ROOF COVER / MEMBRANE SECUREMENT:

Roof Cover Fasteners: Trade Name:	Length:	Diameter/No.:
Stress Plate/Batten: Trade Name:	Size:	
Row Spacing: Zone 1':	Zone 1:	Zone 2: Zone 3:
Fastener Spacing: Zone 1':	Zone 1:	Zone 2: Zone 3:
Bonding Adhesive: Trade Name:		
Adhesive Ribbon Width (in.):		
Adhesive Ribbon Spacing (in.): Zone 1':	Zone 1:	Zone 2: Zone 3:
Adhesive Application Rate (gal./sq.):		
Additional Detail:		
See DS 1-49 for additional securement for all ballasted, or mechanically fastened or ribbon adhered roof covers if the roof cover is not secured within 12 in. (300 mm) of the outside edge of the nailer.		

### INSULATION / COVER BOARD:

Layer	Insulation / Cover Board Trade Name	Board Dimensions (ft. x. ft.)	Thickness (in.)	Fastened	Adhered	Tapered
1. Top		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Next		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Next		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Next		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Thermal Barrier		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Glass Fiber/Mineral Wool/Batt <input type="checkbox"/> Facer Type/Vapor Barrier <input type="checkbox"/> Other: <input type="checkbox"/> None						
Additional Detail:						

### INSULATION / COVER BOARD SECUREMENT:

Insulation / Cover Board Fasteners: Trade Name:	Type:	Size:
Stress Plate: Trade Name:	Size:	
Fastener Spacing: Zone 1':	Zone 1:	Zone 2: Zone 3:
Bonding Adhesive: Trade Name:		
Adhesive Ribbon Width (in.):		
Adhesive Ribbon Spacing (in.): Zone 1':	Zone 1:	Zone 2: Zone 3:
Adhesive Application Rate (gal./sq.):		
Additional Detail:		

### BASE SHEET: (Include Trade Name, Type, and Width)

<input type="checkbox"/> None	
Trade Name:	Width: <input type="checkbox"/> 36 in. <input type="checkbox"/> 1 meter (39 in.)
<input type="checkbox"/> Fastened	<input type="checkbox"/> Adhered
<input type="checkbox"/> Lap Width in/mm	<input type="checkbox"/> Lap Adhesion Type
<input type="checkbox"/> Air Retarder	<input type="checkbox"/> Vapor Retarder
Additional Detail:	

### BASE SHEET SECUREMENT:

Base Sheet Adhesive Name:	Adhesive Application Rate:
Base Sheet Fastener Trade Name:	Type:
Head Diameter:	Length:
Spacing: (Attached Sketches as necessary)	
Spacing Along Laps: Zone 1':	Zone 1: Zone 2: Zone 3:
No. Intermediate Rows: Zone 1':	Zone 1: Zone 2: Zone 3:
Spacing Along Intermediate Rows: Zone 1':	Zone 1: Zone 2: Zone 3:
Additional Detail:	



## CHECKLIST FOR ROOFING SYSTEM

### DECK:

<input type="checkbox"/> Steel:	Manufacturer:	Type (e.g., wide rib):	Thickness / Gauge:	Yield Strength:
<input type="checkbox"/> LWIC (Form Deck):	<input type="checkbox"/> Cementitious Wood Fiber (Pullout Test Required):			
<input type="checkbox"/> Concrete:	<input type="checkbox"/> Pre-cast panels or <input type="checkbox"/> Cast in Place			
<input type="checkbox"/> Wood (Pullout Test Required):				
<input type="checkbox"/> Fiber Reinforced Cement:	<input type="checkbox"/> Fiber Reinforced Plastic			
<input type="checkbox"/> Gypsum (Pullout Test Required):	<input type="checkbox"/> Plank	or	<input type="checkbox"/> Poured	
<input type="checkbox"/> Other:				
Additional Detail:				

### DECK or ROOF PANEL SECUREMENT:

Deck Or Roof Panel Fasteners:		Type:					
Trade Name:		Size Washer:					
Length:		Washer:					
If Weld: Size:		Weld:	Washer:				
Fastener / Weld / External Seam Clamp (ESC) for Standing Seam Roof Spacing							
External Seam Clamp (ESC): Trade Name:							
Roof Slope deg.							
≤ 7			>7, ≤ 27			>27, ≤45	
Zone	Fastener / Weld Spacing	External Seam Clamp Spacing	Zone	Fastener / Weld Spacing	External Seam Clamp Spacing	Zone	Fastener / Weld Spacing
1'							
1			1, 2e			1, 2e, 2r	
2			2n, 2r, 3e			2n, 3r	
3			3r			3e	
Deck Side Lap Fastener Spacing:		Zone 1':	Zone 1:	Zone 2:	Zone 3:		
Additional Detail:							

### ROOF STRUCTURE (Include Size, Gage, Etc.):

<input type="checkbox"/> Purlins	<input type="checkbox"/> "C" or <input type="checkbox"/> "Z"	Thickness:
Purlin Spacing: Zone 1': Zone 2: Zone 3:		
<input type="checkbox"/> Joists	<input type="checkbox"/> Wood or <input type="checkbox"/> Steel	
Joist Spacing: Zone 1': Zone 2: Zone 3:		
<input type="checkbox"/> Beams	<input type="checkbox"/> Wood or <input type="checkbox"/> Steel	
Beam Spacing: Zone 1': Zone 2: Zone 3:		
<input type="checkbox"/> Other:		
Additional Detail:		

### PERIMETER FLASHING: (Attach a detailed sketch of metal fascia, gravel stop, nailer, blocking, coping, etc.)

<input type="checkbox"/> FM Approved Flashing
<input type="checkbox"/> Other (applicable only when FM Approved system is not available):
Manufacturer/Trade Name:
Flashing Wind Rating: Zone 2 Zone 3
Fascia / Coping Detail: Face Height: Thickness:
Hook Strip Detail: Height: Thickness: Fastener spacing: Zone 2 Zone 3
Fastener Details: Length: Type & Diameter/No.
Nailer / Blocking Details Per FM Global Data Sheet 1-49? <input type="checkbox"/> Yes <input type="checkbox"/> No (Attach Details)
Nailer Securement: Diameter: Spacing: Zone 2 Zone 3 Embedment:
Additional Detail:

### DRAINAGE:

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## CHECKLIST FOR ROOFING SYSTEM

For new construction: Has roof drainage been designed by a Qualified Engineer per FM Global Loss Prevention Data Sheet 1-54 and the local building code? <input type="checkbox"/> Yes <input type="checkbox"/> No (Attach details)
For re-roofing and recovering: Will the roof drainage be changed from the original design (i.e., drains inserted/covered/removed, new expansion joints, blocked or reduced scupper size)? <input type="checkbox"/> Yes <input type="checkbox"/> No
If yes, were the changes reviewed by a Qualified Engineer? <input type="checkbox"/> Yes <input type="checkbox"/> No (Attach details)
Is secondary (emergency) roof drainage provided per FM Global Data Sheet 1-54? <input type="checkbox"/> Yes <input type="checkbox"/> No (Attach details)
Additional Detail:

### ROOF MOUNTED EQUIPMENT: (Attach drawings, calculations and any supporting detail.)

Roof mounted equipment secured per FM Global Loss Prevention Data Sheet 1-28 and the local building code? <input type="checkbox"/> Yes <input type="checkbox"/> No
Additional Detail:



## **SECTION 074213 – METAL WALL AND SOFFIT PANELS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.3 SUMMARY.**

- A. Work described in this section includes single-skin, labyrinth-joint metal cladding panels for rainscreen-principle wall system, complete with sub-structural metal framing, perimeter and penetration flashing, soffit panels and closures.
- B. Related work specified elsewhere:
  - 1. Division 05: Steel studs, girts, and furring.
  - 2. Division 06: Gypsum sheathing, wood sheathing, rough carpentry.
  - 3. Division 07: Flashing and sheet metal, water resistive air barriers, thermal insulation, joint sealants.

#### **1.5 DESIGN AND PERFORMANCE CRITERIA.**

- A. General Performance: Metal wall panel assemblies shall be furnished and installed without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Rainscreen Wall System Performance Rating. The metal wall panel assemblies, and the substructural furring/framing system supporting the panels shall be tested in accordance with AAMA 509 and achieve the following performance results:
  - 1. Water Infiltration: The water infiltration performance of the metal wall panel assembly shall not exceed the classification of W-1.
  - 2. Back Ventilation: The air ventilation performance of the rainscreen cavity air space shall have a minimum classification of V-4.
- C. Rainscreen Wall System Performance Rating. The metal wall panel assemblies, and the substructural furring/framing system supporting the panels shall be tested in accordance with AAMA 508-07 and achieve the following performance results: PASS.
- D. Abrasion Resistance of Underside Coating for Zinc Wall Panels.
  - 1. The underside of all zinc roof panel and flashing materials shall be coated with a high performance abrasion resistant coating to prevent corrosion from the underside due to condensation and/or water vapor.

2. The underside coating shall provide a minimum abrasion resistance equal to 250 liters of falling sand, as testing in accordance with ASTM D968, Method A.

E. Thermal Expansion and Contraction.

1. Completed metal wall panel and flashing system shall be capable of withstanding expansion and contraction of components caused by changes in temperature without buckling, or reducing performance ability.
2. The design temperature differential shall be not less than 220 degrees Fahrenheit.
3. Interface between panel and clip shall provide for unlimited thermal movement in each direction along the longitudinal direction.

F. Uniform Wind Load Capacity.

1. Installed wall system shall withstand negative wind pressures complying with the following criteria.
  - a. Design Code: ASCE 7, Method 2 for Components and Cladding.
  - b. Safety Factor: The metal panel system shall be tested to proof load of 1.5 times the design service load condition, as required by the ASTM E330 method.
  - c. Category III Building with an Importance Factor of 1.15.
  - d. Wind Speed: 124 mph.
  - e. Exposure Category: B..
  - f. Height at Top of Wall System: 40 feet.
  - g. Minimum Building Width: 125 feet.
  - h. Roof Pitch (Above Wall System): 1 inches per foot.
2. The ultimate capacity of the panel system shall be determined based on performance testing in accordance with ASTM E330. The system shall be tested to a proof load that shall be 1.5 times the allowable design service load.

1.6 SUBMITTALS.

A. General, Rainscreen Wall Assembly Components: Complete submittals shall be made jointly and simultaneously for all components of the Rainscreen wall assembly, including:

1. Metal rainscreen wall cladding panels and subframing components;
2. All other trim, flashing, sealants, and components necessary for a complete rainscreen wall assembly as required by these specifications.

B. Shop drawings.

1. All components shall be integrated into a single comprehensive and complete shop drawing set prepared by the metal cladding system manufacturer.

2. Shop drawings shall identify each product and component by manufacturer, product name, and thickness, size, style, or other uniquely distinguishing characteristics.
- C. Warranty: Provide unexecuted specimen warranty documents for each warranty as required in specification article 1.10.
- D. Design Test Reports.
  1. Submit copies of design test reports for each of the performance testing standards listed in specification article 1.4.
  2. Test reports shall be performed by independent, accredited testing laboratories, and shall bear the seal of a registered professional engineer.
- E. Samples.
  1. Submit sample of panel section, at least 6" x 6" showing seam profile, and also a sample of color selected.
  2. Submit sample field applied sealants and all other system components.

#### **1.7 QUALITY CRITERIA/INSTALLER QUALIFICATIONS.**

- A. Engage an experienced metal wall panel contractor (erector) to install wall panel system who has a minimum of three (3) years experience specializing in the installation of Rainscreen metal wall systems.
- B. Contractor must be certified by manufacturer specified as a supplier of the metal wall system and obtain written certification from manufacturer that installer is approved for installation of the specified system.
- C. Successful contractor must obtain all components of Rainscreen wall system from a single manufacturer. Any secondary products that are required which cannot be supplied by the specified manufacturer must be recommended and approved in writing by primary manufacturer prior to bidding.
- D. Fabricator/Installer shall submit work experience and evidence of adequate financial responsibility. Architect reserves the right to inspect fabrication facilities in determining qualifications.

#### **1.8 DELIVERY, STORAGE, AND HANDLING.**

- A. Inspect materials upon delivery.
- B. Handle materials to prevent damage.
- C. Store materials off ground providing for drainage; under cover providing for air circulation and preventing direct UV exposure; and protected from any debris.

#### **1.9 PROJECT CONDITIONS**

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit metal wall panel work to be performed according to manufacturer's written instructions and warranty requirements.

1. For natural (unpainted) panel materials, remove any protective films from the exposed surface of panels only after a complete elevation has been full installed.
  2. Rolled zinc materials may only be formed and installed in weather conditions that insure that the primary metal temperature (PMT) is 50 degrees Fahrenheit or greater.
- B. Field Measurements: Verify actual dimensions of construction contiguous with metal wall panels by field measurements before fabrication.

#### 1.11 COORDINATION

- A. Coordinate sizes and locations of windows, doors, and wall penetrations with actual equipment provided.
- B. Coordinate metal wall cladding system with wall sheathing, masonry, air and water resistive barriers, thermal insulation, rain drainage work, flashing, trim, and construction of other adjoining work to provide a leak proof, secure, and noncorrosive installation.

#### 1.12 WARRANTIES

- A. The Manufacturer shall furnish the following warranties for materials and finishes:
1. Exterior metal cladding system Manufacturer's 10 year warranty against defective materials and fabrication.
  2. Exterior metal cladding system Manufacturer's 20 year warranty for performance of prefinished finishes. The finish warranty shall provide coverage for the following:
    - a. Fade Resistance: For a period of 20-years from date of first exposure to UV or weathering, the post-painted material finishes shall exhibit no more than a 5 "delta E" rating for color change from original color standard.
    - b. Chalk Resistance: For a period of 20-years from date of first exposure to UV or weathering, the post-painted material finishes shall exhibit a chalk rating of 8 or less, in accordance with ASTM D4214, Method A.
    - c. Film Integrity: For a period of 20-years from date of first exposure to UV or weathering, the post-painted material finishes shall not chip, peel, crack, or blister as a result of defective coatings, improper preparation of the substrate, improper application of the coatings, or improper curing of the coating system.
  3. Exterior metal cladding system Manufacturer's warranty for performance of Post-painted aluminum finishes. The finish warranty shall provide coverage for the following:
    - a. Fade Resistance: For a period of 10-years from date of first exposure to UV or weathering, the post-painted material finishes shall exhibit no more than a 5 "delta E" rating for color change from original color standard.

- b. Chalk Resistance: For a period of 10-years from date of first exposure to UV or weathering, the post-painted material finishes shall exhibit a chalk rating of 8 or less, in accordance with ASTM D4214, Method A.
  - c. Gloss Retention: For a period of 10-years from date of first exposure to UV or weathering, the post-painted material finishes shall retain at least 50% of original Specular Gloss, as measured in accordance with ASTM D523.
  - d. Film Integrity: For a period of 20-years from date of first exposure to UV or weathering, the post-painted material finishes shall not chip, peel, crack, or blister as a result of defective coatings, improper preparation of the substrate, improper application of the coatings, or improper curing of the coating system.
- B. Installer's 3 year warranty covering wall panel system installation and watertightness.
- C. Warranties shall commence on date of substantial completion.

## **PART 2 - PRODUCTS**

### **2.15 PANEL MATERIALS**

#### **A. Painted Aluminum Sheet.**

- 1. Recycle Content: Provide steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is at least 45 percent.
- 2. Aluminum alloy 3003, 3004, 3005, or 3105 with H14 or H24 heat treatment, as per ASTM B209/209M.
- 3. Texture: Smooth surface.
- 4. Prefinished Painted Aluminum:
  - a. Exposed Surfaces: 2-Coat Fluoropolymer finish in accordance with AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Manufacturers' approved applicator to prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - b. Exposed surface coating system shall provide nominal 1.0 mil (0.025 mm) dry film thickness, consisting of primer and color coat.
  - c. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
- 5. Post-Painted Aluminum

- a. Exposed Surfaces: 2-Coat Fluoropolymer finish in accordance with AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Coating manufacturer's approved applicator to prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
- b. Exposed surface coating system shall provide nominal 1.2 mil (0.030 mm) dry film thickness, consisting of primer and color coat.
- c. Concealed Finish: The unexposed sheet surfaces shall be bare as furnished by the mill. Overspray of primer and/or top coat(s) will not affect the use or performance of the unexposed surface of the material.

**A. Sealants:**

1. Sealant Tape: Non-curing, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1-inch- (13-mm-) wide and 1/16-inch- (3-mm-) thick.
2. Exposed Sealant: ASTM C 920; elastomeric tripolymer, polyurethane, or other advanced polymer sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
3. Concealed Sealant: ASTM C 1311: Butyl-Based, Solvent-Release, One-Part Sealant.

**2.13 METAL SUBFRAMING**

- A. See section 074800 Rainscreen attachment systems
- B. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653, G90 (Z275) hot-dip galvanized

**2.14 METAL WALL PANELS (MTL-1 & MTL-2), LAP-SEAM METAL WALL PANELS**

- A. General: Provide factory-formed metal wall panels designed to be field assembled by interlocking seams incorporating concealed anchor clips, allowing thermal movement.
- B. Concealed clip, lap-seam wall panels with pan ribs in varying widths.
  1. Basis of Design: Panel shall be IMETCO LATITUDE Wall system or approved equal
  2. Other manufacturers:
    - a. Atas
    - b. Pac-Clad
    - c. Or approved equal
  3. Material: Aluminum sheet, 0.040 inch (1.02 mm) thick.
  4. Colors shall be:
    - a. MTL-1: IMETCO "Platinum Silver" or approved equal

- b. MTL-2: IMETCO “Charcoal” or approved equal
- 5. Characteristics.
  - a. Fabrication: Panels shall be factory formed from specified metal.
  - b. Profiles: as indicated project drawings.
    - 1) MTL-1 – Varying Widths of 6”, 12”, and 20” coverage panels
      - a) Pan Rib D – 6” Coverage, 1” Reveal
      - b) Pan Rib B – 12” Coverage, 1” Reveal
      - c) Pan Rib A – 20” Coverage, ¾” Reveal
    - 2) MTL-2 – 6” coverage panels
      - a) Pan Rib D – 6” Coverage, 1” Reveal
  - c. Panel orientation: Vertical.
  - d. Configuration: Panel shall have interlocking seams incorporating concealed anchor clips allowing thermal movement.
  - e. Panel Depth (Concealed Leg Height): 7/8 inches (22 mm), nominal.
  - f. Anchor clips: Clips shall be 18 gauge galvanized steel designed to allow thermal movement of the panel in each direction along the longitudinal dimension.
  - g. Panel length: Up to 21 feet (6.4 m) maximum length.

#### **2.15 METAL WALL PANELS (MTL-3), REVEAL JOINT METAL WALL PANELS**

- A. General: Provide factory-formed metal wall panels designed to be field assembled by interlocking seams and incorporating concealed fasteners.
- B. Concealed clip, longitudinal lap-seam panel with labyrinth-joint and reveal on four sides.
  - 1. Basis of Design: Panel shall be IMETCO ELEMENT Wall system or approved equal
  - 2. Other Manufacturers:
    - a. Atas
    - b. Pac-Clad
    - c. Or approved equal

3. Material: Aluminum sheet, 0.063 inch thick.
4. Colors shall be:
  - a. MTL-3 Color A: Custom “Light Gray” as selected by architect.
  - b. MTL-3 Color B: Custom “Orange” as selected by architect.
5. Characteristics.
  - a. Fabrication: Panels shall be factory formed from specified metal.
  - b. The standard profile shall be flat pans with reveal joints on all four sides.
  - c. Panel orientation: Vertical
  - d. Configuration (Vertical): Panel shall be 12-inches long nominal by 14-inches up to 108-inches high nominal, with interlocking seams incorporating concealed fasteners.
  - e. Panel Depth (Concealed Leg Height): 1 1/4 inch (32 mm), nominal.
  - f. Reveal Joint: Panel seams shall join such that adjacent panels form vertical and horizontal reveal joints 3/4-inch- (19-mm) wide.
    - 1) Horizontal reveal joints shall be staggered from panel to panel, as shown on drawings.
    - 2) Vertical reveal joints shall be aligned from panel to panel, as shown on drawings.
  - g. End Folds: Panel ends shall be factory notched by automatic mechanical press equipment to form end tabs of 1 inch (25 mm) nominal length. The end tabs shall be factory folded 90 degrees to produce a “box pan” effect and allow for reveal joints on all four sides of the panel. Vertically oriented panels to have a double end fold.

## **2.16 METAL WALL PANELS (MTL-4), REVEAL JOINT METAL WALL PANELS**

- A. General: Provide factory-formed metal wall panels designed to be field assembled by interlocking seams and incorporating concealed fasteners.
- B. Concealed clip, longitudinal lap-seam panel with labyrinth-joint and reveal on four sides.
  1. Basis of Design: Panel shall be IMETCO ELEMENT Wall system or approved equal
  2. Other Manufacturers:
    - a. Atas
    - b. Pac-Clad
    - c. Or approved equal



6. Material: Aluminum sheet, 0.063 inch thick.
7. Colors shall be:
  - a. MTL-4: Custom “Orange” as selected by architect,
8. Characteristics.
  - a. Fabrication: Panels shall be factory formed from specified metal.
  - b. The standard profile shall be flat pans with reveal joints on all four sides.
  - c. Panel orientation: horizontal
  - d. Configuration (horizontal): Panel shall be up to 96” long nominal by up to 24” height as shown on the drawings, with interlocking seams incorporating concealed fasteners.
  - e. Panel Depth (Concealed Leg Height): 1 1/4 inch (32 mm), nominal.
  - f. Reveal Joint: Panel seams shall join such that adjacent panels form vertical and horizontal reveal joints 3/4-inch- (19-mm) wide.
    - 1) Horizontal reveal joints shall be staggered from panel to panel, as shown on drawings.
    - 2) Vertical reveal joints shall be aligned from panel to panel, as shown on drawings.
  - g. End Folds: Panel ends shall be factory notched by automatic mechanical press equipment to form end tabs of 1 inch (25 mm) nominal length. The end tabs shall be factory folded 90 degrees to produce a “box pan” effect and allow for reveal joints on all four sides of the panel. Vertically oriented panels to have a double end fold.

#### **2.15 METAL SOFFIT PANEL (MSP-1), CONCEALED FASTENER, FLUSH PANEL**

- A. General: Provide factory-formed metal wall panels designed to be field assembled by interlocking seams incorporating concealed anchor clips, allowing thermal movement.
- B. Concealed fastener, flat pan, flush seam wall panels
  1. Basis of Design: Panel shall be IMETCO Super Flush-Lock 311 panel wall system or approved equal
  2. Other Manufacturers:
    - a. Atas
    - b. Pac-Clad
    - c. Or approved equal
  3. Material: Aluminum sheet, 0.040 inch thick.
  4. Colors shall be IMETCO “Charcoal”
  5. Characteristics.
    - a. Fabrication: Panels shall be factory formed from specified metal.

- b. Coverage: 12-inches
- c. Profile: 1 Bead, Model # 311SFL-.75-1B
- d. Panel orientation: per architectural drawings
- e. Panel Depth (Concealed Leg Height):  $\frac{3}{4}$ -inch nominal.

## 2.16 ACCESSORIES

- B. Wall Panel Accessories: Provide components approved by panel manufacturer and as required for a complete metal wall panel assembly including trim, corner units, closures, clips, flashings, sealants, gaskets, fillers, and similar items. Match material and finish of metal wall panels unless otherwise indicated.
  - 1. Anchor Clips: Clips shall be 18 gauge galvanized steel designed to allow thermal movement of the panel in each direction along the longitudinal dimension.
  - 2. Gutter Splice at Element Reveal: At the reveal joint, a sheet metal gutter splice shall be provided in the same material type and finish as the metal cladding panels for all visible space at the reveal joint. Gutter splice material thickness shall be as recommended by manufacturer based on panel height.
  - 3. Ventilation strips shall be provided at top of wall panels, window sills, and transitions between metal panels and other exterior finish materials to allow for air exhaust at top of wall cavity. Vent strips shall be internally baffled to prevent wind driven rain from freely entering the wall cavity.
  - 4. Ventilation strips shall be provided at base of wall panels, window head, and transitions between metal panels and other exterior finish materials to allow for air intake and water weep holes at bottom of wall cavity.
- C. Flashing and Trim: Formed from same material, finish, and gauge as wall panels. Provide flashing and trim as required to provide finished appearance. Locations include, but are not limited to, head, sill, corners, jambs, framed openings, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

## 2.16 FABRICATION

- B. Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Form flashing components from full single width sheet in minimum 10'-0" (3 m) sections. Provide mitered trim corners, joined using closed end pop rivets and butyl-based, solvent released one-part sealant.

- E. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
  - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
  - 2. Sealed Joints: Form nonexpanding but movable joints in metal to accommodate butyl-based sealant to comply with SMACNA standards.
  - 3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
  - 4. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA's "Architectural Sheet Metal Manual" or by metal wall panel manufacturer for application, but not less than thickness of metal being secured.

## 2.17 FINISHES

- B. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- C. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D. Prevent unpainted metals from contact with oils or solvents, including fingerprints, which may cause staining of the natural finishes.
- E. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast. Note that some variation is anticipated and acceptable when natural (unpainted) material finishes are specified.

## PART 3 - PREPERATION & EXECUTION

### 3.15 EXAMINATION

- B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of the Work.
- A. Examine primary and secondary wall framing to verify that girts, studs, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal wall panel manufacturer.
- B. Examine solid wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

- C. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.
- A. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.4 PREPARATION**

- A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
- B. Establish straight, side and crosswise benchmarks
- C. All walls shall be checked for square and straightness. Inside and outside corners may not be plumb; set a true line for the corner flashing with string line.
- D. Measure the wall lengthwise to confirm panel lengths and verify clearances for thermal movement.

### **3.5 METAL SUBFRAMING INSTALLATION**

- A. See also section 074800 Rainscreen Attachment system
- B. Install metal subframing directly over continuous thermal insulation. Metal subframing shall attach to the structural wall elements with screw fasteners. Metal subframing shall be spaced as necessary to accommodate the required clip spacing for the metal cladding panels.
- C. Attachments shall be as recommended by the metal claddings system manufacturer's approved shop drawings.

### **3.6 METAL WALL PANEL INSTALLATION**

- A. All details will be shown on in accordance with approved shop drawings and manufacturer's product data, within specified erection tolerances

- A. Directly over the completed wall substrate, fasten the top flange of the panel to the metal subframing using panel clips. All panels clips will be fastened into the metal subframing as indicated on the metal cladding panel manufacturer's approved shop drawings.
- B. Installation of Wall Panels: Wall panels can be installed by starting from one end and working towards the opposite end (vertical orientation), or from the bottom of wall working towards the top of the wall (horizontal orientation).
- C. Metal wall panels and trim must be installed only in accordance with the manufacturer's recommendation for acceptable temperature range.
- D. Isolate dissimilar metals and masonry or concrete from metals with bituminous coating. Use gasketed fasteners where required to prevent corrosive action between fastener, substrate, and panels.
- E. Limit exposed fasteners to extent indicated on contract drawings.
- F. Seal laps and joints in accordance with metal cladding panel system manufacturer's product data.
- G. Coordinate flashing and sheet metal work to provide weathertight conditions at wall terminations. Fabricate and install in accordance with standards of SMACNA Manual.
- H. Provide for temperature expansion/contraction movement of panels at wall penetrations and wall mounted equipment in accordance with system manufacturer's product data and design calculations.
- I. Installed system shall be true to line and plane and free of dents, and physical defects. In light gauge panels with wide flat surfaces, some oil canning may be present. Oil canning does not affect the finish or structural integrity of the panel and is therefore not cause for rejection.
- J. At joints in linear sheet metal items, other than metal cladding panels which are intended to provide ventilation, set sheet metal items in two 1/4-inch- (6-mm-) beads of butyl sealant. Extend sealant over all metal surfaces. Mate components for positive seal. Allow no sealant to migrate onto exposed surfaces.
- K. Remove damaged work and replace with new, undamaged components.
- L. Touch up exposed fasteners using paint furnished by the panel manufacturer and matching exposed panel surface finish.
- M. Clean exposed surfaces of wall panels and accessories after completion of installation. Leave in clean condition at date of substantial completion. Touch up minor abrasions and scratches in finish.

### **3.8 ERECTION TOLERANCES**

- A. Installation Tolerances: Shim and align metal wall panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) at location lines as indicated and within 1/16-inch (1.5-mm) offset of adjoining faces and of alignment of matching profiles.

**3.9 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect metal wall panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal wall panels where inspections indicate that they do not comply with specified requirements.
- C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

**3.11 CLEANING**

- A. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.
- B. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113

## SECTION 07 4800 - RAINSCREEN ATTACHMENT SYSTEM

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Provide a thermally broken, rainscreen attachment and subgirt system for attachment of exterior cladding installed over continuous exterior-insulation.
- B. Related Sections:
  - 1. Refer to Division 05 Section "Cold-formed metal Framing".
  - 2. Refer to Division 06 Section "Sheathing".
  - 3. Refer to Division 07 Section "Fluid Applied Air Barrier"
  - 4. Refer to Division 07 Section "Formed metal wall panel"
  - 5. Refer to Division 07 Section "Thermal Insulation" for exterior continuous insulation.

#### 1.2 SYSTEM DESCRIPTION

- A. System assembly shall include the following components from the substrate out:
  - 1. Substrate 1: Wall framing assembly and sheathing, and Substrate 2: Concrete masonry unit.
  - 2. Weather Resistant/Air Barrier over substrate.
  - 3. Continuous insulation.
  - 4. Thermally broken rainscreen attachment and subgirt system.
  - 5. Exterior cladding.
- B. Design Requirements:
  - 1. Manufacturer is responsible for designing system, including anchorage to structural system and necessary modifications to meet specified requirements and maintain visual design concepts.
  - 2. Employ registered professional engineer, licensed to practice engineering in jurisdiction where Project is located, to engineer each component of rainscreen attachment system.
  - 3. Structural Design: Exterior-insulated rainscreen wall assembly capable of withstanding effects of load and stresses from dead loads, wind loads, ice loads (if applicable) as indicated on Structural General Notes on Structural Drawings, and normal thermal movement without evidence of permanent defects of assemblies or components.
    - a. Thermal Movements: Provide assemblies that allow for thermal movements resulting from the following maximum ambient temperatures by preventing overstressing of components and other detrimental effects:

- 1) Temperature Change (range): 120 degrees Fahrenheit (67 degrees C), ambient:

C. Performance Requirements:

1. Rainscreen Attachment System Performance: Comply with ANSI/ASHRAE 90.1-2016 definition of continuous insulation (c.i.).
2. No thermal bridges other than fasteners and service openings.
3. Thermal Performance:
  - a. Full constructed assembly must have a minimum 95% EFFECTIVE R-value when compared to the exterior continuous insulations rated R-Value.
  - b. Continuous framing profiles (including C- or Z-shaped sections or furring) penetrating insulation not allowed except where specifically noted in details.
4. Structural Performance:
  - a. Wind Load Performance – Attachment system must show the following results when tested in accordance with ASTM E330-02.
    - 1) 90 pound per square foot negative and positive pressure held for 60 seconds, system components shall not experience failure or gross permanent distortion.
    - 2) 135 pound per square foot negative and positive pressure held for 10 seconds, system components shall not experience failure or gross permanent distortion.
  - b. Wind cycling (air pressure cycling) performance – Attachment system must show conformance to the following results when tested in accordance with ASTM E1886-05.
    - 1) A total of 4,500 air pressure cycles. Cycles must include 50 cycles at a maximum pressure of 90 pounds both positive and negative. Average cycle time must not be less than 3.25 seconds for both negative and positive cycles. Cladding weight supported during test must be a minimum of 11.5 pounds per square foot. No damage or deformation must be seen at end of test.
  - c. Gravity load (dead load) performance – Attachment system must demonstrate resistance to deflection under shear loading, applied parallel to the wall assembly and directly to the attachment system. Testing must be conducted using calibrated equipment by an IAS accredited third party laboratory. Deflection not to exceed 0.050 inches at 150 pounds per square foot.
5. Framing Members:
  - a. Test framing components to AAMA TIR- A8-[04] – Section 7.2 to determine structural performance and effective moment of inertia for each perforated component. Minimum Effective Moment of Inertia: 0.0066 in<sup>4</sup>.



- b. Localized bending stress for eccentrically loaded framing members must be evaluated with the maximum effective length of resisting element not more than 12 inches.
- 6. Fasteners:
  - a. Minimum Safety Factor of 3 for both tension and shear values
  - b. Combined tension and shear shall be evaluated according to an interaction formula. Sum of terms shall not exceed 1.0.

### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product literature and descriptions of testing performed on system components to indicate meeting or exceeding specified performance.
- B. Shop Drawings:
  - 1. Submit connection details to the cladding manufacturer, showing interface of rainscreen attachment system to substrate and panels with adjacent construction, signed and sealed by Professional Engineer.
  - 2. Show system installation and attachment, including fastener size and spacing.
  - 3. Show thru-wall flashings
- C. Structural Calculations:
  - 1. Submit rainscreen attachment manufacturer's comprehensive Structural Design analysis signed and sealed by a Professional Engineer.
- D. Samples: Submit following material samples for verification:
  - 1. Vertical Girts: 12-inch long sample
  - 2. Horizontal panelgirts: 12 inch long sample.
- E. Test Reports:
  - 1. Test to the following standards and provide written test reports by a third party:
    - a. AAMA TIR-A8-[04]: Structural Performance of Composite Thermal Barrier Framing Systems – Section 7.2
    - b. ASTM E330
    - c. ASTM E1233
    - d. Gravity load test report, performed by IAS accredited third party

### 1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
  - 1. Minimum 5 years' experience specializing in the manufacturing of façade attachment/support framing similar to those specified.
  - 2. Ability to demonstrate conformance to testing requirements.

- B. Installer Qualifications:
  - 1. Minimum of 3 years' documented experience or minimum of 5 completed projects of equivalent scope and quality and recommended by manufacturer to perform work of this Section.
  - 2. Onsite superintendent or foreman overseeing installation on site during entire work of this Section with experience equivalent to installer and in good standing with the manufacturer.
- C. Engineer Qualifications: Registered professional engineer experienced in the design of curtain wall systems, anchors, fasteners and licensed to practice engineering in the jurisdiction where Project is located.
- D. Pre-Installation Meeting:
  - 1. Discuss sequence and scheduling of work and interface with other trades.
  - 2. Review metal wall framing assemblies for potential interference and conflicts and coordinate layout and support provisions for interfacing work.
  - 3. Review and document methods, procedures and manufacturer's installation guidelines and safety procedures for exterior wall assembly.
- E. Mock-Ups: Coordinate mock-up materials and requirements with in-place mock-up as noted on exterior elevations to proceed full mobilization and installation.

## 1.5 QUALITY CONTROL

- A. Single source responsibility:
  - 1. Furnish engineered rainscreen attachment system components under direct responsibility of single manufacturer.
- B. Field Measurements: Verify actual supporting and adjoining construction before fabrication.
- C. Record field measurements on project record shop drawings.
- D. Established Dimensions: Where field measurements cannot be made without delaying work, guarantee dimensions and proceed with fabrication of rainscreen attachment system corresponding to established dimensions.

## 1.6 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver materials and components in manufacturers' original, unopened and undamaged containers or bundles, fully identified. Exercise care to avoid damage during unloading, storing and installation.
- B. Store, protect and handle materials and components in accordance with manufacturer recommendations to prevent damage, contamination and deterioration. Keep materials clean, dry, and free of dirt and other foreign matter, and protect from damage due to weather or construction activities.

## 1.7 SEQUENCING

- A. Ordering: Comply with manufacturers' ordering instructions and lead time requirements to avoid construction delays.
- B. Coordinate construction to ensure that assemblies fit properly to supporting and adjoining construction; coordinate schedule with construction in progress to avoid delaying work.

## 1.8 WARRANTY

- A. Manufacturer Warranties:
  - 1. Attachment System: Ten (10) year Limited Warranty.
    - a. Covers components of the attachment system, including structural failure of components when all the materials and components are supplied and installed per manufacturer's requirements.
    - b. Includes labor and material for removal and replacement of defective material.
    - c. Includes labor to remove and reinstall façade finish panels, finish closures and façade finish accessories necessary to access defective material.
- B. Contractor's Warranties: 2-year labor warranty, starting from Substantial Completion, to cover repair of materials found to be defective as a result of installation errors.
- C. Limitation of Warranties: Exclude repairs, replacement, and corrective work to the substrate, primary structure, finish panels, and/or property – unless otherwise noted above. Warranties exclude mechanical damage due to abuse, neglect, primary structure failure, or forces of nature greater than normal weather conditions.

## PART 2 - PRODUCTS

### 2.1 RIGID INSULATION

- A. Refer to Section 07 21 00 – Thermal Insulation.

### 2.2 RAINSCREEN ATTACHMENT/SUPPORT FRAMING SYSTEM

- A. Basis of Design: CI girt as manufactured by Knightwall systems
- B. Other Manufacturers:
  - 1. Imetco IntelliFrame
  - 2. Or Approved equal
- C. Comply with ANSI/ASHRAE 90.1-2016 definition of continuous insulation (c.i.).
- D. Coating Material: ASTM A1046, Zinc-Aluminum-Magnesium, minimum thickness ZM40 or approved equal.
- E. Steel Classification: Structural Steel (SS), Grade 50, 50 ksi Yield.
- F. Spacing: Comply with manufacturer's Professional Engineers calculations but not spaced more the following:

1. Vertical installation of girts: 16" o.c. max
  2. Horizontal installation of girts: 24" o.c. max.
- G. Girt: girt with pre-punched attachment holes, directly attached on top of rigid insulation at regular spacing, with engineered thermally isolated washer assembly and fasteners.
1. Steel Thickness: Minimum 0.046-inch thick (18 gauge).
  2. Profile Depth: 0.75 inches.
  3. Girt Fastening Face, Width: 2-inches.
- H. Thermally isolated Z-furring: Provide where indicated on drawing only. Thru-insulation z-girts are not acceptable at all locations
1. Steel thickness: minimum 0.046-inch thick (18 gauge)
  2. Depth: 1.5 inches
  3. Profile: perforated Z-furring with thermal isolation pad and washers
  4. Furring fastening face width: 1-5/8"
  5. Basis of design: ThermaZee by knightwall
    - a. Or approved equal
- I. Fasteners:
1. Sufficient length to provide solid attachment through rigid insulation to structure as required by manufacturer.
  2. Thermal Isolating Washers: Minimum 0.125 inch thick Polyoxymethylene copolymer (POM) washers with integral centering lip to act as a thermal break between wall anchor fasteners and girt.
    - a. Tensile Yield Strength: 9.57 ksi per ISO 527
    - b. Melting Temperature: 329 degrees Fahrenheit per ISO 3146
    - c. Basis of Design: ThermaStop™ Isolator by Knight Wall Systems.
      - 1) Or approved equal.
  3. Steel stud framing substrate: Self-drill hex-washer-head stainless steel with 1,000 hour salt-spray rated thermoset polyester coating.
    - a. Embedment depth: 0.625 inches or three full threads minimum, whichever is greater.
    - b. Minimum ultimate pull-out capacity from 18 gauge steel: 450 pounds.
  4. Concrete masonry units substrate:
    - a. Embedment depth: 1.25 inches minimum.
    - b. Minimum ultimate pull-out capacity from substrate material: 450 pounds.
      - 1) 1/4 inch Kwik-Con II+ by Hilti

- 2) 1/4 inch Tapcon by Buildex
- 3) 1/4 inch UltraCon by Elco Industries
- 4) Or approved equal.

J. Accessories:

1. Galvanic Protection: Utilize tapes and other methods as necessary to separate and prevent contact between dissimilar metals.

## 2.3 SIDING/CLADDING PANEL

- A. Refer to Division 07 Section "Formed metal wall panels"

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with manufacturer requirements for installation conditions affecting performance of the work.
1. Do not proceed with installation until unsatisfactory conditions have been corrected.
  2. Ensure weather-resistant barrier (WRB) and rigid insulation is installed prior to installing rainscreen attachment system.
  3. Ensure fenestration, transitions, discontinuities, sills, and ledgers are flashed and sealed to move moisture to the exterior of the building.
- B. Field verify architectural details and mechanical and electrical requirements prior to commencing installation.
- C. Commencement of installation constitutes acceptance of existing conditions and acceptance of responsibility for satisfactory performance.

### 3.2 RAINSCREEN ATTACHMENT SYSTEM INSTALLATION

- A. Preparation:
1. Verify vertical girt does not cantilever past rigid insulation.
- B. Installation
1. Install girts in vertical or horizontal orientation in strict accordance with manufacturer's installation instructions.
  2. Do not use shims to plumb the wall between the vertical girt and insulation.
  3. Minimum length of installed cut girt is 24-inches and shall be attached with at least two (2) fasteners.

4. Mount box girts, fastened up to 16 inches on center over installed rigid insulation, using one wall anchor per pre-punched attachment hole at spacing indicated on engineering calculations.
  - a. Check plumb of vertical girts both parallel and perpendicular to the structure.
  - b. Tighten screws that attach vertical girt through insulation to substructure to a snug tight condition and not stripped. Do not over-torque beyond manufacturer's recommendation. If installed using hand tools, verify for each installer at beginning of project using snug-tight criteria. Do not use stripped holes.
  - c. Where obstructions are present and unavoidable (i.e. window openings), use laser or chalk line to restart girt.
  - d. Locate vertical girt at jamb conditions and outside corner conditions.
  - e. Use shearing instruments (i.e. snips, nibbler, etc.) for cutting metal framing components. Saws are not recommended, as the sparks produced during cutting will damage the anti-corrosion coating. If sparks are generated during cutting, be sure the portion of the component to be installed on the building is protected from sparks and that any stockpile near the cutting station is also protected.
  - f. The systems components should not be cut while installed on the building, unless using a shearing instrument.
  - g. Replace thermal isolator pieces that break during installation.
  - h. Provide a 3/8" – 1/2" gap between girts for expansion when multiple lengths of vertical girts are installed.

END OF SECTION 07 48 00

## SECTION 07 5400 PVC THERMOPLASTIC SINGLE-PLY ROOFING

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Fully adhered PVC thermoplastic single-ply roofing system.
- B. Roof insulation.
- C. Coverboard
- D. Flashing accessories.
- E. Edgings and terminations.
- F. Walkways
- G. Snow guards attached directly to roof deck

#### 1.2 REFERENCES

- A. American Society of Civil Engineers (ASCE) - ASCE 7 - Minimum Design Loads for Buildings and Other Structures, Current Revision.
- B. Factory Mutual (FM Global):
  - 1. Approval Guide.
    - a. Factory Mutual Standard 4470 - Approval Standard for Class 1 Roof Covers.
    - b. Loss Prevention Data Sheets 1-28, 1-29.
- C. International Code Council (ICC):
  - 1. International Building Code (IBC).
- D. National Roofing Contractors Association (NRCA) - Low Slope Roofing and Waterproofing Manual, Current Edition.
- E. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) - Architectural Sheet Metal Manual.
- F. Underwriters Laboratories (UL):
  - 1. TGFU R1306 - "Roofing Systems and Materials Guide".
  - 2. UL-790 - Standard Test Method for Fire Tests of Roof Coverings.

#### 1.3 DESIGN CRITERIA

- A. FM Approved assemblies required
- B. Wind Uplift Performance:
  - 1. Roof system is designed to withstand wind uplift forces as calculated using the current revision of ASCE-7. – Zone 1 (-42.3 psf), Zone 2 (-71 psf), Zone 3 (-106.9 psf)
  - 2. Roof system is designed to achieve a minimum FM 1-90 wind uplift rating with prescriptive enhancements at corners and perimeter
  - 3. Safety Factor Requirement: 2.0

- A) Steel Deck - FM Roof NAV # 387334-0-0
- B) Concrete Deck – FM Roof NAV # 364511-0-0 (FM 1-315 Rating)
- C. Fire Resistance Performance:
  - 1. Roof system will achieve a UL Class A rating when tested in accordance with UL-790.
- D. Thermal Performance: Roof system will achieve a minimum R value not less than 30.
- E. Drainage: Provide a roof system with positive drainage where all standing water dissipates within 48 hours after precipitation ends.
- F. Building Codes:
  - 1. Roof system will meet the requirements of all federal, state and local code bodies having jurisdiction.

#### 1.4 SUBMITTALS

- A. Submit under provisions of Section 01 30 00.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- C. Samples: For each finish product specified, two samples, minimum size 4 inches square representing actual product, color, and patterns.
- D. Manufacturer Assembly Letter: stating all components of each roof assembly including the fastening/adhesive spacing of each.
  - 1. Letter shall confirm warranty provided by submitted assembly, uplift criteria met, and state FM assembly number.
- E. Snow guard manufacturer installation instructions and written recommended layout and spacing
- F. Completed form FM GLOBAL FORM X2688 Checklist for roofing system.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of twenty (20) years experience.
- B. Installer Qualifications:
  - 1. All products listed in this section are to be installed by a single installer with a minimum of five (5) years demonstrated experience in installing products of the same type and scope as specified.
  - 2. Installer shall be capable of extending the Manufacturer's Labor and Materials guarantee.
  - 3. Installer shall be capable of extending the Manufacturer's No Dollar Limit guarantee.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of local authorities having jurisdiction.



## 1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

## 1.8 WARRANTY

- A. At project closeout, provide to Owner or Owners Representative an executed copy of the manufacturer's Total System warranty, outlining its terms, conditions, and exclusions from coverage.
  - 1. Duration: 30 Years, 72 mph Edge to Edge Warranty
  - 2. Coverage to be extended to include roof edge metal water tightness in accordance with terms stated in the Warranty document.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis of Design Manufacturer:
  - 1. Carlisle SynTec Systems
- B. Other Manufacturers:
  - 1. Versico
  - 2. Sika Corporation
  - 3. Or approved equal

### 2.2 SCOPE / APPLICATION

- A. Roof System: Provide a waterproof roof system, capable of withstanding uplift forces as specified in this section.
  - 1. Membrane Attachment: Fully Adhered.
- B. Base Flashing: Provide a waterproof, fully adhered base flashing system at all penetrations, plane transitions and terminations.
- C. Insulation: Provide a roof insulation system beneath the finish membrane.
- D. Parapet insulation: Provide nailable composite osb insulation at parapet walls and where indicated on drawings

### 2.3 MEMBRANE ATTACHMENT: FULLY ADHERED

- A. Sure-Flex PVC KEE HP Membrane as manufactured by Carlisle SynTec Systems or approved equal as part of a tested assembly:
  - 1. Membrane consists of polyester fabric that is encapsulated between the monolithically formed PVC KEE HP based top and bottom plies. PVC membrane enhanced with KEE HP/ High Performance Elvaloy copolymer (Elvaloy(r) KEE-Ketone Ethylene Ester) provides enhanced chemical resistance, heat resistance, UV resistance and long-term weldability.
  - 2. Color: White.
  - 3. Membrane Thickness: 80 mil nominal.
    - a. Thickness over Scrim (ASTM D 4434): 0.036 inches (0.91 mm) minimum.
    - b. Breaking Strength (ASTM D 751): 330 lbf/in (58kN/m) minimum.
    - c. Tearing Strength (ASTM D 751): 150 lbf (667 N) minimum.
    - d. Elongation (ASTM D 751): 30 percent.
    - e. Field Sheet Width: 120 inches (3048 mm) maximum.

- f. Length: 75 feet (22.86 m) maximum.

## **2.4 INSULATION**

- A. Polyisocyanurate: A foam core insulation board covered on both sides with glass fiber reinforced facer (GRF) meeting ASTM C 1289, Type II, Class 1. Carlisle InsulBase or approved equal.
  - 1. Compressive Strength: Grade 2 (20 psi) .

## **2.5 COVERBOARD & SUBSTRATE PROTECTION BOARD**

- A. Moisture-, mold- and impact-resistant, nonstructural fiber-reinforced gypsum panel made from 95 percent recycled materials. Securock or approved equal
  - 1. Board Thickness: 1/2 inch (13 mm).

## **2.6 MEMBRANE BASE SHEET VAPOR BARRIER**

- A. VapAir 725TR Air & Vapor Barrier/Temporary Roof or approved equal as part of tested assembly: 40mil composite consisting of 35mils self-adhereing rubberized asphalt laminated to a 5-mil woven polypropylene film. See manufacturer installation requirements.

## **2.7 INSULATION ADHESIVE**

- A. Flexible FAST Adhesive or approved equal: A spray or extruded applied, two-component polyurethane, low-rise expanding foam adhesive used for attaching approved insulations to compatible substrates (concrete, cellular lightweight insulating concrete, gypsum, cementitious wood fiber, wood or steel) or existing smooth or gravel surfaced BUR, modified bitumen or cap sheets.
- B. Flexible FAST Dual Tank Adhesive or approved equal: A two-component, polyurethane construction grade, low-rise expanding adhesive designed for bonding insulation to various substrates using a portable applicator.

## **2.8 NAILABLE COMPOSITE OSB INSULATION**

- A. StormBase or approved equal: rigid insulation composite panel composed of closed-cell polyisocyanurate foam core bonded during the manufacturing process directly to 7/16" oriented strand board (OSB)
  - 1. ATSM C1289, type V
  - 2. APA-TECO-rated exposure 1 oriented strand board one face
  - 3. Provide where indicated: Thickness: 1.5inch, LTTR = 6.3
  - 4. Provide where indicated: Thickness 3inches, LTTER = 15.0

## **2.9 FLASHING ACCESSORIES**

- A. Roof Manufacturer's PVC Inside Corners: Pre-molded corner flashing for inside corners. 60 mil thickness.
  - 1. Color: White.
- B. Roof Manufacturer's PVC Outside Corners: Pre-molded corner flashing for outside corners. 60 mil thickness.
  - 1. Color: White.
- C. Roof Manufacturer's PVC T-Joint Covers: 60 mil thick non-reinforced PVC flashing cut into a 4.5 inch (114 mm) diameter circle used to seal step-offs at splice intersections.
  - 1. Color: White.

- D. Roof Manufacturer's PVC Molded Pipe Flashings: A pre-molded flashing and clamping ring used for pipe penetrations. Available for 3/4 inch to 8 inch (19 to 203 mm) diameter pipes.
- E. Roof Manufacturer's PVC Split Pipe Seals: Pre-fabricated flashing consisting of 60 mil thick reinforced Sure-Flex Membrane for pipes 1 inch to 6 inch (25 to 152 mm) in diameter. A split (cut) and overlap tab are incorporated to allow the pipe seal to be opened and wrapped around the pipe when it is not possible to pull a standard pipe flashing over a round penetration.
- F. Roof Manufacturer's PVC Square Tubing Wraps: Fabricated flashings made of 60 mil thick reinforced Sure-Flex membrane for square tubing. A split (cut) and overlap tab are incorporated into these parts to allow the seals to be opened and wrapped around a square penetration. Available for 3 inches, 4 inches and 6 inches (76, 102, 152 mm) diameter square tubing. Available in white or gray.
- G. Roof Manufacturer's PVC Molded Sealant Pockets:
  - 1. Pre-fabricated, interlocking, 2-piece, injection molded, flexible pocket with a semi rigid PVC vertical wall and pre-formed deck flanges.
  - 2. Use in conjunction with Thermoplastic One-Part Pourable Sealer as specified in this section for waterproofing pipe clusters or other odd shaped penetrations. Forms a 7-1/2 inches by 6 inches (191 x 152 mm) oval when completed. Available in white only.
- H. Roof Manufacturer's PVC Heat Weldable Walkway Rolls: Membrane offering superior tear, puncture and weather resistance and designed to protect membrane in those areas exposed to repetitive foot traffic or other hazards. Walkway material may be heat welded to membrane using an automated heat welder or hand held heat welder. Walkway Rolls are 36 inches (914 mm) wide by 60 feet (18.3 M) long and are nominal 110 mils thick. Color - Gray.
- I. Roof Manufacturer's PVC Non-Reinforced Flashing: 60 mil thick rolls 12 inches (305 mm) and 24 inches (610 mm) wide. Used for inside/outside corners and field fabricated pipe flashings when use of pre-molded accessories is not feasible. Available in white, gray, light gray, slate gray and tan.

## **2.10 CLEANERS, PRIMERS, ADHESIVES AND SEALANTS**

- A. Low VOC PVC Bonding Adhesive: A high-strength solvent based adhesive that allows bonding of PVC and KEE-enhanced PVC membrane to various porous and non-porous substrates.
- B. Flexible FAST Adhesive or approved equal: A two-component (Part A and B), spray applied, low-rise adhesive for bonding FleeceBACK membrane to various surfaces.
- C. Flexible FAST Dual Tank Adhesive or approved equal: A two component (Part A and B), extrusion applied, low rise adhesive for bonding FleeceBACK membrane and insulation to various surfaces.
- D. Water Cut-Off Mastic: A one-component, low viscosity, self wetting, Butyl blend mastic used as a compression sealing agent between membrane and applicable substrates.
- E. Universal Single-Ply Sealant: A 100 percent solids, solvent free, one-part polyether sealant that is used as a termination bar sealant. Available in white only.
- F. PVC and KEE HP Membrane Cleaner: Clear, solvent-based cleaner used to loosen and remove contaminants from the surface of exposed membrane.

## **2.11 FASTENERS**

- A. HP-X Fastener or approved equal: A heavy duty #15 threaded fastener with a #3 Phillips drive used with Carlisle's Piranha Fastening Plate to secure Mechanically Fastened Roofing Systems. It is used on minimum 22 gauge steel decks or minimum 15/32 inch (12 mm) CDX plywood decks. It is also designed to offer an optimum combination of driving performance, back-out and corrosion resistance with excellent pullout performance.
- B. InsulFast Fasteners or approved equal : A threaded Phillips drive fastener used with Carlisle Insulation Plates for insulation attachment to steel or wood decks.
- C. Piranha Plate or approved equal: A 2-3/8 inches (60 mm) diameter metal barbed fastening plate used with Carlisle HP-X, CD-10 or HD 14-10 Fasteners for membrane or insulation securement. This plate can be used for membrane or insulation securement on Mechanically Fastened Roofing Systems.
- D. Insulation Fastening Plate: A nominal 3 inches (76 mm) metal plate used for insulation attachment in conjunction with the appropriate Carlisle Fastener.

## 2.12 EDGINGS AND TERMINATIONS

- A. SecurEdge 2000 or approved equal: An anchor bar roof edge fascia system consisting of 0.100 inch (2.5 mm) thick extruded aluminum bar, corrosion resistant stainless steel fasteners and snap-on fascia cover.
  - 1. Profiles: provide standard fascia and drip edge fascia as indicated on the drawings with associated gutters and leaders.
  - 2. Minimum .040 aluminum thickness.
  - 3. Face dimension: as indicated on the drawings but not less than 5-1/2"
  - 4. Provide accessories as required including miters
  - 5. See specification 076200 sheet metal flashing and trim for gutters and leader requirements
- B. SecurEdge 200 Coping or approved equal: An anchor cleat with pre-slotted holes, a concealed joint cover, and 10 or 12 foot sections of coping cap. Kynar 500 finish as noted on the Finish Schedule of the Contract Drawings.
  - 1. Provide welded accessories at corners and T-intersections
  - 2. Minim .050 aluminum thickness
  - 3. Face Dimension: as shown on drawings but not less than 6" at outside face and 4" at inside face

## 2.13 ROOF GUARDS

- A. Fence style snow and ice guard manufactured by Alpine snowguards PP115 or approved equal attached directly to the roof deck. System shall be approved by roofing membrane manufacturer and not impact or prevent warranty.
  - 1. Components:
    - a. milled aluminum bracket with 2 fastener holes to accept a 5/16" minum base stud and holes in flag to accept 2 continuous horizontal pipes.
    - b. Base plate shall be 8"x8" minimum stainless steel with furrule tubes designed to fit into insulation to be fastened to metal decking.
    - c. Target patch flashing of same material and manufacturer as roofing membrane in size acceptable to roofing manufacturer to meet warranty but not less than 12"x12"
    - d. Pipes fabricated from and couples fabricated from aluminum with internal couples, end caps and end collars
    - e. Ice flags between each bracket to prevent ice and snow from sliding underneath the pipe.
  - 2. Design requirements:

- a. Spacing to be as recommended by manufacturer but not less than 24 inches on center
  - b. Minimum 6 fasteners per snow guard base plate
- 3. Materials:
  - a. Snow Guard Bracket - 6000 Series Aluminum.
  - b. Base Plate – 11-gauge 304 stainless steel with two 5/16" 304 stainless steel machine screws welded into countersinks.
  - c. Pipes: Aluminum – 6000 Series, 1" outside diameter and .120" wall thickness, extruded.
  - d. Couplings: Aluminum – 6000 Series, Internal and concealed coupling 3" long.
  - e. End Caps: 304 Stainless Steel
  - f. End Collars: 6000 Series Aluminum
  - g. Ferrules – 6000 Series Aluminum 1" O.D, .120" wall thickness x 24" long. Cut to length on site.
  - h. Ice Flags: 6000 Series Aluminum 3" wide x length as recommended by manufacturer.
  - i. Fasteners to be compatible with chosen roof application and meet specified pull-out values as shown in load test data.
- 4. FINISH
  - a. Powder Coated selected from manufacturers full range

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Do not commence Work until all other work trades have completed jobs that require them to traverse the deck on foot or with equipment.
- D. A vapor retarder / temporary roof (Carlisle VapAir Seal725 TR Air & Vapor Barrier/Temporary Roof or approved equal as part of tested assembly) to be applied to protect the inside of the structure prior to the roof system installation.

### 3.3 SUBSTRATE PREPARATION

- A. Structural Concrete Deck:
  - 1. Minimum deck thickness for structural concrete is 4 inches (102 mm).
  - 2. Allow roof deck to cure prior to application of the roofing system. Where curing is in question, evaluate surface moisture and deck's dryness with the ASTM D 4263 or hot bitumen test procedures.
  - 3. Repair cracks greater than 1/8 inch (3 mm) in width in accordance with the deck manufacturer's recommendations.
  - 4. Sumps for the roof drains shall be provided in the casting of the deck.
  - 5. Where insulation is to be adhered with hot asphalt, prime the deck with

asphalt/concrete primer, ASTM D 41 at the rate of one gallon per 100 square feet (0.4 l/sm). Allow the primer to dry prior to the application of the roofing system.

- B. Steel Deck:
  - 1. Metal decks shall be a minimum uncoated thickness of 22 gauge and have a G-90 galvanized finish on all panels.
  - 2. Decks must comply with the gauge and span requirements in the current Factory Mutual Approval Guide and be installed in accordance with Loss Prevention Data Sheet 1-28 or specific FM approval.
  - 3. Remove any surface corrosion and repair severely corroded areas. Properly fasten loose or inadequately secured decking.

### 3.4 INSULATION - SYSTEM DESIGN

- A. Base Layer:
  - 1. Type: INSULBASE INSULATION or approved equal as part of a tested system
  - 2. Thickness: 2.6 inches
  - 3. Attachment Method: ADHERED
- B. Top Layer:
  - Type: INSULBASE INSULATION or approved equal as part of a tested system
  - 1. Thickness: 2.6 inches
  - 2. Attachment Method: ADHERED
- C. Crickets:
  - 1. Type: INSULBASE TAPERED INSULATION or approved equal as part of a tested system
  - 2. Slope: ½" per foot
  - 3. Attachment Method: Adhered
- D. Coverboard:
  - 1. Type: Securock Gypsum Fiber Roof Board
  - 2. Thickness: 1/2 inch
  - 3. Attachment Method: ADHERED

### 3.5 INSULATION PLACEMENT

- A. Install insulation or membrane underlayment over the substrate with boards butted tightly together with no joints or gaps greater than 1/4 inch (6 mm). Stagger joints both horizontally and vertically if multiple layers are provided.
- B. Secure insulation to the substrate with the required mechanical fasteners or insulation adhesive in accordance with the manufacturer's current application guidelines.
- C. Do not install wet, damaged or warped insulation boards.
- D. Stagger joints in one direction unless joints are to be taped. Install insulation boards snug. Gaps between board joints shall not exceed 1/4 inch (6 mm). Fill all gaps in excess of 1/4 inch (6 mm) with same insulation material.
- E. Wood nailers must be at least 3 1/2 inches (89 mm) wide or 1 inch (25 mm) wider than adjacent metal flange. Thickness must equal that of insulation but not less than 1 inch (25 mm) thickness.
- F. Miter and fill the edges of the insulation boards at ridges, valleys and other changes in plane to prevent open joints or irregular surfaces. Avoid breaking or crushing of the insulation at the corners.

- G. Do not install any more insulation than will be completely waterproofed each day.

### **3.6 INSULATION ATTACHMENT**

- A. Securely attach insulation to the roof deck for Adhered or Mechanically Fastened Roofing Systems. Attachment must have been successfully tested to meet or exceed the calculated uplift pressure required by the International Building Code (ASCE-7) or ANSI/SPRI WD-1.
- B. Enhance the perimeter and corner areas in accordance with the International Building Code (ASCE-7) or ANSI/SPRI WD-1.
- C. Install insulation layers, maximum 4 feet by 4 feet (1220 mm by 1220 mm), applied with FAST adhesive, or a maximum 4 feet by 8 feet (1220 mm by 2438 mm), applied with Flexible FAST Adhesive, coverage rate as necessary to achieve the specified attachment and uplift rating. Press each board firmly into place after adhesive develops strings when touched, typically 1-1/2 to 2 minutes after adhesive was applied, and roll with a weighted roller. Add temporary weight and use relief cuts to ensure boards are well adhered. Stagger the joints of additional layers by a minimum of 6 inches (152 mm).

### **3.7 MEMBRANE PLACEMENT AND ATTACHMENT (Fully Adhered)**

- A. Position Sure-Flex membrane over the acceptable substrate. Fold membrane sheet back lengthwise so half the underside of the membrane is exposed.
- B. Apply Sure-Flex Bonding Adhesive in accordance with the manufacturer's published instructions, to the exposed underside of the membrane and the corresponding substrate area. Do not apply Bonding Adhesive along the splice edge of the membrane to be hot air welded over the adjoining sheet. Allow the adhesive to dry until it is tacky but will not string or stick to a dry finger touch.
  - 1. Roll the coated membrane into the coated substrate while avoiding wrinkles. Brush down the bonded section of the membrane sheet immediately after rolling the membrane into the adhesive with a soft bristle push broom to achieve maximum contact.
  - 2. Fold back the unbonded half of the sheet lengthwise and repeat the bonding procedures.
- C. Position adjoining sheets to allow a minimum overlap of 2 inches (51 mm).
- D. Hot-air weld the Sure-Flex membrane sheets using the Automatic Hot Air Welding Machine or Hot Air Hand Welder in accordance with the manufacturer's hot air welding procedures.
- E. Continue to install adjoining membrane sheets in the same manner, overlapping edges a minimum of 2 inches (51 mm) and complete the bonding procedures as stated previously.

### **3.8 SEAM WELDING**

- A. Hot-air weld membrane using an Automatic Hot Air Welding Machine or Hot Air Hand Welder in accordance with the manufacturer's current guidelines. At all splice intersections, roll the seam with a silicone roller to ensure a continuous hot air welded seam.
- B. Overlay all splice intersections with Sure-Flex T-Joint Covers.
- C. Probe all seams once the hot air welds have thoroughly cooled (approximately 30 minutes).
- D. Repair all seam deficiencies the same day they are discovered.
- E. Apply Cut Edge Sealant on all cut edges of reinforced membrane (where the scrim

reinforcement is exposed) after seam probing is complete. Cut Edge Sealant is not required but recommended on flat surfaces and is not required on vertical splices.

### **3.9 FLASHING**

- A. Flashing of parapets, curbs, expansion joints and other parts of the roof must be performed using Sure-Flex reinforced membrane. Sure-Flex non-reinforced membrane may be used for flashing pipe penetrations, Sealant Pockets, and scuppers, as well as inside and outside corners, when the use of pre-molded accessories is not feasible.
- B. Follow manufacturer's typical flashing procedures for all wall, curb, and penetration flashing including metal edging/coping and roof drain applications.

### **3.10 DAILY SEALS**

- A. On phased roofing, when the completion of flashings and terminations is not achieved by the end of the work day, a daily seal must be performed to temporarily close the membrane to prevent water infiltration.
- B. Complete an acceptable membrane seal in accordance with the manufacturer's requirements.

### **3.11 WALK WAYS**

- A. Position walkways and cut into maximum 10ft segments and position with minimum 1" gap between adjacent pieces to allow for water drainage. Walkways are to be installed perpendicular to field splices and provide minimum 4 to 6" gap at field splices.
- B. Weld all four sides with automatic heat welder to membrane.

### **3.12 SNOW GUARDS:**

- A. Inspect structure on which snow guard system is to be installed and verify it will withstand any additional loading that it may incur. Notify Architect of any deficiencies before installing snow guards
- B. Verify roofing material has been installed correctly prior to installing snow guards.
- C. Comply with architectural drawings and snow guard manufacturer's recommendations for location of system. Comply with manufacturer's written installation instructions for installation and layout.

### **3.13 CLEAN UP**

- A. Perform daily clean-up to collect all wrappings, empty containers, paper, and other debris from the project site. Upon completion, all debris must be disposed of in a legally acceptable manner.
- B. Prior to the manufacturer's inspection for warranty, the applicator must perform a pre-inspection to review all work and to verify all flashing has been completed as well as the application of all caulking.

### **3.14 PROTECTION**

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.





## CHECKLIST FOR ROOFING SYSTEM

FM Global Clients: submit completed form and completed RoofNav Contractor Package to local FM Global field office for review.

<b>CONTACT INFORMATION:</b>		<b>FM GLOBAL INDEX NUMBER:</b>	
ROOFING CONTRACTOR (NAME, ADDRESS, PROJECT NO.)		TELEPHONE NO.:	CONTACT:
		E-MAIL ADDRESS:	FAX:
CLIENT SITE (NAME & ADDRESS)		TELEPHONE NO.:	CONTACT:
		E-MAIL ADDRESS:	FAX:

### OVERVIEW OF WORK: (Submit 1 form per roof area)

Building Name & Number (provide building diagram as appropriate):			
Type of Work:	<input type="checkbox"/> New Construction <input type="checkbox"/> Recover (New roof over existing Roofing System) <input type="checkbox"/> Reroof (New cover/remove existing roofing system to deck) <input type="checkbox"/> Other (describe)		
Building Dimensions: Length:	ft/m:	Width:	ft/m:
Roof Slope:	in. per ft. / degrees		
Parapet Height, max (in./m):	Parapet Height, min (in./m): (enter "0" if not always present)		
Roof Zone Width/Dimension*:			
Zone 1':	Zone 1:	Zone 2:	Zone 3:
FM Approved RoofNav Assembly Numbers (provide Assembly Number for individual roof zones as appropriate):			

\*Refer to FM Global Property Loss Prevention Data Sheet 1-28, *Wind Design* or RoofNav for determination of various zone dimensions.

### ROOF SURFACING:

<input type="checkbox"/> None			
<input type="checkbox"/> Coating (Trade Name/Application Rate)			
<input type="checkbox"/> Granules (Application Rate)			
<input type="checkbox"/> Gravel/Slag (Application Rate)			
<input type="checkbox"/> Ballast: <input type="checkbox"/> Stone Size <input type="checkbox"/> Pavers (Beveled, strapped or square edge); <input type="checkbox"/> Other:			
Ballast Weight (psf):	Zone 1':	Zone 2:	Zone 3:
Additional Detail:			

### ROOF COVER / MEMBRANE:

(Provide ALL applicable details including trade name, type, number of plies, thickness, reinforced, adhesive, etc.)

Roof Cover: Trade Name:			
Hail Rating Provided:			
<input type="checkbox"/> Single Ply: <input type="checkbox"/> Reinforced <input type="checkbox"/> Unreinforced <input type="checkbox"/> Adhered <input type="checkbox"/> Fastened <input type="checkbox"/> Ballasted			
<input type="checkbox"/> Multi-Ply <input type="checkbox"/> Built Up Roofing (BUR) <input type="checkbox"/> Modified Bitumen			
Number of Plies:			
<input type="checkbox"/> Lap Width in/mm <input type="checkbox"/> Lap Adhesion Type			
<input type="checkbox"/> Panel: <input type="checkbox"/> Through Fastened Metal <input type="checkbox"/> Standing Seam metal <input type="checkbox"/> Steel <input type="checkbox"/> Aluminum <input type="checkbox"/> Copper    Thickness:			
Rib Spacing:    Clip Model: <input type="checkbox"/> 1-Piece <input type="checkbox"/> 2-Piece			
<input type="checkbox"/> Insulated Metal Panel Roof: Bottom facer: Metal type:    Thickness:			
Top facer: Material:    Thickness:			
<input type="checkbox"/> Fiber Reinforced Plastic (FRP)			
<input type="checkbox"/> Other:			
<input type="checkbox"/> Spray Applied <input type="checkbox"/> Other:			
Additional Detail:			
<input type="checkbox"/> Asphalt Shingles <input type="checkbox"/> Metal Shingles: Manufacturer:    Model: <input type="checkbox"/> Ring Shank Nails			
<input type="checkbox"/> Smooth Shank Nails <input type="checkbox"/> Screws    Size    Number per shingle:			
<input type="checkbox"/> Concrete Tile <input type="checkbox"/> Clay Tile: Manufacturer    Model: <input type="checkbox"/> Ring Shank Nails			
<input type="checkbox"/> Smooth Shank Nails <input type="checkbox"/> Screws    Size    Number <input type="checkbox"/> Mortar or urethane at lower end of tile			
<input type="checkbox"/> Only mortar or urethane adhesive at top and bottom (No fasteners)			
<input type="checkbox"/> Slate tile: Width:    Thickness    Length of reveal: <input type="checkbox"/> Ring Shanks Nails <input type="checkbox"/> Smooth Shank Nails			
Number per tile:			
<input type="checkbox"/> Self-Adhering modified bitumen underlayment Trade Name:			



## CHECKLIST FOR ROOFING SYSTEM

### ROOF COVER / MEMBRANE SECUREMENT:

Roof Cover Fasteners: Trade Name:	Length:	Diameter/No.:
Stress Plate/Batten: Trade Name:	Size:	
Row Spacing: Zone 1':	Zone 1:	Zone 2: Zone 3:
Fastener Spacing: Zone 1':	Zone 1:	Zone 2: Zone 3:
Bonding Adhesive: Trade Name:		
Adhesive Ribbon Width (in.):		
Adhesive Ribbon Spacing (in.): Zone 1':	Zone 1:	Zone 2: Zone 3:
Adhesive Application Rate (gal./sq.):		
Additional Detail:		
See DS 1-49 for additional securement for all ballasted, or mechanically fastened or ribbon adhered roof covers if the roof cover is not secured within 12 in. (300 mm) of the outside edge of the nailer.		

### INSULATION / COVER BOARD:

Layer	Insulation / Cover Board Trade Name	Board Dimensions (ft. x. ft.)	Thickness (in.)	Fastened	Adhered	Tapered
1. Top		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Next		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Next		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Next		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Thermal Barrier		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Glass Fiber/Mineral Wool/Batt <input type="checkbox"/> Facer Type/Vapor Barrier						
<input type="checkbox"/> Other:						
<input type="checkbox"/> None						
Additional Detail:						

### INSULATION / COVER BOARD SECUREMENT:

Insulation / Cover Board Fasteners: Trade Name:	Type:	Size:
Stress Plate: Trade Name:	Size:	
Fastener Spacing: Zone 1':	Zone 1:	Zone 2: Zone 3:
Bonding Adhesive: Trade Name:		
Adhesive Ribbon Width (in.):		
Adhesive Ribbon Spacing (in.): Zone 1':	Zone 1:	Zone 2: Zone 3:
Adhesive Application Rate (gal./sq.):		
Additional Detail:		

### BASE SHEET: (Include Trade Name, Type, and Width)

<input type="checkbox"/> None	
Trade Name:	Width: <input type="checkbox"/> 36 in. <input type="checkbox"/> 1 meter (39 in.)
<input type="checkbox"/> Fastened	<input type="checkbox"/> Adhered
<input type="checkbox"/> Lap Width in/mm	<input type="checkbox"/> Lap Adhesion Type
<input type="checkbox"/> Air Retarder	<input type="checkbox"/> Vapor Retarder
Additional Detail:	

### BASE SHEET SECUREMENT:

Base Sheet Adhesive Name:	Adhesive Application Rate:
Base Sheet Fastener Trade Name:	Type:
Head Diameter:	Length:
Spacing: (Attached Sketches as necessary)	
Spacing Along Laps: Zone 1':	Zone 1: Zone 2: Zone 3:
No. Intermediate Rows: Zone 1':	Zone 1: Zone 2: Zone 3:
Spacing Along Intermediate Rows: Zone 1':	Zone 1: Zone 2: Zone 3:
Additional Detail:	



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	E-MAIL ADDRESS:	FAX:	
CLIENT SITE (NAME & ADDRESS)	TELEPHONE NO.:	CONTACT:	
	E-MAIL ADDRESS:	FAX:	

### OVERVIEW OF WORK: (Submit 1 form per roof area)

Building Name & Number (provide building diagram as appropriate):			
Type of Work:	<input type="checkbox"/> New Construction <input type="checkbox"/> Recover (New roof over existing Roofing System) <input type="checkbox"/> Reroof (New cover/remove existing roofing system to deck) <input type="checkbox"/> Other (describe)		
Building Dimensions: Length:	ft/m:	Width:	ft/m:
Roof Slope:	in. per ft. / degrees		
Parapet Height, max (in./m):	Parapet Height, min (in./m): (enter "0" if not always present)		
Roof Zone Width/Dimension*:			
Zone 1:	Zone 1:	Zone 2:	Zone 3:
FM Approved RoofNav Assembly Numbers (provide Assembly Number for individual roof zones as appropriate):			

\*Refer to FM Global Property Loss Prevention Data Sheet 1-28, *Wind Design* or RoofNav for determination of various zone dimensions.

### ROOF SURFACING:

<input type="checkbox"/> None
<input type="checkbox"/> Coating (Trade Name/Application Rate)
<input type="checkbox"/> Granules (Application Rate)
<input type="checkbox"/> Gravel/Slag (Application Rate)
<input type="checkbox"/> Ballast: <input type="checkbox"/> Stone Size <input type="checkbox"/> Pavers (Beveled, strapped or square edge); <input type="checkbox"/> Other:
Ballast Weight (psf): Zone 1:    Zone 1:    Zone 2:    Zone 3:
Additional Detail:

### ROOF COVER / MEMBRANE:

(Provide ALL applicable details including trade name, type, number of plies, thickness, reinforced, adhesive, etc.)

Roof Cover: Trade Name:	
Hail Rating Provided:	
<input type="checkbox"/> Single Ply: <input type="checkbox"/> Reinforced <input type="checkbox"/> Unreinforced <input type="checkbox"/> Adhered <input type="checkbox"/> Fastened <input type="checkbox"/> Ballasted	
<input type="checkbox"/> Multi-Ply <input type="checkbox"/> Built Up Roofing (BUR) <input type="checkbox"/> Modified Bitumen	
Number of Plies:	
<input type="checkbox"/> Lap Width in/mm <input type="checkbox"/> Lap Adhesion Type	
<input type="checkbox"/> Panel: <input type="checkbox"/> Through Fastened Metal	
<input type="checkbox"/> Standing Seam metal <input type="checkbox"/> Steel <input type="checkbox"/> Aluminum <input type="checkbox"/> Copper    Thickness:	
Rib Spacing: Clip Model: <input type="checkbox"/> 1-Piece <input type="checkbox"/> 2-Piece	
<input type="checkbox"/> Insulated Metal Panel Roof: Bottom facer: Metal type:    Thickness:	
Top facer: Material:    Thickness:	
<input type="checkbox"/> Fiber Reinforced Plastic (FRP)	
<input type="checkbox"/> Other:	
<input type="checkbox"/> Spray Applied <input type="checkbox"/> Other:	
Additional Detail:	
<input type="checkbox"/> Asphalt Shingles <input type="checkbox"/> Metal Shingles: Manufacturer:    Model: <input type="checkbox"/> Ring Shank Nails	
<input type="checkbox"/> Smooth Shank Nails <input type="checkbox"/> Screws    Size    Number per shingle:	
<input type="checkbox"/> Concrete Tile <input type="checkbox"/> Clay Tile: Manufacturer    Model: <input type="checkbox"/> Ring Shank Nails	
<input type="checkbox"/> Smooth Shank Nails <input type="checkbox"/> Screws    Size    Number <input type="checkbox"/> Mortar or urethane at lower end of tile	
<input type="checkbox"/> Only mortar or urethane adhesive at top and bottom (No fasteners)	
<input type="checkbox"/> Slate tile: Width:    Thickness    Length of reveal: <input type="checkbox"/> Ring Shanks Nails <input type="checkbox"/> Smooth Shank Nails	
Number per tile:	
<input type="checkbox"/> Self-Adhering modified bitumen underlayment Trade Name:	



## CHECKLIST FOR ROOFING SYSTEM

### ROOF COVER / MEMBRANE SECUREMENT:

Roof Cover Fasteners: Trade Name:	Length:	Diameter/No.:
Stress Plate/Batten: Trade Name:	Size:	
Row Spacing: Zone 1':	Zone 1:	Zone 2: Zone 3:
Fastener Spacing: Zone 1':	Zone 1:	Zone 2: Zone 3:
Bonding Adhesive: Trade Name:		
Adhesive Ribbon Width (in.):		
Adhesive Ribbon Spacing (in.): Zone 1':	Zone 1:	Zone 2: Zone 3:
Adhesive Application Rate (gal./sq.):		
Additional Detail:		
See DS 1-49 for additional securement for all ballasted, or mechanically fastened or ribbon adhered roof covers if the roof cover is not secured within 12 in. (300 mm) of the outside edge of the nailer.		

### INSULATION / COVER BOARD:

Layer	Insulation / Cover Board Trade Name	Board Dimensions (ft. x. ft.)	Thickness (in.)	Fastened	Adhered	Tapered
1. Top		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Next		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Next		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Next		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Thermal Barrier		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Glass Fiber/Mineral Wool/Batt <input type="checkbox"/> Facer Type/Vapor Barrier						
<input type="checkbox"/> Other:						
<input type="checkbox"/> None						
Additional Detail:						

### INSULATION / COVER BOARD SECUREMENT:

Insulation / Cover Board Fasteners: Trade Name:	Type:	Size:
Stress Plate: Trade Name:	Size:	
Fastener Spacing: Zone 1':	Zone 1:	Zone 2: Zone 3:
Bonding Adhesive: Trade Name:		
Adhesive Ribbon Width (in.):		
Adhesive Ribbon Spacing (in.): Zone 1':	Zone 1:	Zone 2: Zone 3:
Adhesive Application Rate (gal./sq.):		
Additional Detail:		

### BASE SHEET: (Include Trade Name, Type, and Width)

<input type="checkbox"/> None	
Trade Name:	Width: <input type="checkbox"/> 36 in. <input type="checkbox"/> 1 meter (39 in.)
<input type="checkbox"/> Fastened	<input type="checkbox"/> Adhered
<input type="checkbox"/> Lap Width in/mm	<input type="checkbox"/> Lap Adhesion Type
<input type="checkbox"/> Air Retarder	<input type="checkbox"/> Vapor Retarder
Additional Detail:	

### BASE SHEET SECUREMENT:

Base Sheet Adhesive Name:	Adhesive Application Rate:
Base Sheet Fastener Trade Name:	Type:
Head Diameter:	Length:
Spacing: (Attached Sketches as necessary)	
Spacing Along Laps: Zone 1':	Zone 1: Zone 2: Zone 3:
No. Intermediate Rows: Zone 1':	Zone 1: Zone 2: Zone 3:
Spacing Along Intermediate Rows: Zone 1':	Zone 1: Zone 2: Zone 3:
Additional Detail:	

## SECTION 07 6200 - SHEET METAL FLASHING AND TRIM

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Formed roof-drainage sheet metal fabrications.
2. Formed low-slope roof sheet metal fabrications.
3. Formed wall sheet metal fabrications.
4. Downspouts and hanging gutters.
5. Cast downspout boots
6. Equipment Support Flashing

B. Related sections:

1. Section for 042000 – Unit Masonry for Through-Wall Flashing.
2. Section 074213.1 Formed Metal Panel Cladding Systems
3. Section 077113 Manufactured Coping and Fascia Copings for fascia at low-slope membrane roofing and low-slope membrane wrapped parapet walls.
4. Section 077116 Manufactured Counterflashing Systems for Two-piece thru-wall Counterflashing

#### 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.3 ACTION SUBMITTALS

A. Product Data: For each of the following

1. Underlayment materials.
2. Elastomeric sealant.
3. Butyl sealant.
4. Epoxy seam sealer.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.

6. Include details of termination points and assemblies.
7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Include details of roof-penetration flashing.
9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Include details of special conditions.
11. Include details of connections to adjoining work.

- C. Samples: For each exposed product and for each color and texture specified, 12 inches (long by actual width).

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested.
- B. Evaluation Reports: For copings and roof edge flashing, from ICC-ES showing compliance with ANSI/SPRI/FM 4435/ES-1.
- C. Sample warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Special warranty.

#### 1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.

#### 1.7 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.

- b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
  - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
- 2. Finish Warranty Period: 30 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. SPRI Wind Design Standard: Manufacture and install copings roof edge flashings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
  - 1. Design Pressure: 120psf.
- D. FM Approvals Listing: Manufacture and install Copings and Roof edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, 1-120. Identify materials with name of fabricator and design approved by FM Approvals.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change: 120 deg F , ambient; 180 deg F, material surfaces.

### 2.2 SHEET METALS

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.
  - 1. Finish: ASTM A480/A480M, No. 2D (dull, cold rolled)

- C. Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
  - 1. Exposed Coil-Coated Finish:
    - a. Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
    - b. Color: as indicated on drawings or to match adjacent aluminum panels
  - 2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of.
- D. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 coating designation or aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 coating designation.

## 2.3 UNDERLAYMENT MATERIALS

- A. Provide underlayment for sheet metal flashing and trim applied directly over metal deck, plywood sheathing, dissimilar metals, pressure treated wood, or corrosive substrates.
  - 1. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.
- B. Slip Sheet: Rosin paper, minimum 3lbs per 100sf

## 2.4 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
  - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.



- c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
  2. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
  3. Fasteners for Aluminum Sheet: pre-finished Aluminum or Series 300 stainless steel to match coil-coated finish
  4. Fasteners for Zinc-Coated (Galvanized) and Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.
- C. Solder:
1. For Stainless Steel: ASTM B32, Grade Sn96, with acid flux of type recommended by stainless steel sheet manufacturer.
  2. For Zinc-Coated (Galvanized) Steel: ASTM B32, with maximum lead content of 0.2 percent].
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- E. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Epoxy Seam Sealer: Two-part, noncorrosive, un-coated aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- G. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.
- H. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

## 2.5 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
  2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
  3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
  4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
  5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
  1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- G. Seams:
  1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
  2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

## 2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters: Box style gutters to dimensions indicated on drawings but not less than size according to SMACNA's architectural Manual. Provide with expansions joints at not less than 50ft, and gutter straps made of aluminum.
  1. Approvals: ANSI/SPRI GT-1; FM approved I-90 system
  2. Formed length: to maximum available but not less than 12ft; spliced shall be lapped 6" minimum
  3. Fabricate from the following materials
    - a. Aluminum: 0.040 thickness
    - b. Finish: Fluoropolymer, 70% minimum in custom color as noted on drawings to match fascia
- B. Downspouts/leaders: rectangular downspouts to dimensions indicated on Drawings but not less than size according to SMACNA's Architectural manual. Provide with curved elbows, corners and offsets to hold tight to wall including at overhangs.
  1. Hanger Style: F-135J per SMACNA formed of double folded sheet metal, with color matched fasteners.
  2. Spacing: provide hangers at 5 feet on center max.
  3. Fabricate from the following materials:
    - a. Aluminum: .040 thick

- b. Finish: Fluoropolymer, 70% minimum, color as noted on drawings to match wall panels
- C. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes, exterior flange trim, and built-in overflows. Fabricate from the following materials:
  - 1. Aluminum: 0.050 thick. F
  - 2. Finish: Fluoropolymer, 70% minimum, color as noted on drawings to match wall panels
- D. Cast downspout boots: cast iron conforming to ASTM A-48-70, or AASHO M-105-621. Boot shall have factory provided primer and shall be field painted to match downleaders unless otherwise noted.
  - 1. Casting shall have ears or other method for attachment to façade and offset to allow connection below grade to piping.
  - 2. Length: 24"
  - 3. Inside diameter/top bell size: not less than downspout, refer to drawings
    - a. Provide adapters below grade as required to connect into laterals and splashblocks where noted to spill to grade or roof
  - 4. Provide with cleanout at side of boot
  - 5. Basis of design: as manufactured by Downspoutboots a division of JR Hoe , series A or approved equal

## 2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing & Coping systems: Refer to Section 075400 PVC roofing and 074100 Standing Seam Metal roofing
- B. Counterflashing: Refer to Section 077116 Manufactured Counterflashing Systems
- C. Roof-Penetration Flashing: Fabricate from the following materials:
  - 1. Stainless Steel: 0.0188 inch thick.
- D. Roof-Drain Flashing: Fabricate from the following materials:
  - 1. Stainless Steel: 0.0156 thick.

## 2.8 WALL SHEET METAL FABRICATIONS

- A. Through-Wall Flashing: refer to Section 042000 Unit Masonry
- B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings where described in details. Extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from the following materials:
  - 1. Stainless Steel: 0.0156 inch thick.

## 2.9 EQUIPMENT SUPPORT FABRICATIONS

- A. Material: Fabricated to configuration required to accommodate equipment supports.

1. Stainless Steel: 0.0239 inch thick.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION OF UNDERLAYMENT**

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.
  1. Install in shingle fashion to shed water.
  2. Lap joints not less than 2 inches.
- B. Install slip sheet, wrinkle free, over underlayment or directly on substrates without underlayments before installing sheet metal flashing and trim.
  1. Install in shingle fashion to shed water.
  2. Lapp joints not less than 4 inches.

#### **3.2 INSTALLATION, GENERAL**

- A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
  1. Install fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
  2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder or sealant.
  3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
  4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
  5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
  6. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
  7. Do not field cut sheet metal flashing and trim by torch.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
  1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
  2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
  - 1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
  - 2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
- D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws or as recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
  - 1. Use sealant-filled joints unless otherwise indicated.
    - a. Embed hooked flanges of joint members not less than 1 inch into sealant.
    - b. Form joints to completely conceal sealant.
    - c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
    - d. Adjust setting proportionately for installation at higher ambient temperatures.
      - 1) Do not install sealant-type joints at temperatures below 40 deg F.
  - 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
  - 1. Pretin edges of sheets with solder to width of 1-1/2 inches; however, reduce pretinning where pretinned surface would show in completed Work.
  - 2. Do not solder aluminum sheet.
  - 3. Do not pretin zinc-tin alloy-coated copper.
  - 4. Do not use torches for soldering.
  - 5. Heat surfaces to receive solder, and flow solder into joint.
    - a. Fill joint completely.
    - b. Completely remove flux and spatter from exposed surfaces.
  - 6. Stainless Steel Soldering:
    - a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
    - b. Promptly remove acid-flux residue from metal after tinning and soldering.
    - c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
  - 7. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.

- H. Rivets: Rivet joints in[uncoated aluminum where necessary for strength.

### 3.3 INSTALLATION OF ROOF-DRAINAGE SYSTEM

- A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Downspouts:
1. Join sections with 1-1/2-inch telescoping joints.
  2. Provide hangers with fasteners designed to hold downspouts securely to walls center.
  3. Locate hangers at top and bottom and at approximately 60 inches o.c.
  4. Where terminate at roof: provide elbows at base of downspout to direct water away from building and onto cast concrete splashblock.
  5. Where terminated at grade: connect downspouts cast downspout boot and underground drainage system.
- C. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of 1 inch below scupper or gutter discharge.
- D. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated on Drawings. Lap joints minimum of 4 inches in direction of water flow.

### 3.4 INSTALLATION OF ROOF FLASHINGS

- A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.
1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
  2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.
- C. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

### 3.5 INSTALLATION OF WALL FLASHINGS

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

- B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

### 3.6 INSTALLATION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

### 3.7 CLEANING

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

### 3.8 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 07 6200

**SECTION 07 7116-MANUFACTURED COUNTERFLASHING SYSTEMS**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Two-piece thru-wall Counterflashing.

**1.2 RELATED REQUIREMENTS**

- A. Section 07 92 00 – Joint Sealants.

**1.3 PREINSTALLATION MEETINGS**

- A. Convene preinstallation meeting 2 weeks before start of installation of counterflashing and coordinate with installation of roofing and wall cladding.
- B. Require attendance of parties directly affecting Work of this Section, including Contractor, Architect, installer, and manufacturer's representative.
- C. Review the Following:
  - 1. Materials.
  - 2. Installation.
  - 3. Adjusting.
  - 4. Cleaning.
  - 5. Protection.
  - 6. Coordination with other Work.

**1.4 SUBMITTALS**

- A. Comply with Division 01.
- B. Product Data: Submit manufacturer's product data, including installation instructions.
- C. Shop Drawings: Submit manufacturer's shop drawings, including plans, elevations, sections, and details, indicating dimensions, materials, components, fasteners, finish, and accessories.
- D. Samples: Submit manufacturer's sample of counterflashing.
  - 1. Sample Length: Minimum 5-1/2 inches
- E. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.
- F. Warranty Documentation: Submit manufacturer's standard warranty.

**1.5 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Manufacturer regularly engaged in the manufacturing of counterflashing of similar type to that specified for a minimum of 10 years.
- B. Installer's Qualifications:
  - 1. Installer regularly engaged in installation of counterflashing of similar type to that specified for a minimum of 5 years.
  - 2. Use persons trained for installation of counterflashing following manufacturer's installation instructions.



## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Delivery Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging.
- B. Storage and Handling Requirements:
  - 1. Store and handle materials in accordance with manufacturer's instructions.
  - 2. Keep materials in manufacturer's original, unopened containers and packaging until installation.
  - 3. Store materials in clean, dry area indoors.
  - 4. Do not store materials directly on floor or ground.
  - 5. Protect materials and finish during storage, handling, and installation to prevent damage.

## **1.7 WARRANTY**

- A. Warranty Period, Product: 5-year workmanship warranty covering replacement or repair of products that are defective in material or workmanship.

# **PART 2 PRODUCTS**

## **2.1 MANUFACTURERS**

- A. Atas international
- B. Metal-Era, Inc
- C. Or approved equal

## **2.2 MANUFACTURED COUNTERFLASHING SYSTEMS**

- A. Counterflashing: "Counter-Flash" 2-piece counterflashing, thru-wall version.
  - 1. Provides watertight termination at leading edge and inside of wall.
  - 2. Model: 5-inch face height.
  - 3. Material: 24-gauge stainless steel
  - 4. Formed Lengths: 12'-0"
  - 5. Slotted Fastening Holes: 12 inches on center.
  - 6. Prenotched Lap Joints: 3 inches.

## **2.3 ACCESSORIES**

- A. Joint Sealants: Specified in Section 07 92 00.
- B. Fasteners: Appropriate for intended substrate.

# **PART 3 EXECUTION**

## **3.1 EXAMINATION**

- A. Examine areas to receive counterflashing.
- B. Verify surfaces to support counterflashing are clean, dry, straight, secure, and of proper dimensions.
- C. Notify Architect of conditions that would adversely affect installation.
- D. Do not begin installation until unacceptable conditions are corrected.

### **3.2 INSTALLATION**

- A. Install counterflashing in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Remove protective vinyl film immediately before installation.
- C. Install counterflashing to provide watertight termination at leading edge of roofing material.
- D. Install counterflashing to allow for thermal movement.
- E. Joint Sealants: Apply joint sealants in accordance with manufacturer's instructions.

### **3.3 ADJUSTING**

- A. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.
- B. Remove and replace with new material, damaged components that cannot be successfully repaired, as determined by Architect.

### **3.4 CLEANING**

- A. Clean counterflashing promptly after installation in accordance with manufacturer's instructions.
- B. Do not use harsh cleaning materials or methods that could damage finish.

### **3.5 PROTECTION**

- A. Protect installed counterflashing to ensure that, except for normal weathering, counterflashing will be without damage or deterioration at time of Substantial Completion.

**END OF SECTION**

## **SECTION 07 7200 - ROOF ACCESSORIES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Roof curbs where not factory provided with equipment.
2. Equipment rails.
3. Roof hatches w/ extendable safety post & guardrail.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data:** For each type of roof accessory.
- B. Shop Drawings:** For roof accessories.
- C. Samples:** For each exposed product and for each color and texture specified.

#### **1.3 INFORMATIONAL SUBMITTALS**

- A. Sample warranties.**

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Operation and maintenance data.**

#### **1.5 WARRANTY**

- A. Special Warranty on Painted Finishes:** Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### **2.1 ROOF CURBS**

- A. Roof Curbs:** Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded

or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.

1. Manufacturers: Subject to compliance with requirements, provide products from one of the following:
  - a. Pate Company
  - b. Greenheck fan corporation
  - c. Loyd industries
  - d. Or approved equal
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported and height to allow minimum of 8" flashing height above adjacent roof surface including crickets. Coordinate with roof insulation shop drawings.
- C. Material: Zinc-coated galvanized steel sheet, 0.052 inch thick minimum or as required to support equipment load.
  1. Finish: Factory prime coating
- D. Construction:
  1. Curb Profile: Manufacturer's standard compatible with roofing system.
  2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
  3. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
  4. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
  5. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
  6. Insulation: Factory insulated with 1-1/2-inch thick glass-fiber board insulation.
  7. Liner: Same material as curb, of manufacturer's standard thickness and finish.
  8. Nailer: Factory-installed wood nailer along top flange of curb or under top flange on side of curb, continuous around curb perimeter as recommended by equipment manufacturer.
  9. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements
    - a. Quantity of fasteners, size of strap per manufacturer for basic wind speed of 130mph
    - b. FEMA
  10. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.
  11. Damper Tray: Provide damper tray or shelf with opening 3 inches less than interior curb dimensions indicated, when equipment calls for damper to be provided.

## 2.2 EQUIPMENT SUPPORTS

- A. Equipment Supports: Rail-type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded corner joints, straight sides, and integrally formed structure-mounting flange at bottom.
  - 1. Manufacturers: Subject to compliance with requirements, provide products from one of the following:
    - a. Pate Company
    - b. Greenheck fan corporation
    - c. Loyd industries
    - d. Or approved equal
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- A. Material: Zinc-coated (galvanized)] steel sheet, 0.052 inch thick minimum or as required to support equipment load.
  - 1. Finish: Factory prime coating
- B. Construction:
  - 1. Curb Profile: Manufacturer's standard compatible with roofing system.
  - 2. Insulation: Factory insulated with 1-1/2-inch thick glass-fiber board insulation.
  - 3. Nailer: Factory-installed continuous wood nailers 5-1/2 inches (on top flange of equipment supports or under top flange on side of curb, continuous around support perimeter as recommended by manufacturer of equipment to be supported.
  - 4. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.
  - 5. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
  - 6. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
  - 7. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
  - 8. Fabricate equipment supports to minimum height of 12 inches above roofing surface unless otherwise indicated.
  - 9. Sloping Roofs: fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

## 2.3 ROOF HATCHES

- A. Roof Hatches: thermally broken Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
1. Manufacturers: Subject to compliance with requirements, provide products from one of the following:
    - a. Bilco Company
    - b. J.L. Industries
    - c. Babcock Davis
    - d. Nystrom
    - e. Or approved equal
  2. Type and Size: Single-leaf lid, size as indicated on Drawings, but not less than 36 by 42 inches
  3. Loads: Minimum 40-lbf/sq. ft. > external live load and 30-lbf/sq. ft. internal uplift load.
    - a. When release is actuated, lid shall open against 10-lbf/sq. ft. snow or wind load and lock in position.
  4. Curb, Framing, and Lid Material: Aluminum sheet.
    - a. Thickness: Manufacturer's standard thickness for hatch size indicated 0.079 inch .
    - b. Finish: Two-coat fluoropolymer
    - c. Color: As selected by Architect from manufacturer's full range
  5. Construction:
    - a. Insulation: 3-inch- thick, polyisocyanurate board].
      - 1) R-Value: 20 according to ASTM C1363.
    - b. Thermally Broken construction
    - c. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
    - d. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
    - e. Exterior Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
    - f. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
    - g. Sloping Roofs: fabricate curb with perimeter curb height that is constant. Equip hatch with water diverter or cricket on side that obstructs water flow.
  6. Hardware: Manufacturer's standard stainless steel; with hinges, hold-open devices, and independent manual-release devices for inside and outside operation of lids.
  7. Safety Ladder Post: Provide spring assisted telescoping safety post for installation at each roof access hatch ladder. Post to lock in place on full extension. Provide release mechanism to return post to closed position.
    - a. Designed to mount to the top two rungs of a fixed vertical ladder

- b. To extend 42" above the landing platform to provide safe ladder access through the roof hatch
  - c. Construction: 1-5/8" OD round tubing with a pull up loop provided at the upper end to facilitate raising of post.
  - d. Finish: powder-coated in safety yellow
- 8. Roof hatch mounted Safety Railing System: Provide Roof-hatch manufacturer's standard hatch mounted system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with OSHA 29 CFR 1910.23 & 29 CFR 1926.502 requirements and authorities having jurisdiction.
  - a. Height: 42 inches above finished roof deck.
  - b. Rails:
    - 1) Aluminum pipe, 1-1/4 inch, 1.66 inch outside diameter, schedule 40 6061 T6 alloy pipe.
    - 2) Fittings: Cast aluminum 5052-H32 alloy with set screw hold.
    - 3) Mounting Brackets: 3/16 inch (4.75 mm) steel, zinc plated with nut backing plate.
    - 4) Exit: Self-closing gate, 1-1/4 inch aluminum self-closing with coil spring

## 2.4 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation
  - 1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
- B. Aluminum Sheet: ASTM B209 , manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
  - 1. Exposed Coil-Coated Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - a. Two-Coat Fluoropolymer Finish: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
  - 2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil .
- C. Aluminum Extrusions and Tubes: ASTM B221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.
- D. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.
- E. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.

- F. Steel Tube: ASTM A500/A500M, round tube.
- G. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.
- H. Steel Pipe: ASTM A53/A53M, galvanized.

## 2.5 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 1, thickness as indicated.
- C. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft. thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F thickness as indicated.
- D. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.
- E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.
- F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
- G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- H. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- I. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
- J. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.



1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
  2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
  3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
  4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
  2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
- C. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

### 3.2 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 7200

## **SECTION 078100 - SPRAYED FIRE-RESISTIVE MATERIALS**

### **PART 1 GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### **1.2 SECTION INCLUDES**

- A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the sprayed fire-resistive materials as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:
  - 1. Spray-on fireproofing for structural steel and metal decking.
  - 2. Seal coat over fireproofing in special areas.
  - 3. Preparation of surfaces.
  - 4. Field quality control.

#### **1.3 RELATED SECTIONS**

- A. Structural steel – Section 051200.
- B. Metal decking – Section 053100.
- C. Firestops and smoke seals – Section 078413.

#### **1.4 SUBMITTALS**

- A. Product Data: For each fire-resistive product specified.
- B. Shop Drawings: Submit structural framing plans indicating the following:
  - 1. Locations and types of surface preparations required before applying sprayed fire-resistive material.
  - 2. Extent of sprayed fire-resistive material for each construction and fire-resistance rating, including the following:
    - a. Applicable fire-resistive design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
    - b. Minimum thicknesses needed to achieve required fire-resistance ratings of structural components and assemblies.
  - 3. Identify restrained and unrestrained assemblies on shop drawings, show required thickness of fireproofing for each assembly.

- C. Product Certificates: Signed by manufacturer of sprayed fire-resistive material certifying that the products furnished comply with requirements.
- D. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
- E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- F. If primer is to be used steel and/or metal deck, submit certifications by supplier of primer that primer is compatible with materials, and will not impair the required performance of the installed fireproofing. Such certification shall be accompanied by evidence that the primer was successfully used in conjunction with the fireproofing material in a UL test applicable to the construction. Submit certification prior to application of primer.
  - 1. Coordinate with Section 051200 – Structural Steel and 053100 – Metal Deck, and Structural Drawings prior to application of primer.
- G. Product Test Reports: Indicate that physical properties of proposed sprayed fire-resistive materials comply with specified requirements based on comprehensive testing of current product formulations by a qualified testing and inspecting agency according to requirements specified in "Quality Assurance" Article.
- H. Code Compliance: Proposed product must comply with prevailing Building Code and be approved by those individuals having jurisdiction.
- I. Letter from manufacturer stating that the UL Design selected for the project is not load restricted.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer certified, licensed, or otherwise qualified by sprayed fire-resistive material manufacturer as having the necessary experience, staff, and training to install manufacturer's products according to specified requirements. A manufacturer's willingness to sell its sprayed fire-resistive materials to Contractor or to an installer engaged by Contractor does not in itself confer qualification on the buyer.
- B. Submit data indicating that products containing no detectable asbestos as determined according to the method specified in 40 CFR, Part 763, Subpart E, Appendix E, Section 1, "Polarized Light Microscopy."
- C. Mockups: After processing of initial submittals and before delivery and installation of fireproofing materials, prepare a sample installation of fireproofing work, approximately 100 sq. ft. in area; providing an example of each type required, applied on each different substrate, to produce each different rating as required and reasonably representative of entire sprayed on fireproofing work, for joint approval by representative of fire resistant material manufacturer and Owner. Work in other areas shall not proceed until mock-up has been completed. Mock-up work which remains in compliance with requirements and is in undamaged and acceptable condition may be retained as final work in place.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver products to Project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; shelf life, if applicable; and fire-resistance ratings applicable to Project.
- B. Use materials with limited shelf life within period indicated. Remove from Project site and discard materials whose shelf life has expired.
- C. Store materials inside, under cover, aboveground, so they are kept dry until ready for use. Remove from Project site and discard materials that have deteriorated.

**1.7 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not apply sprayed fire-resistive material when ambient or substrate temperatures are 40 deg F. or lower, unless temporary protection and heat is provided to maintain temperatures at or above this level for 24 hours before, during, and for 24 hours after product application.
- B. Ventilation: Ventilate building spaces during and after application of sprayed fire-resistive material to achieve a minimum of four air changes per hour. Use natural means or, where this is inadequate, forced-air circulation until fire-resistive material dries thoroughly.

**1.8 SEQUENCING**

- A. Sequence and coordinate application of sprayed fire-resistive materials with other related work specified in other Sections to comply with the following requirements:
  - 1. Provide temporary enclosures for interior applications to prevent deterioration of fire-resistive material due to exposure to unfavorable environmental conditions.
  - 2. Avoid unnecessary exposure of fire-resistive material to abrasion and other damage likely to occur during construction operations subsequent to its application.
  - 3. Do not apply fire-resistive material to metal roof deck substrates until roofing has been completed; prohibit roof traffic during application and drying of fire-resistive material. Fireproofing shall be considered dry when the moisture content is 6% or less.
  - 4. Do not begin applying fire-resistive material until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
  - 5. Defer installing ducts, piping, and other items that would interfere with applying fire-resistive material until application of fire protection is completed.
  - 6. Do not install enclosing or concealing construction until after fire-resistive material has been applied, inspected, tested, and corrections have been made to defective applications.
  - 7. Protect permanently exposed walls, floor or special surfaces.

**1.9 WARRANTY**

- A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in

addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- B. Special Warranty: Submit a written warranty, executed by Contractor and cosigned by Installer, agreeing to repair or replace sprayed fire-resistive materials that fail within the specified warranty period.
  - 1. Failures include, but are not limited to, cracking, flaking, eroding in excess of specified requirements; peeling; and delaminating of sprayed fire-resistive materials from substrates due to defective materials and workmanship within the specified warranty period.
  - 2. Not covered under the warranty are failures due to damage by occupants and Owner's maintenance personnel, exposure to environmental conditions other than those investigated and approved during fire-response testing, and other causes not reasonably foreseeable under conditions of normal use.
- C. Warranty Period: Three (3) years from date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.1 SPRAYED FIRE-RESISTIVE MATERIALS**

- A. General: For applications of sprayed fire-resistive, provide manufacturer's standard products complying with requirements indicated for material composition and for minimum physical properties of each product listed, measured by standard test methods referenced with each property.
  - 1. Steel members are to be considered unrestrained unless specifically noted otherwise.
- B. UL design listings must state that the loading was determined by Allowable Stress Design Method or Load and Resistance Factor Design Method. UL design listings requiring a load restriction factor will not be allowed.
- C. Cementitious Sprayed Fire-Resistive Material: Factory-mixed, dry, cement aggregate formulation, chloride-free formulation of Portland cement binders, additives, and inorganic aggregates, mixed with water at Project site to form a slurry or mortar for conveyance and application, complying with the following requirements:
  - 1. Dry Density: Values for average and individual densities as required for fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Appendix A, "Alternate Method for Density Determination," but with an average density of not less than 22 lb./cu. ft.
  - 2. Bond Strength: 2000 psf minimum per ASTM E 736.
  - 3. Compressive Strength: 100 psi per ASTM E 761.
  - 4. Corrosion Resistance: No evidence of corrosion per ASTM E 937.
  - 5. Deflection: No cracking, spalling, delamination, or the like per ASTM E 759.

6. Effect of Impact on Bonding: No cracking, spalling, delamination, or the like per ASTM E 760.
  7. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. per ASTM E 859.
  8. Combustion Characteristics: Passes ASTM E 136.
  9. Fire-Test-Response Characteristics: Provide sprayed fire-resistive materials with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
    - a. Flame Spread: 10 or less.
    - b. Smoke Developed: 0.
  10. Fungal Resistance: No observed growth on specimens per ASTM G 21.
  11. For exterior applications of sprayed fire-resistive material, provide manufacturer's formulation approved for surfaces exposed to the exterior.
- D. Products: Subject to compliance with requirements, provide one of the following:
1. Cement-Aggregate Cementitious Sprayed Fire-Resistive Material:
    - a. Pyrocrete 239; Carbolite Co., Fireproofing Products Div.
    - b. Monokote Type Z106HY; GCP Applied Technologies.
    - c. F4; Promat Firetemp.
    - d. Cafco 400, Isolatek International Corp; Cafco Products
    - e. Or approved equal.

## 2.2 AUXILIARY FIRE-RESISTIVE MATERIALS

- A. General: Provide auxiliary fire-resistive materials that are compatible with sprayed fire-resistive materials and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistive designs indicated.
- B. Adhesive for Bonding Fire-Resistive Material: Product approved by manufacturer of sprayed fire-resistive material, used where required by manufacturer to insure proper bond.
- C. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required to comply with fire-resistive designs indicated and fire-resistive product manufacturer's written recommendations. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive sprayed fire-resistive material.
- D. Sealer for Sprayed Fire-Resistive Material in Elevator Shafts and Open Area Plenums: Transparent-drying, water-dispersible protective coating by manufacturer of fire-resistive material.
  1. Product: Subject to compliance with requirements, provide "Firebond Concentrate" by GCP Applied Technologies or approved equal

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, with Installer present, to determine whether they are in satisfactory condition to receive sprayed fire-resistive material. A substrate is in satisfactory condition if it complies with the following:
  - 1. Substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt, or other foreign substances capable of impairing bond of fire-resistive material with substrate under conditions of normal use or fire exposure.
  - 2. Objects penetrating fire-resistive material, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
  - 3. Substrates are not obstructed by ducts, piping, equipment, and other suspended construction that will interfere with applying fire-resistive material.
- B. Do not proceed with installation of fire-resistive material until unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Clean substrates of substances that could impair bond of fire-resistive material, including oil, grease, rolling compounds, incompatible primers, and loose mill scale.
- B. For exposed applications, repair substrates to remove any surface imperfections that could affect uniformity of texture and thickness in finished surface of sprayed fire-resistive material. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.
- C. Cover other work subject to damage from fallout or overspray of fire-resistive materials during application. Provide temporary enclosure as required to confine spraying operations, protect the environment, and ensure maintenance of adequate ambient conditions for temperature and ventilation.

### **3.3 INSTALLATION**

- A. Comply with fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to convey and spray on fire-resistive material, as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- B. Install metal lath, as required, to comply with fire-resistance ratings and fire-resistive material manufacturer's written recommendations for conditions of exposure and intended use. Securely attach lath to substrate in position required for support and reinforcement of fire-resistive material. Use anchorage devices of type recommended in writing by fire-resistive material manufacturer. Attach lathing accessories where indicated or required for secure attachment to substrate.

- C. Coat substrates with adhesive before applying fire-resistive material where required to achieve fire-resistance rating or as recommended in writing by fire-resistive material manufacturer for material and application indicated.
- D. Extend fire-resistive material in full thickness over entire area of each substrate to be protected.
- E. Spray apply fire-resistive materials to maximum extent possible. Following the spraying operation in each area, complete the coverage by method recommended by the manufacturer.
- F. Where sealers are used, apply products that are tinted to differentiate them from the sprayed fire-resistive material over which they are applied.
- G. Maintain ambient conditions during installation and for cure period following installation, as recommended by manufacturer. Provide ventilation and avoid excessive rate of drying.
- H. Fireproofing to the underside of roof deck assemblies shall be done only after roofing application is complete, all roof mounted mechanical equipment is in place, and the roof is watertight.
- I. No fireproofing shall be applied prior to completion of concrete work on steel decking.
- J. Installation Sequence of Fireproofing: All patching and repairing of sprayed fireproofing, due to cutting by other trades or testing and inspection, shall be performed under this Section.
- K. Provisions shall be made for ventilation to properly dry the fireproofing after application. In enclosed areas lacking natural ventilation, air circulation and ventilation must be provided.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.
  - 1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
- B. Testing and inspecting of completed applications of sprayed fire-resistive material will take place in successive stages, in areas of extent and using methods as follows. Do not proceed with application of fire-resistive material for the next area until test results for previously completed applications of fire-resistive material show compliance with requirements.
  - 1. For each 1000-sq. ft. area, or partial area, on each floor, testing and inspecting agency will evaluate the following characteristics. Tested values must equal or exceed values indicated and values required for approved fire-resistance design.
    - a. Thickness for Floors, Roofs, and Walls: From the average of 10 measurements from a 144-sq. in. sample area, with sample width of not less than 6 inches per ASTM E 605.
  - 2. Thickness for Structural Frame Members: From a sample of 25 percent of structural members per floor, taking 9 measurements at a single cross section for structural frame beams or girders, 7 measurements of a single cross section for joists and trusses, and 12 measurements of a single cross section for columns per ASTM E 605.



3. For each 10,000 sq. ft. area, or partial area, on each floor, testing and inspection agency will evaluate the following characteristics. Tested values must equal or exceed values indicated and values required for approved fire resistance design.
    - a. Bond Strength for Floors, Roofs, Walls, and Structural Framing Members: Cohesion and adhesion at frequency and from sample size indicated for determining thickness of each type of construction, per ASTM E 736.
  4. Density for Floors, Roofs, Walls, and Structural Frame Members: At frequency and from sample size indicated for determining thickness of each type of construction, per ASTM E 605 or AWCI Technical Manual 12-A, Appendix A, "Alternate Method for Density Determination."
  5. When testing discovers applications of fire-resistive material not in compliance with requirements, testing and inspecting agency will perform additional random testing to determine extent of noncompliance.
- C. Remove and replace applications of fire-resistive material where test results indicate that they do not comply with specified requirements for cohesion and adhesion or for density, or both.
  - D. Apply additional fire-resistive material per manufacturer's written instructions where test results indicate that thickness does not comply with specified requirements.
  - E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

### 3.5 CLEANING, PROTECTING, AND REPAIR

- A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.
- B. Cure exposed sprayed fire-resistive material according to product manufacturer's written recommendations to prevent premature drying.
- C. Protect fire-resistive material, according to advice of product manufacturer and Installer, from damage resulting from construction operations or other causes so fire protection will be without damage or deterioration at the time of Substantial Completion.
- D. Coordinate application of fire-resistive material with other construction to minimize the need to cut or remove fire protection. As installation of other construction proceeds, inspect fire-resistive material and patch any damaged or removed areas.
  1. Patch and repair fireproofing where Owner's Testing Agency has performed tests.
- E. Repair or replace work that has not been successfully protected.

END OF SECTION

## **SECTION 07 8413 - PENETRATION FIRESTOPPING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

- 1. Penetration firestopping systems for the following applications:**
  - a. Penetrations in fire-resistance-rated walls.**

#### **1.2 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.**

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.**
- B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.**
- C. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.**

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Product test reports.**

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.**

#### **1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: A firm that has been approved by FM Approval according to FM Approval 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."**

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

#### A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
  - a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
    - 1) UL in its "Fire Resistance Directory."

### 2.2 PENETRATION FIRESTOPPING SYSTEMS

- #### A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
1. Manufacturers:
    - a. 3M fire protection
    - b. Hilti, Inc
    - c. Specified Technologies, inc
    - d. Tremco, inc
    - e. Or approved equal
- #### B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- #### C. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.
- #### D. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
  - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- D. Install fill materials by proven techniques to produce the following results:
  - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
  - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### **3.2 IDENTIFICATION**

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
  - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet .
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
  - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Contractor's name, address, and phone number.
  - 3. Designation of applicable testing and inspecting agency.

4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

### 3.3 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 078413

## **SECTION 07 8443 - JOINT FIRESTOPPING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Joints in or between fire-resistance-rated constructions.

#### **1.2 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference:** Conduct conference at Project site.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data:** For each type of product.

**B. Product Schedule & Shop drawing**

1. Provide Schedule identifying each joint firestopping system to be installed
2. Include floor plan and indicate location of each joint to be installed and design designation of qualified testing agency.
3. Include illustration and description of firestopping system to be used.

- C. Engineering Judgments:** Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Product test reports.**

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Installer Certificates:** From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

#### **1.6 QUALITY ASSURANCE**

- A. Installer Qualifications:** A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

#### A. Fire-Test-Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
  - a. Joint firestopping systems shall bear classification marking of a qualified testing agency.
    - 1) UL in its "Fire Resistance Directory."
    - 2) Intertek Group in its "Directory of Listed Building Products."

### 2.2 JOINT FIRESTOPPING SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.
  1. Joints between fire-rated gwb partitions to unrated metal roof deck and steel framing
  2. Joints between fire-rated gwb partition and CMU partitions
  3. Joints between fire-rated CMU partitions and unrated concrete on metal deck floors
  4. Manufactured by:
    - a. Hilti, inc
    - b. Specified Technologies, Inc
    - c. 3m fire-protective products
    - d. Or approved equal
  5. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
- C. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.
- D. Accessories: Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. General: Install joint firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- C. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
  - 1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- D. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:
  - 1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
  - 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
  - 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### 3.2 IDENTIFICATION

- A. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
  - 1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Contractor's name, address, and phone number.
  - 3. Designation of applicable testing agency.
  - 4. Date of installation.
  - 5. Manufacturer's name.
  - 6. Installer's name.

### 3.3 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2393.



- B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.
- C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 07 8443

## **SECTION 07 9200 - JOINT SEALANTS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Nonstaining silicone joint sealants.
  - 2. Mildew Resistant joints
  - 3. Urethane joint sealants.
  - 4. Latex joint sealants.

#### **1.2 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each joint-sealant product.
- B. Samples: For each kind and color of joint sealant required.
- C. Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.
  - 2. Joint-sealant manufacturer and product name.
  - 3. Joint-sealant formulation.
  - 4. Joint-sealant color.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Product test reports.
- B. Preconstruction laboratory test reports.
- C. Preconstruction field-adhesion-test reports.
- D. Sample warranties.

#### **1.5 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.

## 1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
  - 1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
  - 2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
  - 3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with masonry substrates.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates. Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

## 1.7 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

- C. Stain-Test-Response Characteristics: Sealants are to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- D. Colors of Exposed Joint Sealants: selected by Architect from manufacturer's full range.

## 2.2 NONSTAINING SILICONE JOINT SEALANTS

- A. Silicone, Nonstaining, type S, NS, 50, NT: Non-staining Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
  - 1. Refer to article 3.3 "joint sealant schedule" for location of acceptable use
  - 2. Basis of design: Dow Corning 795, as manufactured by Dow Corning Corp
  - 3. Other Manufacturers:
    - a. Pecora Corporation
    - b. Sika Corporation
    - c. GE construction sealants
    - d. Or approved equal

## 2.3 URETHANE JOINT SEALANTS FOR INTERIOR HORIZONTAL TRAFFIC SURFACES

- A. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T.
  - 1. Refer to article 3.3 "joint sealant schedule" for location of acceptable use
  - 2. as Manufactured by, subject to performance requirements
    - a. Dow Corning
    - b. Pecora Corporation
    - c. Sika Corporation
    - d. GE construction sealants
    - e. Or approved equal

## 2.4 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

Silicone, Mildew Resistant, S, NS, 25, NT, G, A, O: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, silicone joint sealant; as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.

- 1. Refer to article 3.3 "joint sealant schedule" for location of acceptable use

2. as Manufactured by, subject to performance requirements
  - a. Dow Corning
  - b. Pecora Corporation
  - c. Sika Corporation
  - d. GE construction sealants
  - e. Or approved equal
- B. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
  1. Refer to article 3.3 "joint sealant schedule" for location of acceptable use
  2. as Manufactured by, subject to performance requirements
    - a. Dow Corning
    - b. Pecora Corporation
    - c. Sika Corporation
    - d. GE construction sealants
    - e. Or approved equal

## 2.5 MASTIC

- A. Butyl based mastic: ASTM C1311, Butyl-based sealant with 10% movement capability
  1. Refer to article 3.3 "joint sealant schedule" for location of acceptable use
  2. as Manufactured by, subject to performance requirements
    - a. Dow Corning
    - b. Pecora Corporation
    - c. Sika Corporation
    - d. GE construction sealants
    - e. tremco
    - f. Or approved equal

## 2.6 JOINT-SEALANT BACKING

- A. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin, Type B (bicellular material with a surface skin or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

## 2.7 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
  - 1. Remove laitance and form-release agents from concrete.
  - 2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces.

#### **3.2 INSTALLATION OF JOINT SEALANTS**

- A. General: Comply with ASTM C1193 and joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
- C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  - 1. Place sealants so they directly contact and fully wet joint substrates.
  - 2. Completely fill recesses in each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  - 1. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.

### 3.3 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces
  - 1. Joint Locations:
    - a. Control and expansion joints in unit masonry
    - b. Façade joints at metal panel cladding locations.
  - 2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors
- B. Joint-Sealant Application: Interior joints in horizontal traffic surfaces
  - 1. Joint Locations:
    - a. Isolation joints in cast-in-place concrete slabs.
  - 2. Joint Sealant: Urethane, S, P, 25, T, NT.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors
- C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement
  - 1. Joint Locations:
    - a. Control joints on exposed interior surfaces of exterior walls.
    - b. Perimeter joints between interior wall surfaces and frames of interior doors
  - 2. Joint Sealant: Acrylic latex.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors
- D. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces
  - 1. Joint Locations:
    - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
    - b. Tile control and expansion joints.
  - 2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors
- E. Joint-Sealant Application: Concealed mastics
  - 1. Joint Locations:
    - a. Aluminum thresholds.
    - b. Sill plates.
    - c. Other joints as indicated on Drawings.
  - 2. Joint Sealant: Butyl-rubber based.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors

END OF SECTION 07 9200



## **SECTION 079500 EXPANSION CONTROL**

### **PART 1 - GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Work of this section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### **1.2 SECTION INCLUDES**

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the expansion joint covers as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:
  - 1. Floor expansion joint cover assemblies.
  - 2. Wall expansion joint cover assemblies.
  - 3. Ceiling expansion joint cover assemblies.
  - 4. Expansion joint covers between new and existing construction for walls, floors, ceilings.
- B. Fire rated expansion joint cover assemblies where required.

#### **1.3 RELATED SECTIONS**

- A. Selective Demolition and Alteration Work - Section 024119.
- B. Cast-in-Place Concrete - Section 033000.
- C. Unit Masonry - Section 042000.
- D. Roofing - Division 7.
- E. Painting and Finishing - Section 099000.

#### **1.4 SUBMITTALS**

- A. Submit product data for each type of expansion joint cover assembly specified, including manufacturer's product specifications, installation instructions, details of construction relative to materials, dimensions of individual components, profiles, and finishes.
- B. Submit shop drawings showing fabrication and installation of expansion joint cover assemblies, including plans, elevations, sections, details of components, joints, splices, and attachments to other units of work.
- C. Submit samples for verification purposes in full size units of each type of expansion joint cover assembly indicated; within sets for each finish, color, texture, and pattern

specified, showing full range of variations expected in these characteristics. Install elastomeric material for joints, samples to verify color selected.

#### 1.5 QUALITY ASSURANCE

- A. Fire Test Response Characteristics: Where indicated, provide expansion joint cover assemblies identical to those assemblies whose fire resistance has been determined per ANSI/UL 263, NFPA 251, U.B.C. 43-1, or ASTM E 119, including hose stream test of vertical wall assemblies, by a testing and inspecting agency acceptable to authorities having jurisdiction.

- 1. Fire Resistance Ratings: Rating as shown on drawings and Specifications.

- B. Joint covers shall permit unrestrained movement of joint without disengagement of cover.
- C. Provide a single source manufacture for all expansion joints in order to maintain manufacturer's warrantee for factory fabricated transitions for both cover and fire barrier.
- D. Floor joint cover plate assemblies shall be capable of supporting a 200 psf uniform load and a 300 lb. concentrated load with a deflection not to exceed 1/16".

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Provide temporary protective cover on finished surfaces.
- B. Deliver joint covers to jobsite in new, clean, unopened crates of sufficient size and strength to protect materials during transit.
- C. Store components in original containers in a clean, dry location.
- D. Handle components with equipment of sufficient size to preclude hazard to personnel or components.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURER

- A. Basis of Design as manufactured by Construction specialties
  - 1. Other Manufacturers, Subject to compliance with requirements specified,
    - a. MM Systems Corporation,
    - b. Watson Bowman Acme
    - c. Or approved equal.
  - 2. Joint width: 2" unless otherwise noted on the drawings.
- B. Designated as EXP-1 On Drawings: Pre-compressed impregnated foam with waterproof silicone on face for construction joints concealed from view to maintain watertight integrity

1. VFR series
2. approved equal
- C. Designated as EXP-2 on drawings: surface mounted Anodized aluminum cover for GWB wall to wall and GWB ceiling to GWB ceiling
  1. ASM series and ASMC series where occurs in a corner.
  2. Or approved equal
- D. Designated as EXP-3 on drawings: Exterior flush cover with silicone gasket for wall to wall joints including masonry to metal joints
  1. SF series
  2. Or approved equal
- E. Designed as formed expansion joint cover: Exterior cover noted on drawings as formed expansion joint cover shall be fabricated from materials matching façade cladding and complying with SMACNA guidelines. As contractor option: manufactured exterior cover with vapor barrier shall be acceptable where can be suitably installed per manufacturer recommendations in finish matching adjacent wall panel:
  1. AFW-S series, AFWC-X:
  2. Or approved equal

## 2.2 MATERIALS

- A. Aluminum: ASTM B 221, alloy 6063-T5 for extrusions; ASTM B 209, alloy 6061-T6, sheet and plate; aluminum to have the following finishes:
  1. Interior and exterior walking surfaces shall have clear anodized (A41) finish.
  2. Exterior surfaces not subject to pedestrian traffic shall have a "Kynar 500" finish conforming to NAAMM 605.2; two (2) colors shall be required, one (1) color to match metal siding and the other color to match adjacent concrete surfaces.
  3. Interior surfaces not subject to pedestrian traffic shall be shop primed with rust inhibitive primer, minimum 2 mils thick, ready to receive field painted finish.
- B. Stainless Steel: ASTM A 666, Type 304, No. 4 finish.
- C. Protect metal surfaces to be placed in contact with cementitious materials with a protective coating.
- D. Extruded Preformed Seals: Single or multi-cellular elastomeric profiles as classified under ASTM D 2000, designed with or without continuous, longitudinal, internal baffles. Formed to fit compatible frames, in color, as selected by Architect from manufacturer's standard colors.
- E. Fire Barriers: provide where noted designed for indicated or required dynamic structural movement without material degradation or fatigue when tested according to

ASTM E 1399. Tested in maximum joint width condition with a field splice as a component of an expansion joint cover per ANSI/UL 263, NFPA 251, U.B.C. 43-1, or ASTM E 119, including hose stream test of vertical wall assemblies by a nationally recognized testing and inspecting agency acceptable to authorities having jurisdiction.

1. Supply Monoflex Fire Barrier Sealing System or approved equals for Architectural Joints fire-resistive barrier systems that have ratings equal to or greater than the rating of adjacent construction when tested in accordance with the aforementioned standards. Provide specified 1 hour rated fire barrier expansion joint assembly for floors and/or specified 2 hour rated fire barrier expansion joint assembly for walls
- F. Accessories: Manufacturer's standard anchors, fasteners, set screws, spacers, flexible moisture barrier and filler materials, drain tubes, lubricants, adhesive, and other accessories compatible with material in contact, as indicated or required for complete installations.

## 2.3 EXPANSION JOINT COVER ASSEMBLIES

- A. General: Provide expansion joint cover assemblies of design, basic profile, materials, and operation indicated on drawings. Provide units comparable to those indicated or required to accommodate joint size, variations in adjacent surfaces, and dynamic structural movement without material degradation or fatigue when tested according to ASTM E 1399. Furnish units in longest practical lengths to minimize number of end joints. Provide hairline mitered corners where joint changes direction or abuts other materials. Include closure materials and transition pieces, tee-joints, corners, transition pieces, curbs, cross-connections, and other accessories as required to provide continuous joint cover assemblies.
1. Special conditions shall be shop fabricated.
  2. Fabricate components in largest practical lengths to minimize field splicing.
- B. Moisture Barrier: Provide manufacturer's continuous, standard, flexible vinyl moisture barrier under covers at locations indicated.
- C. All shop drawings shall be signed and sealed by a third-party engineering firm.
- D. Fire Rated Joint Covers: Provide expansion joint cover assemblies with manufacturer's continuous, standard, flexible fire barrier seals under covers at locations indicated to provide fire-resistive rating not less than the rating of adjacent construction.
- E. All transitions between vertical and horizontal joints shall be factory fabricated.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Manufacturer's Instructions: In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for phases of Work, including preparing substrate, applying materials, and protecting installed units.

- B. Coordinate and furnish anchorages, setting drawings, templates, and instructions for installation of expansion joint cover assemblies to be embedded in or anchored to concrete or to have recesses formed into edges of concrete slab for later placement and grouting-in of frames.
- C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary to secure expansion joint cover assemblies to in-place construction, including threaded fasteners with drilled-in expansion shields for masonry and concrete where anchoring members are not embedded in concrete. Provide fasteners of metal, type, and size to suit type of construction indicated and provide for secure attachment of expansion joint cover assemblies.

### 3.2 INSTALLATION

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting into new and existing construction as required to install expansion joint covers. Install joint cover assemblies in true alignment and proper relationship to expansion joints and adjoining finished surfaces measured from established lines and levels. Allow adequate free movement of thermal expansion and contraction of metal to avoid buckling. Set floor covers at elevations to be flush. Locate wall, ceiling, roof, and soffit covers in continuous contact with adjacent surfaces. Securely attach in place with required accessories. Locate anchors at interval recommended by manufacturer, but not less than 3" from each end and not more than 24" o.c.
  - 1. Where cutting into existing construction, conform to the requirements of Section 024119.
- B. Continuity: Maintain continuity of expansion joint cover assemblies with a minimum number of end joints and align metal members mechanically using splice joints. Cut and fit ends to produce joints that will accommodate thermal expansion and contraction of metal to avoid buckling of frames. Adhere flexible filler materials (if any) to frames with adhesive or pressure sensitive tape as recommended by manufacturer.
- C. Extruded Preformed Seals: Install seals complying with manufacturer's instructions and with minimum number of end joints. For straight sections provide preformed seals in continual lengths. Vulcanize or heat-weld field splice joints in preformed seal material to provide watertight joints using procedures recommended by manufacturer. Apply adhesive, epoxy, or lubricant adhesive approved by manufacturer to both frame interfaces before installing preformed seal. Seal transitions according to manufacturer's instructions.
- D. Elastomeric Sealant Joint Assemblies: Seal end joints within continuous runs and joints at transitions according to manufacturer's directions to provide a watertight installation.
- E. Fire Barriers: Install fire barriers, including transitions and end joints, according to manufacturer's instructions so that fire-rated construction is continuous.

### 3.3 CLEANING AND PROTECTION

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's instructions.

END OF SECTION

## SECTION 080671 – DOOR HARDWARE SCHEDULE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section references specification sections relating to commercial door hardware for the following:
  - 1. Swinging doors.
  - 2. Sliding Doors.
  - 3. Other doors to the extent indicated.
- B. Commercial door hardware includes, but is not necessarily limited to, the following:
  - 1. Mechanical door hardware.
  - 2. Electromechanical and access control door hardware.
  - 3. Electromechanical and access control door hardware power supplies, back-ups and surge protection.
  - 4. Automatic operators.
  - 5. Cylinders specified for doors in other sections.
- C. Related Sections:
  - 1. Division 08 Section “Integrated Door Opening Assemblies”.
  - 2. Division 08 Section “Door Hardware”.
  - 3. Division 26 Section “Electrical”.
  - 4. Division 28 Section “Access Control Hardware Devices”.
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
  - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
  - 2. ICC/IBC - International Building Code.
  - 3. NFPA 70 - National Electrical Code.
  - 4. NFPA 80 - Fire Doors and Windows.
  - 5. NFPA 101 - Life Safety Code.
  - 6. NFPA 105 - Installation of Smoke Door Assemblies.
  - 7. State Building Codes, Local Amendments.

- E. Standards: Reference Related Sections for requirements regarding compliance with applicable industry standards.

### 1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
  - 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
  - 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
  - 3. Content: Include the following information:
    - a. Type, style, function, size, label, hand, and finish of each door hardware item.
    - b. Manufacturer of each item.
    - c. Fastenings and other pertinent information.
    - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    - e. Explanation of abbreviations, symbols, and codes contained in schedule.
    - f. Mounting locations for door hardware.
    - g. Door and frame sizes and materials.
  - 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Keying Schedule: Prepared under the supervision of the Owner, separate schedule detailing final keying instructions for locksets and cylinders in writing. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner to approve submitted keying schedule prior to the ordering of permanent cylinders.
- D. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.



- E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.
- F. Warranties and Maintenance: Special warranties and maintenance agreements specified in the Related Sections.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

#### 1.5 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

#### 1.6 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

### PART 2 - PRODUCTS

#### 2.1 SCHEDULED DOOR HARDWARE

- A. Refer to "PART 3 – EXECUTION" for required specification sections.

## PART 3 - EXECUTION

### 3.1 DOOR HARDWARE SETS

- A. The door hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
1. Quantities listed are for each pair of doors, or for each single door.
  2. The supplier is responsible for handling and sizing all products.
  3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
  4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.
- B. Products listed in the hardware sets shall be supplied by and in accordance with the requirements described in the specification section as noted for each item.
1. Section 08 17 00 – Integrated Door Opening Assemblies.
  2. Section 08 71 00 – Door Hardware (unless noted otherwise).
  3. Section 28 15 00 (Div 28) – Access Control Hardware Devices.
- C. Manufacturer's Abbreviations:
1. MK - McKinney
  2. MR - Markar
  3. PE - Pemko
  4. RI - RITE Door
  5. SU - Securitron
  6. RO - Rockwood
  7. RU - Corbin Russwin
  8. AD - Adams Rite
  9. RF - Rixson
  10. NO - Norton
  11. OT – Other

### Hardware Sets

#### Set: 1.0

Description: Exterior Alum Pair - Card Access; Auto

2 Continuous Hinge	CFM-SLF-HD1-M EL-CEPTx32D	PE
1 Magnetic Lock (double)	DM62BD	SU

2	Dual Sense Touch Bar	DSB-CL		SU
2	Door Pull (straight)	BF 112	US32D	RO
2	Concealed Overhead Stop	6-X36	630	RF
1	Closer (Reg or PA)	DC8200 / DC8210	689	RU
1	Door Operator (hard-wired)	5831xLPB 24VDC	689	NO
1	Threshold (coord w/ details)	2010APK Frost Guard FHSL14SS-2		PE
4	Door & Frame Wire Harness	QC-Series		MK
1	Emerg Exit Button (pneumatic)	EEB2		SU
1	Bollard	530POST (prep card reader & switch)		NO
1	Wireless Interface Module	ADA1028W		NO
1	Hard-Wired Kit (24VDC output)	ADA1015P		NO
2	Door Switch	501 (sgl or 2-gang elec box)		NO
1	Power Supply	AQD-8F8R Series (coord w/ security)		SU
1	Card Reader	Owner furnished, Contractor installed		
1	Weather Seals	Supplied with door & frame assembly		00
1	Remote Release Button	TS-33		AC

Notes: Provide KCFM hinge where required to suit door mfg. Provide (2) M62BD maglocks where a DM62 will not fit. (Typ)

Operation: Doors are normally closed and secured. Valid card at reader (or signal from remote release button at reception, where shown) unlocks maglock for momentary access, then enables outside actuator. Inside actuator unlocks maglock, then auto opens door. Monitoring by internal door position switch/bond sensor. During a loss of power the maglock will unlock immediately. Free egress at all times via touch bar built-in switch. Maglock status will change to unlocked when fire detection/suppression systems are activated. Emergency exit button will unlock maglock for 30 seconds.

**Set: 2.0**

Description: Exterior Alum Single - Card Access; Auto

1	Continuous Hinge	CFM-SLF-HD1-M EL-CEPTx32D		PE
1	Magnetic Lock	M62BD		SU
1	Dual Sense Touch Bar	DSB-CL		SU
1	Door Pull (straight)	BF 112	US32D	RO
1	Concealed Overhead Stop	6-X36	630	RF
1	Door Operator (hard-wired)	5831xLPB 24VDC	689	NO
1	Threshold (coord w/ details)	2010APK Frost Guard FHSL14SS-2		PE
1	Door & Frame Wire Harness	QC-Series		MK
1	Emerg Exit Button (pneumatic)	EEB2		SU
1	Bollard	530POST (prep card reader & switch)		NO
1	Wireless Interface Module	ADA1028W		NO
1	Hard-Wired Kit (24VDC output)	ADA1015P		NO
1	Door Switch	501 (sgl or 2-gang elec box)		NO
1	Power Supply	AQD-8F8R Series (coord w/ security)		SU
1	Card Reader	Owner furnished, Contractor installed		
1	Weather Seals	Supplied with door & frame assembly		00

Notes: Provide KCFM hinge where required to suit door mfg.

Operation: Doors are normally closed and secured. Valid card at reader (or signal from remote release button at reception, where shown) unlocks maglock for momentary access, then enables outside actuator. Inside actuator unlocks maglock, then auto opens door. Monitoring by internal door position switch/bond sensor. During a loss of power the maglock will unlock immediately. Free egress at all times via touch bar built-in switch. Maglock status

will change to unlocked when fire detection/suppression systems are activated. Emergency exit button will unlock maglock for 30 seconds.

**Set: 3.0**

Description: Exterior Alum Pair

2 Continuous Hinge	CFM-SLF-HD1-M EL-CEPTx32D		PE
1 Magnetic Lock (double)	DM62BD		SU
2 Dual Sense Touch Bar	DSB-CL		SU
2 Door Pull (straight)	BF 112	US32D	RO
2 Concealed Overhead Stop	6-X36	630	RF
2 Closer (Reg or PA)	DC8200 / DC8210	689	RU
1 Threshold (coord w/ details)	2010APK Frost Guard FHSL14SS-2		PE
4 Door & Frame Wire Harness	QC-Series		MK
1 Emerg Exit Button (pneumatic)	EEB2		SU
1 Power Supply	AQD-8F8R Series (coord w/ security)		SU
1 Weather Seals	Supplied with door & frame assembly		00

Notes:

Operation: Doors are normally closed and secured. Monitoring by internal door position switch/bond sensor. During a loss of power the maglock will unlock immediately. Free egress at all times via touch bar built-in switch. Maglock status will change to unlocked when fire detection/suppression systems are activated. Emergency exit button will unlock maglock for 30 seconds.

**Set: 4.0**

Description: Exterior Alum Pair - Exit Only

2 Continuous Hinge	CFM-SLF-HD1-M EL-CEPTx32D		PE
1 Magnetic Lock (double)	DM62BD		SU
2 Dual Sense Touch Bar	DSB-CL		SU
2 Concealed Overhead Stop	6-X36	630	RF
2 Closer (Reg or PA)	DC8200 / DC8210	689	RU
1 Threshold (coord w/ details)	2010APK Frost Guard FHSL14SS-2		PE
4 Door & Frame Wire Harness	QC-Series		MK
1 Emerg Exit Button (pneumatic)	EEB2		SU
1 Power Supply	AQD-8F8R Series (coord w/ security)		SU
1 Weather Seals	Supplied with door & frame assembly		00

Notes:

Operation: Doors are normally closed and secured. Monitoring by internal door position switch/bond sensor. During a loss of power the maglock will unlock immediately. Free egress at all times via touch bar built-in switch. Maglock status will change to unlocked when fire detection/suppression systems are activated. Emergency exit button will unlock maglock for 30 seconds.

**Set: 5.0**

Description: Vestibule Alum Pair - Auto

2 Continuous Hinge	CFM-SLF-HD1-M		PE
2 Inactive Pushrail	8099-M0	628	AD
2 Door Pull (straight)	BF 112	US32D	RO
2 Concealed Overhead Stop	6-X36	630	RF
1 Closer (Reg or PA)	DC8200 / DC8210	689	RU

1 Door Operator (hard-wired)	5831xLPB 24VDC	689	NO
1 Threshold (coord w/ details)	272A FHSL14		PE
1 Wireless Interface Module	ADA1028W		NO
1 Hard-Wired Kit (24VDC output)	ADA1015P		NO
1 Door Switch	501 (sgl or 2-gang elec box)		NO
1 Vestibule Switch (dual)	504 (2-gang elec box)		NO
1 Weather Seals	Supplied with door & frame assembly		00

Notes: Provide KCFM hinge where required to suit door mfg.  
 Actuator from either direction auto opens door.

**Set: 6.0**

Description: Vestibule Alum Single - Auto

1 Continuous Hinge	CFM-SLF-HD1-M		PE
1 Inactive Pushrail	8099-M0	628	AD
1 Door Pull (straight)	BF 112	US32D	RO
1 Concealed Overhead Stop	6-X36	630	RF
1 Door Operator (hard-wired)	5831xLPB 24VDC	689	NO
1 Threshold (coord w/ details)	272A FHSL14		PE
1 Wireless Interface Module	ADA1028W		NO
1 Hard-Wired Kit (24VDC output)	ADA1015P		NO
1 Door Switch	501 (sgl or 2-gang elec box)		NO
1 Vestibule Switch (dual)	504 (2-gang elec box)		NO
1 Weather Seals	Supplied with door & frame assembly		00

Notes: Provide KCFM hinge where required to suit door mfg.  
 Actuator from either direction auto opens door.

**Set: 7.0**

Description: Vestibule Alum Pair

2 Continuous Hinge	CFM-SLF-HD1-M		PE
2 Inactive Pushrail	8099-M0	628	AD
2 Door Pull (straight)	BF 112	US32D	RO
2 Concealed Overhead Stop	6-X36	630	RF
2 Closer (Reg or PA)	DC8200 / DC8210	689	RU
1 Threshold (coord w/ details)	272A FHSL14		PE
1 Weather Seals	Supplied with door & frame assembly		00

Notes: Provide KCFM hinge where required to suit door mfg.

**Set: 8.0**

Description: Vestibule Alum Pair (Rated) - Natatorium

2 Continuous Hinge	CFM-SLF-HD1-M		PE
2 Exit Device (SVR, LBR, passage)	ED5470B N910ET M55	630	RU
2 Concealed Overhead Stop	6-X36	630	RF
2 Closer (Reg or PA)	DC8200 / DC8210	689	RU
1 Threshold (coord w/ details)	272A FHSL14		PE
1 Weather Seals	Supplied with door & frame assembly		00

Notes: Provide KCFM hinge where required to suit door mfg. Coordinate hardware with alum door manufacturer.

**Set: 9.0**

Description: Exterior HM Pair - Card Access

2	Continuous Hinge	FM300 EL-CEPTx32D	630	MR
1	Magnetic Lock (double)	DM62BD		SU
2	Dual Sense Touch Bar	DSB-CL		SU
2	Door Pull (straight)	BF 112	US32D	RO
2	Closer (Unitrol)	DC8210 A11	689	RU
2	Kick Plate	K1050 10"	US32D	RO
2	Astragal	305CN		PE
1	Rain Guard	346C		PE
1	Head & Jamb Gasketing	2891APK		PE
2	Sweep	345AV		PE
1	Threshold (coord w/ details)	2010APK Frost Guard FHSL14SS-2		PE
4	Door & Frame Wire Harness	QC-Series		MK
1	Emerg Exit Button (pneumatic)	EEB2		SU
1	Power Supply	AQD-8F8R Series (coord w/ security)		SU
1	Card Reader	Owner furnished, Contractor installed		

**Notes:**

Operation: Doors are normally closed and secured. Valid card at reader unlocks maglocks for momentary access. Monitoring by internal door position switch/bond sensor. During a loss of power the maglock will unlock immediately. Free egress at all times via touch bar built-in switch. Maglock status will change to unlocked when fire detection/suppression systems are activated. Pressing emergency exit button will unlock maglock for 30 seconds.

**Set: 10.0**

Description: Exterior HM Pair - Card Access; Auto; Remote Release

2	Continuous Hinge	FM300 EL-CEPTx32D	630	MR
1	Magnetic Lock (double)	DM62BD		SU
2	Dual Sense Touch Bar	DSB-CL		SU
2	Door Pull (straight)	BF 112	US32D	RO
1	Closer (Unitrol)	DC8210 A11	689	RU
1	Door Operator (hard-wired)	5831xLPB 24VDC	689	NO
2	Kick Plate	K1050 10"	US32D	RO
2	Astragal	305CN		PE
1	Rain Guard	346C		PE
1	Head & Jamb Gasketing	2891APK		PE
2	Sweep	345AV		PE
1	Threshold (coord w/ details)	2010APK Frost Guard FHSL14SS-2		PE
4	Door & Frame Wire Harness	QC-Series		MK
1	Emerg Exit Button (pneumatic)	EEB2		SU
1	Wireless Interface Module	ADA1028W		NO
1	Hard-Wired Kit (24VDC output)	ADA1015P		NO
2	Door Switch	501 (sgl or 2-gang elec box)		NO
1	Power Supply	AQD-8F8R Series (coord w/ security)		SU
1	Card Reader	Owner furnished, Contractor installed		
1	Remote Release Button	TS-33		AC

**Notes:**

Operation: Doors are normally closed and secured. Valid card at reader (or signal from remote release button, where shown) unlocks maglock for momentary access, then enables outside actuator. Inside actuator unlocks maglock, then auto opens door. Monitoring by internal door position switch/bond sensor. During a loss of power the maglock will

unlock immediately. Free egress at all times via touch bar built-in switch. Maglock status will change to unlocked when fire detection/suppression systems are activated. Emergency exit button will unlock maglock for 30 seconds.

**Set: 11.0**

Description: Corridor Integrated Assembly Pair - Hold Open

2 Continuous Hinge	D309 (Section 081700)	630	RI
2 Recessed Panic (LBR)	D3676 MEC (081700)	US32D	RI
2 Lever Trim (classroom)	D3080 x matching lever (081700)	US32D	RI
2 Cylinder	As required	626	RU
2 Door Closer (pocket)	D-DCT-351PKT90 (Section 081700)	EN	RI
2 Electromagnetic Holder	D-MDH-310 (or to suit pocket depth, 081700)	689	RI
1 Head; Jamb; Mtg Stile Seal Kit	D-SS-STK-DBZ (Section 081700)	Dark Bronze	RI

Notes: Interface with building fire alarm system to release door(s) from hold open.

**Set: 12.0**

Description: Assembly Area Pair; Weights / Cardio; Natatorium Pair - Panic; Card Access

6 Hinge (heavy weight)	T4A3786	US26D	MK
2 Electric Power Transfer	EL-CEPT	630	SU
1 Access Control SVR Exit, LBR (Div 28)	ED5470N-SN200 N9S605ET BIPS B03 M55	630	RU
1 Surface Vert Rod Exit, Exit Only	ED5470 EO M55 M92 M51	630	RU
2 Closer (Reg or PA)	DC8200 / DC8210	689	RU
2 Kick Plate	K1050 10"	US32D	RO
2 Door Stop	400 / 441CU; overhead per part 2	US26D	RO
1 Astragal (adhesive, edge)	S772D		PE
1 Head & Jamb Gasketing (adhesive)	S88BL (HM frames)		PE
4 Door & Frame Wire Harness	QC-Series		MK
1 Power Supply	AQD-8F8R Series (coord w/ security)		SU

Notes: Coordinate hardware with aluminum door manufacturer at alum doors. Provide fire-rated hardware at rated conditions.

Provide CFM-SLF-HD1-M EL-CEPT hinges for aluminum doors.

Operation: Door is normally closed and locked. Valid card at reader unlocks outside lever for momentary access. Monitoring by door position switch. During a loss of power the door will default to secure. Free egress at all times. Lock status will not change when the fire detection/suppression systems are activated. Depressing pushrail will activate request to exit switch for appropriate monitor by EAC systems. Outside key override.

**Set: 13.0**

Description: Single Interior - Panic; Card Access

3 Hinge (heavy weight)	T4A3786	US26D	MK
1 Electric Power Transfer (no wires)	CEPT-NW	630	SU
1 Access Control Exit Device (PoE)	Owner provided, Contractor installed (Div 28)	630	RU
1 Closer (Reg or PA)	DC8200 / DC8210	689	RU
1 Kick Plate	K1050 10"	US32D	RO
1 Door Stop	400 / 441CU; overhead per part 2	US26D	RO
1 Head & Jamb Gasketing (adhesive)	S88BL (HM frames)		PE
1 PoE Door & Frame Wire Harness	PoE-Series		MK

Notes: Coordinate hardware with door manufacturer at aluminum doors. Provide CFM-SLF-HD1-M CEPT hinges for aluminum doors.

Operation: Door is normally closed and secured. Valid card at reader unlocks outside lever for momentary access. Monitoring by door position switch. During a loss of power the door will default to secure. Free egress at all times. Depressing pushrail will activate request to exit switch for appropriate monitor by EAC systems. No Outside key override.

**Set: 14.0**

Description: Storage

3 Hinge, Full Mortise	TA2714	US26D	MK
1 Storeroom Lock	ML2057 NSA	626	RU
1 Closer (Reg or PA)	DC8200 / DC8210	689	RU
1 Kick Plate	K1050 10"	US32D	RO
1 Door Stop	400 / 441CU; overhead per part 2	US26D	RO
3 Silencer	608		RO

**Set: 15.0**

Description: Weight Rm / Cardio Pair - Mech Hold Open 180 Deg

6 Hinge (heavy weight)	T4A3786	US26D	MK
1 Dust Proof Strike	570	US26D	RO
2 Flush Bolt	555	US26D	RO
1 Classroom Lock	ML2055 NSA	626	RU
1 Half Dummy Trim	ML2050 NSA	626	RU
2 Surface Closer w/ Hold Open	DC8210 A2	689	RU
2 Kick Plate	K1050 10"	US32D	RO
2 Door Stop	400 / 441CU; overhead per part 2	US26D	RO
2 Silencer	608		RO

**Set: 16.0**

Description: Single Interior - Card Access

3 Hinge (heavy weight)	T4A3786	US26D	MK
1 Electric Power Transfer (no wires)	CEPT-NW	630	SU
1 Access Control Mort Lock (PoE)	Owner provided, Contractor installed (Div 28)	626	RU
1 Closer (Reg or PA)	DC8200 / DC8210	689	RU
1 Kick Plate	K1050 10"	US32D	RO
1 Door Stop	400 / 441CU; overhead per part 2	US26D	RO
1 Head & Jamb Gasketing (adhesive)	S88BL (HM frames)		PE
1 PoE Door & Frame Wire Harness	PoE-Series		MK

Notes: Alum frames are supplied with integral perimeter gasketing (typ).  
Provide CFM-SLF-HD1-M CEPT hinges for aluminum doors and omit kickplate.

Operation: Door is normally closed and secured. Valid card at reader unlocks outside lever for momentary access. Monitoring by door position switch. During a loss of power the door will default to secure. Free egress at all times. Rotating inside lever will activate request to exit switch for appropriate monitor by EAC systems. No Outside key override.

**Set: 17.0**

Description: Single Interior - Card Access; Remote Release

3 Hinge (heavy weight)	T4A3786	US26D	MK
1 Electric Power Transfer (no wires)	CEPT-NW	630	SU



1 Access Control Mort Lock (PoE)	Owner provided, Contractor installed (Div 28)	626	RU
1 Closer (Reg or PA)	DC8200 / DC8210	689	RU
1 Kick Plate	K1050 10"	US32D	RO
1 Door Stop	400 / 441CU; overhead per part 2	US26D	RO
1 Head & Jamb Gasketing (adhesive)	S88BL (HM frames)		PE
1 PoE Door & Frame Wire Harness	PoE-Series		MK

Notes: Alum frames are supplied with integral perimeter gasketing.

Operation: Door is normally closed and secured. Valid card at reader (or signal from remote switch at reception) unlocks outside lever for momentary access. Monitoring by door position switch. During a loss of power the door will default to secure. Free egress at all times. Rotating inside lever will activate request to exit switch for appropriate monitor by EAC systems. No Outside key override.

**Set: 18.0**

Description: Pair Interior - Card Access

6 Hinge (heavy weight)	T4A3786	US26D	MK
1 Electric Power Transfer (no wires)	CEPT-NW	630	SU
1 Dust Proof Strike	570	US26D	RO
1 Constant-Latching Flush Bolts	2845	US32D	RO
1 Access Control Mort Lock (PoE)	Owner provided, Contractor installed (Div 28)	626	RU
1 Closer (Reg or PA)	DC8200 / DC8210	689	RU
2 Kick Plate	K1050 10"	US32D	RO
2 Door Stop	400 / 441CU; overhead per part 2	US26D	RO
1 Astragal (adhesive, edge)	S772D		PE
1 Astragal (flat bar)	357SP		PE
1 Head & Jamb Gasketing (adhesive)	S88BL (HM frames)		PE
1 PoE Door & Frame Wire Harness	PoE-Series		MK

Notes: Alum frames are supplied with integral perimeter gasketing.

Operation: Door is normally closed and secured. Valid card at reader unlocks outside lever for momentary access. Monitoring by door position switch. During a loss of power the door will default to secure. Free egress at all times. Rotating inside lever will activate request to exit switch for appropriate monitor by EAC systems. No Outside key override.

**Set: 19.0**

Description: Pair Interior - Card Access (VIF existing conditions)

6 Hinge (heavy weight)	T4A3786	US26D	MK
1 Electric Power Transfer (no wires)	CEPT-NW	630	SU
1 Dust Proof Strike	570	US26D	RO
1 Constant-Latching Flush Bolts	2845	US32D	RO
1 Access Control Mort Lock (PoE)	Owner provided, Contractor installed (Div 28)	626	RU
1 Closer (Reg or PA)	DC8200 / DC8210	689	RU
2 Kick Plate	K1050 10"	US32D	RO
2 Door Stop	400 / 441CU; overhead per part 2	US26D	RO
1 Astragal (adhesive, edge)	S772D		PE
1 Astragal (flat bar)	357SP		PE
1 Head & Jamb Gasketing (adhesive)	S88BL (HM frames)		PE
1 PoE Door & Frame Wire Harness	PoE-Series		MK

Notes: Prep & modify existing frame for new hardware.

Operation: Door is normally closed and secured. Valid card at reader unlocks outside lever for momentary access. Monitoring by door position switch. During a loss of power the door will default to secure. Free egress at all times. Rotating inside lever will activate request to exit switch for appropriate monitor by EAC systems. No Outside key override.

**Set: 20.0**

Description: Restroom - Sgl User

3 Hinge (heavy weight)	T4A3786	US26D	MK
1 Privacy Lock w/ Indicator	ML2060 NSA V20	626	RU
1 Closer (Reg or PA)	DC8200 / DC8210	689	RU
1 Kick Plate	K1050 10"	US32D	RO
1 Mop Plate	K1050 4"	US32D	RO
1 Door Stop	400 / 441CU; overhead per part 2	US26D	RO
3 Silencer	608		RO
1 Coat Hook	806	US26D	RO

**Set: 21.0**

Description: Restroom (Multi-User)

3 Hinge (heavy weight)	T4A3386	US32D	MK
1 Deadbolt (dbl cyl classroom)	DL4122	626	RU
1 Push Pull	110x73C/73CL CFC CFTT	US32D	RO
1 Closer (Reg or PA)	DC8200 / DC8210	689	RU
1 Kick Plate	K1050 10"	US32D	RO
1 Mop Plate	K1050 4"	US32D	RO
1 Door Stop	400 / 441CU; overhead per part 2	US26D	RO
3 Silencer	608		RO

**Set: 22.0**

Description: Pool Mech / Chem Storage

3 Hinge (heavy weight)	T4A3386	US32D	MK
1 Storeroom Lock (chem resist)	ML2057 NSA M26	630C	RU
1 Closer w/ Stop	DC8210 A4	689	RU
1 Kick Plate	K1050 10"	US32D	RO
1 Head & Jamb Seals (SS)	319SSN		PE
1 Z-Bracket (to suit seal size)	BKT050; BKT075; BKT1532SP		PE
1 Threshold (SS, coord w/ details)	154SS FHSL14SS		PE

**Set: 23.0**

Description: Pool Mech / Elec / ATS - Panic

3 Hinge (heavy weight)	T4A3386	US32D	MK
1 Exit Device (rim, storeroom, CPC)	ED5200A N957ET	630C	RU
1 Closer w/ Stop	DC8210 A4	689	RU
1 Kick Plate	K1050 10"	US32D	RO
1 Head & Jamb Seals (SS)	319SSN		PE
1 Z-Bracket (to suit seal size)	BKT050; BKT075; BKT1532SP		PE
1 Threshold (SS, coord w/ details)	154SS FHSL14SS		PE

**Set: 24.0**

Description: Waiting to Sick Waiting

3 Hinge (heavy weight)	T4A3786	US26D	MK
1 Passage Latch	ML2010 NSA	626	RU
1 Closer (Reg or PA)	DC8200 / DC8210	689	RU
1 Kick Plate	K1050 10"	US32D	RO
1 Door Stop	400 / 441CU; overhead per part 2	US26D	RO
1 Head & Jamb Gasketing (adhesive)	S88BL (HM frames)		PE

Notes: Alum frames are supplied with integral perimeter gasketing (typ).

END OF SECTION 080671

## SECTION 081103: FIRE-PROTECTIVE FRAMING AND GLAZING SYSTEMS

### PART 1 GENERAL

#### 1.01 SUMMARY

- A. Section Includes: Fire protective framing system.
  - 1. Fire Protective 45 minute fire protective doors and openings for interior applications.
  - 2. Applications of fire protective framing includes:
    - a. Vision lites in fire protective doors, fire protective openings, fire protective sidelites, borrowed lites, and transoms with fire rating requirements as specified.
- B. Related Sections:
  - 1. Section 08 71 00: Door Hardware

#### 1.03 SYSTEM DESCRIPTION

- A. Performance Requirements:
  - 1. Fire Rating: must meet 45 minutes for fire protective doors and openings as specified.
  - 2. Window Certifications: Window assemblies with ratings of less than 60 minutes may be tested in accordance with ASTM E2010-01, NFPA 80, NFPA 257, UL 9, CAN4-S106.
  - 3. Door Certifications: Doors shall be tested in accordance with ASTM E2074-00, NFPA 80, NFPA 252, UL 10C, 10C, or CAN4-S104.
  - 4. Testing Laboratory: Fire test must be conducted by a nationally recognized independent testing laboratory.
  - 5. Glazing: Must use fire protective glazing less than 60 minutes up to the max. size tested. All glazing used in doors, sidelites and other hazardous locations must meet CPSC Cat. I or II impact safety.
  - 6. Max. Door Opening Sizes: must meet maximum sizes of 54 in. x 120 in. for single doors and 108 in. x 120 in. for pair doors. No intermediate rails required. For max. door sizes, continuous hinges may be required.
- B. Listings and Labels:
  - 1. Fire rated framing system shall be under current follow-up service by a nationally recognized independent testing laboratory approved by OSHA and maintain a current listing or certification. Assemblies shall be labeled in accordance with limits of listings.

#### 1.04 SUBMITTALS

- A. Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedure Section.
  - 1. Shop Drawings: Submit shop drawings showing layout, profiles and product components.
  - 2. Samples: Submit samples for finishes, colors and textures.
    - a. Provide sample chips on metal substrate of color, finishes, texture for selection of manufacturer's full range.
    - b. 12"x12" glazing sample for each type of glass.
  - 3. Technical Information: Submit latest edition of manufacturer's product data.

#### 1.05 DELIVERY, STORAGE AND HANDLING

- A. General: Comply with Division 1 Product Requirements Sections.
- B. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
- C. Delivery: Deliver materials to specified destinations in manufacturer's or distributor's packaging undamaged, complete with installation instructions.
- D. Storage and Protection: Store off ground, under cover, protected from weather and construction activities and at temperature conditions recommended by manufacturer.

#### 1.06 FABRICATION DIMENSIONS

- A. Field Measurements: Verify actual measurements for openings by field measurements before fabrication. Show recorded measurements on shop drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

#### 1.07 WARRANTY

- A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fire-rated framing system that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
  - a. Failures include, but are not limited to, the following:
    - i. Structural failures including, but not limited to, excessive deflection.
    - ii. Deterioration of metals or metal finishes, and other materials beyond normal weathering.
    - iii. Failure of operating components to function properly.
  - b. Warranty Period: Five years from date of Substantial Completion.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS – FIRE PROTECTIVE FRAMING AND GLAZING SYSTEMS

- A. Fire - resistive glass and framing shall be provided from a single-source, US manufacturer. Distributors of fire rated glass and framing are not to be considered as manufacturers.
- B. Basis-of-Design; Products for Fire-protective Framing Systems: Subject to project requirements, provide the following or approved equal:
  - a. GPX builder Series Fire Protective Framing as supplied by SAFTI FIRST Fire Rated Glazing Solutions or approved equal
  - b. Glazing Materials: SuperClear 45-HS as supplied by SAFTI FIRST Fire Rated Glazing Solutions in durations specified on drawings and meeting hose stream and radiant heat barrier requirements.

- C. Other Manufacturers:
  - a. 'TGP'- Technical Glass Products
  - b. McGory
  - c. Or approved equal.

## 2.02 MATERIALS – FRAMING

- A. Fire protective framing system for 45 minute doors and openings.
- B. Properties:
  - 1. Constructed in accordance with the individual manufacturer's listings or in accordance with HMMA 861-06 and HMMA 850.
  - 2. Maximum door opening sizes are 54 in. x 120 in. for single doors and 96 in. x 120 in. for pair doors. No intermediate rails required. For max. door sizes, continuous hinges may be required.
  - 3. Standard door profile includes 5 in. rail and 2 in. frame. Narrow door profile includes 3- 3/4 in. rail and 1-1/8 in frame.
  - 4. 10 in. ADA compliant bottom rail
  - 5. 4 to 5 in. door depth

## 2.03 MATERIALS – GLASS

- A. Properties:
  - 1. Fire protective glazing 45 minutes rated and complying with hose stream and radiant heat protection up to the max. size tested.
  - 2. Individual Lites shall be permanently identified with a listing mark.
  - 3. Glazing material installed in "Hazardous Locations" (subject to human impact) shall be certified to meet the applicable requirements for fire rated assemblies referenced in ANSI Z97.1 Standard for Safety Glazing Materials Used In Buildings and/or CPSC 16 CFR 1201 Safety Standard for Architectural Glazing Materials
  - 4. STC: 37 min
- B. Logo: Each piece of fire rated glazing shall be labeled with a permanent logo.

## 2.03 FABRICATION

- A. Assemblies shall be furnished knocked down for field assembly and will be glazed in the field
- B. Door assemblies shall be factory prepared for field mounting of hardware.
- C. Fabrication Dimensions: Fabricate to approved dimensions. The general contractor shall guarantee dimensions within required tolerance. Obtain approved shop drawings prior to fabrication.

## 2.04 FINISHES

- A. Aluminum clad door with high performance 2-coat fluoropolymer finish applied
  - a. Color selected from manufacturer's full range.
- B. Framing to receive with high performance 2-coat fluoropolymer finishes applied
  - a. Color selected from manufacturer's full range

## 2.05 DOOR HARDWARE FOR DOORS

- A. Manufacturer to prep for all hardware with hardware field installed.
- B. Refer to specification 087100 for hardware and 080671 for hardware sets.
- C. Hardware to be coordinated with manufacturer to maintain fire-ratings and UL listing.

## PART 3 EXECUTION

### 3.01 MANUFACTURER'S INSTRUCTIONS

- A. Compliance: Comply with manufacturer's product data including product technical bulletins and installation instructions.

### 3.02 EXAMINATION

- A. Site Verification of Conditions: Verify substrate conditions, have been previously installed under other sections, and are acceptable for product installation in accordance with manufacturer's instructions. Openings shall be plumb, square and within allowable tolerances. The Architect/Engineer shall be notified of any conditions that jeopardize the integrity of the proposed fire wall/door framing system. Do not proceed until such conditions are corrected.

### 3.03 INSTALLATION

- A. Fire door/window installation shall be by a licensed contractor and in strict accordance with the approved shop drawings.

### 3.04 CLEANING AND PROTECTION

- 1. Protect glass from contact with contaminating substances resulting from construction operations. Remove such substances by method approved by manufacturer.
- 2. Wash glass on both faces not more than four days prior to date schedule for inspections intended to establish date of Substantial Completion. Wash glass by method recommended by glass manufacturer.
- 3. Remove temporary coverings and protection of adjacent work areas.
- 4. Remove construction debris from project site and legally dispose of debris.

END OF SECTION

## SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Standard and custom hollow metal doors and frames.
  - 2. Steel sidelight, borrowed lite and transom frames.
  - 3. Louvers installed in hollow metal doors.
  - 4. Light frames and glazing installed in hollow metal doors.

#### 1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.
- B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".
- C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL10C (neutral pressure at 40" above sill) or UL 10C.
  - 1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.
  - 2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
  - 3. Smoke Control Door Assemblies: Comply with NFPA 105.
    - a. Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.
- D. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having



jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.

- E. Energy Efficient Exterior Openings: Comply with minimum thermal ratings, based on ASTM C1363. Openings to be fabricated and tested as fully operable, thermal insulating door and frame assemblies.
  - 1. Thermal Performance (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM C1363 and meet or exceed the following requirements:
    - a. Door Assembly Operable U-Factor and R-Value Ratings: U-Factor 0.37, R-Value 2.7, including insulated door, thermal-break frame and threshold.
  - 2. Air Infiltration (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM E283 to meet or exceed the following requirements:
    - a. Rate of leakage of the door assembly shall not exceed 0.25 cfm per square foot of static differential air pressure of 1.567 psf (equivalent to 25 mph wind velocity).
- F. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.
  - 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

#### 1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

## 1.6 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Building Information Modeling (BIM) Support: Utilize designated BIM software tools and obtain training needed to successfully participate in the Project BIM processes. All technical disciplines are responsible for the product data integration and data reliability of their Work into the coordinated BIM applications.

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
- B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from a SDI Certified manufacturer:
  - 1. CECO Door Products (C).
  - 2. Curries Company (CU).
  - 3. Pioneer Industries (PI).
  - 4. Or approved equal

### 2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

### 2.3 HOLLOW METAL DOORS

- A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.

- B. Exterior Doors (Energy Efficient): Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A924 A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model, ANSI/SDI A250.4 for physical performance level, and HMMA 867 for door construction.
1. Basis of design: Curries Company (CU) - Energy Efficient - 777 Trio-E Series or approved equal subject to performance criteria below..
  2. Design: Flush panel.
  3. Core Construction: Foamed in place polyurethane and steel stiffened laminated core with no stiffener face welds, in compliance with HMMA 867 "Laminated Core".
    - a. Provide 22-gauge steel stiffeners at 6 inches on-center internally welded at 5" on-center to integral core assembly, foamed in place polyurethane core chemically bonded to all interior surfaces. No stiffener face welding is permitted.
    - b. Thermal properties to rate at a fully operable minimum U-Factor 0.37 and R-Value 2.7, including insulated door, thermal-break frame and threshold.
    - c. Kerf Type Frames: Thermal properties to rate at a fully operable minimum U-Factor 0.38 and R-Value 2.6, including insulated door, kerf type frame, and threshold.
  4. Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), Minimum 16 gauge (0.053 inch - 1.3-mm) thick steel, Model 2.
  5. Vertical Edges: Vertical edges to be mechanically interlocked with hairline seam. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
  6. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
  7. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9".
  8. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
  9. Hot-dipped galvanized G90 galvanizing coating
- C. Interior Doors: Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
1. Basis of design Interior doors: Curries Company (CU) - honeycomb Core - 707 Series or approved equal subject to performance criteria below.
  2. Design: Flush panel.
  3. Core Construction: Manufacturer's standard kraft-paper honeycomb, securely bonded to both faces.
    - a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

4. Level/Model: Level 2 and Physical Performance Level B (Heavy Duty), Minimum 18 gauge (0.042-inch - 1.0-mm) thick steel, Model 2.
5. Vertical Edges: Vertical edges to have the face sheets spot welded and filled full height with an epoxy filler. Welds are to be ground, filled and dressed smooth. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
6. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
7. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
8. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
9. Tested STC = 31, OITC = 29
10. Provide hot dipped galvanized G90 galvanizing coating where specified within the door schedule.

## 2.4 HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
- B. Thermal Break Frames: Subject to the same compliance standards and requirements as standard hollow metal frames. Tested for thermal performance in accordance with NFRC 102, and resistance to air infiltration in accordance with NFRC 400. Where indicated provide thermally broken frame profiles available for use in both masonry and drywall construction. Fabricate with 1/16" positive thermal break and integral vinyl weatherstripping.
- C. Exterior Frames: Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A90/G90.
  1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
  2. Frames: Minimum 14 gauge (0.067-inch -1.7-mm) thick steel sheet.
- D. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M. Where noted by door schedule provide with hot-dipped zinc coated steel that complies with ASTM A653/A653M, coating designation A90/G90
  1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
  2. Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
- E. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.
- F. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.
- G. Fill frames with mineralwool insulation

## 2.5 FRAME ANCHORS

- A. Jamb Anchors:
  - 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
  - 2. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.
  - 3. Compression Type for Drywall Slip-on (Knock-Down) Frames (requires Architect approval): Adjustable compression anchors.
- B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.
- C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

## 2.6 LOUVERS

- A. Metal Louvers: Unless otherwise indicated provide louvers to meet the following requirements.
  - 1. Blade Type: Vision proof inverted V or inverted Y.
  - 2. Metal and Finish: G90 Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish. Match pre-finished door paint color where applicable.
- B. Louvers for Fire Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire protection rating of 1-1/2 hours and less.
  - 1. Manufacturers: Subject to compliance with requirements, provide louvers to meet rating indicated.
  - 2. Metal and Finish: G90 Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish. Match pre-finished door paint color where applicable.

## 2.7 LIGHT OPENINGS AND GLAZING

- A. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator's shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.
- B. Moldings for Glazed Lites in Doors and Loose Stops for Glazed Lites in Frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.
- C. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated. Provide fixed frame moldings and stops on outside of exterior and on secure side of interior doors and frames.

- D. Preformed Metal Frames for Light Openings: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated. Match pre-finished door paint color where applicable.

## 2.8 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

## 2.9 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.
- C. Hollow Metal Doors:
  - 1. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.
  - 2. Glazed Lites: Factory cut openings in doors with applied trim or kits to fit. Factory install glazing where indicated.
  - 3. Astragals: Provide overlapping astragals as noted in door hardware sets in Division 08 Section "Door Hardware" on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
  - 4. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge strap for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
  - 5. Electrical Raceways: Provide hollow metal doors to receive electrified hardware with concealed wiring harness and standardized Molex™ plug connectors on both ends to accommodate up to twelve wires. Coordinate connectors on end of the wiring harness to plug directly into the electrified hardware and the through-wire transfer hardware or wiring harness specified in hardware sets in Division 08 Sections "Door Hardware" and "Access Control Hardware". Wire nut connections are not acceptable.
- D. Hollow Metal Frames:
  - 1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
  - 2. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

- a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.
3. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
4. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.
5. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge straps for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
6. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.
7. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.
8. Electrical Knock Out Boxes: Factory weld 18 gauge electrical knock out boxes to frame for electrical hardware preps; including but not limited to, electric through wire transfer hardware, electrical raceways and wiring harnesses, door position switches, electric strikes, magnetic locks, and jamb mounted card readers as specified in hardware sets in Division 08 Sections "Door Hardware" and "Access Control Hardware".
  - a. Provide electrical knock out boxes with a dual 1/2-inch and 3/4-inch knockouts.
  - b. Conduit to be coordinated and installed in the field (Division 26) from middle hinge box and strike box to door position box.
  - c. Electrical knock out boxes to comply with NFPA requirements and fit electrical door hardware as specified in hardware sets in Division 08 Section "Door Hardware".
  - d. Electrical knock out boxes for continuous hinges should be located in the center of the vertical dimension on the hinge jamb.
9. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
10. Jamb Anchors: Provide number and spacing of anchors as follows:
  - a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches on-center and as follows:
    - 1) Two anchors per jamb up to 60 inches high.
    - 2) Three anchors per jamb from 60 to 90 inches high.
    - 3) Four anchors per jamb from 90 to 120 inches high.
    - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
  - b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
    - 1) Three anchors per jamb up to 60 inches high.
    - 2) Four anchors per jamb from 60 to 90 inches high.
    - 3) Five anchors per jamb from 90 to 96 inches high.

- 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
    - 5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.
  11. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".
  12. Bituminous Coating: Where frames are fully grouted with an approved Portland Cement based grout or mortar, coat inside of frame throat with a water based bituminous or asphaltic emulsion coating to a minimum thickness of 3 mils DFT, tested in accordance with UL 10C and applied to the frame under a 3rd party independent follow-up service procedure.
- E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
  2. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
  3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
  4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

## 2.10 STEEL FINISHES

- A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).
- C. Proceed with installation only after unsatisfactory conditions have been corrected.



### 3.2 PREPARATION

- A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.
- C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."
- D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.
- E. Verify tolerances against manufacturers installations instructions for tornado and hurricane storm shelter openings.

### 3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.
  - 1. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
  - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
  - 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
  - 4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
  - 1. Non-Fire-Rated Standard Steel Doors:
    - a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
    - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
    - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
    - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
  - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

- D. Field Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

### 3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

### 3.5 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
  - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

END OF SECTION 081113

## SECTION 081217 INTERIOR ALUMINUM FRAMES AND GLAZING FRAMES

### PART 1 GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### 1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the interior aluminum frames and glazing frames as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:
  - 1. Pre-finished aluminum window frames for interior use.
  - 2. Pre-finished aluminum framing systems for interior use.

#### 1.3 RELATED SECTIONS

- A. Door Hardware - Section 087100.
- B. Glass and Glazing - Section 088000.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer: Provide office partition system manufactured by a single firm specializing in production of this type of work.
- B. Shop Assembly: Preassemble items in shop to greatest extent possible. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- C. Installed partitions shall have a deflection limit of L/240 when subject to a 5 psf uniform lateral load and a concentrated load of 200 lbs.

#### 1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's detailed materials and fabrication specifications and installation instructions. Include catalog cuts of fastenings and other data as required.
- B. Shop Drawings: Submit shop drawings for fabrication and erection of partition assemblies which are not fully described by manufacturer's data. Show anchorage and accessory items and finishes.
- C. Samples: Submit samples of each required finish and color. Prepare samples on same materials which will be used in partition assemblies.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver partition components cartoned or crated to provide protection during transit and job storage.

- B. Inspect partition components upon delivery for damage. Minor damages may be repaired, provided finish items are equal to new work and acceptable to Architect. Remove and replace damaged items as directed.
- C. Store partition components on raised platforms in vertical positions with blocking between units to allow air circulation. Keep stored material covered and protected from damage.

#### 1.7 WARRANTY

- A. Warrant against defects in manufacturing of materials for a period of 2 years from date of substantial completion.
- B. Warrant framing finish against defects, including cracking, flaking, blistering, peeling and excessive fading, chalking and non-uniformity in color for a period of 5 years.

### PART 2 PRODUCTS

#### 2.1 PARTITION SYSTEM

- A. Provide interior aluminum frames Series 200 as manufactured by Wilson Partitions, or approved equal.
  - 1. Extruded Aluminum Frames: Provide frames with 2" snap-on trim profile. System shall be designed to accept 1/4", 3/8" or 1/2" glass as scheduled glass.
  - 2. Snap-On Trim Profile: Rectilinear design, 2" trim, expandable throat from 3" to 9-1/2" or approved equal

#### 2.2 MATERIALS

- A. Aluminum: Extruded aluminum conforming to alloy 6063-T5, ASTM B 221. Exposed fasteners shall be stainless steel. Frames shall be internally reinforced as required for door hardware and to meet performance standard specified herein. Provide door hardware reinforcing as standard with the manufacturer.
- B. Anchorage Devices, Clips and Fasteners: Manufacturer's standard type, compatible with materials being secured.
- C. Finish: Flurocryn coating, complying with AAMA (2603) 603.8 and AA-DAF-45.
  - 1. Factory applied painted finish.
  - 2. Color Coat: Dry film thickness 0.8 +/- 0.05 mil.
  - 3. Color: As selected by Architect.
- D. Glass: refer to glazing schedule
- E. Glazing: Set glass in glazing strips for firm retention and tight seal and to permit easy removal and reinstallation without damage. Loose glazing stops and exposed screws are not acceptable.
- F. Connectors and Accessories: Provide connectors, fasteners, and accessories required for rigid, secure, complete, and finished partition system.

## 2.3 FABRICATION

- A. Pre-machine jambs and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required, and fastened within the frame.
- B. Provide corner reinforcements and alignment clips for precise butt or mitered connections.
- C. Fabricate all components to allow secure installation without exposed fasteners.
- D. Manufacturer shall pre-cut and ship all frame materials knock-down.

## PART 3 EXECUTION

### 3.1 INSPECTION

- A. Examine the areas and conditions where interior aluminum partitions are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected by the Contractor in a manner acceptable to the Architect.

### 3.2 INSTALLATION

- A. Install partitions before floor coverings and after suspended drywall ceilings have been installed. Coordinate partition work with work of other trades which are affected by partition installation. Avoid damage to installed work.
- B. Repair damaged or defaced work or replace with new work, as acceptable to Architect. Completely refinish defaced partition components with factory finished materials or replace defaced components.
- C. Furnish, drill for and install anchoring devices required, and secure partitions to floor, ceiling and walls, using concealed fasteners.
- D. Install partitions rigid, level, plumb and in alignment, with components secure together, in accordance with manufacturer's instructions.
- E. Provide through posts to ceiling, or other concealed supports as required to assure lateral stability of partition runs.
- F. Install continuous and positive seal to prevent light and sound transmission at partition contacts with floor, ceiling, wall and other abutting surfaces.

END OF SECTION

## SECTION 08 1416 - FLUSH WOOD DOORS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Solid core doors with wood veneer faces.
  - 2. Factory finishing wood doors.
  - 3. Light frames and glazing installed in wood doors.

- B. Related Sections:

- 1. Division 08 Section "Door Schedule".
  - 2. Division 08 Section "Hollow Metal Doors and Frames".
  - 3. Division 08 Section "Glazing".
  - 4. Division 08 Section "Door Hardware".

- C. Standards and References: Comply with the version year adopted by the Authority Having Jurisdiction.

- 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
  - 2. ANSI A208.1 – Wood Particleboard.
  - 3. Intertek Testing Service (ITS Warnock Hersey) - Certification Listings for Fire Doors.
  - 4. NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
  - 5. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
  - 6. UL 10C - Positive Pressure Fire Tests of Door Assemblies; UL 1784 - Standard for Air Leakage Tests of Door Assemblies.
  - 7. Window and Door Manufacturers Association - WDMA I.S.1-A Architectural Wood Flush Doors.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of door indicated. Include details of core and edge construction, louvers, trim for openings, and WDMA I.S.1-A classifications. Include factory finishing specifications.

- B. Shop Drawings shall include:

1. Indicate location, size, and hand of each door.
2. Indicate dimensions and locations of mortises and holes for hardware.
3. Indicate dimensions and locations of cutouts.
4. Indicate requirements for veneer matching.
5. Indicate location and extent of hardware blocking.
6. Indicate construction details not covered in Product Data.
7. Indicate doors to be factory finished and finish requirements.
8. Indicate fire protection ratings for fire rated doors.

C. Samples for Initial Selection: For factory finished doors.

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.
2. Corner sections of doors, 8 by 10 inches, with door faces and edges representing actual materials to be used.
  - a. Provide samples for each species of veneer and core material.
  - b. Finish veneer faced door samples with same materials proposed for factory finished doors.
3. Frames for light openings, 6 inches long, for each material, type, and finish required.

D. Warranty: Provide sample of manufacturer's warranty.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer wherever possible.
- B. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, latest edition, "Industry Standard for Architectural Wood Flush Doors".
- C. Fire Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing at positive pressure according to NFPA 252 (neutral pressure at 40" above sill) or UL10C.
  1. Oversize Fire Rated Door Assemblies: For units exceeding sizes of tested assemblies provide manufacturer's construction label, indicating compliance to independent 3<sup>rd</sup> party certification agency's procedure, except for size.
  2. Temperature Rise Limit: Where required and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire test exposure.

3. Smoke Control Door Assemblies: Comply with NFPA 105.

- 1) Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.

- D. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for receiving, handling, and installing flush wood doors.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package pre-finished doors individually in plastic bags and wrap bundles of doors in plastic sheeting.
- C. Mark each door on top rail with opening number used on Shop Drawings.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
    - b. Telegraphing of core construction in wood face veneers exceeding 0.01 inch in a 3-inch span.
  2. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.
  3. Warranty Period for Solid Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 DOOR CONSTRUCTION – GENERAL

- A. WDMA I.S.1-A Performance Grade: Extra Heavy Duty; Aesthetic Grade: Premium.



B. Fire Rated Doors: Provide construction and core as needed to provide fire ratings indicated.

1. Category A Edge Construction: Provide fire rated door edge construction with intumescent seals concealed by outer stile (Category A) at 45, 60, and 90 minute rated doors. Comply with specified requirements for exposed edges.
2. Pairs: Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
  - a. Provide fire retardant stiles that are listed and labeled for applications indicated without formed steel edges and astragals.

## 2.2 CORE CONSTRUCTION

A. Structural Composite Lumber Core Doors:

1. Structural Composite Lumber: Engineered hardwood composite wood products tested in accordance with WDMA I.S.1A, Testing Cellulosic Composite Materials for Use in Fenestration Products containing no added Urea Formaldehyde.

## 2.3 BLOCKING

A. Non-Fire-Rated Doors:

1. Blocking is not required when using SCLC or SLC doors.

B. Fire Rated Doors:

1. Provide blocking as indicated below:
  - a. HB1: 5 inch in doors indicated to have closers and overhead stops.
  - b. HB4: Two 5 inch x 14 inch lock blocking, in doors indicated to have exit devices.
  - c. HB5: Two 5 inch x 14 inch corner blocking, in doors indicated to have flush bolts.
  - d. HB8: Two 5 inch x 14 inch corner blocking and two 5 inch x 14 inch lock blocking on doors to have vertical rod exit devices.

## 2.4 VENEERED DOORS FOR TRANSPARENT FINISH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. VT industries
2. Masonite Industries
3. Mohawk
4. Or approved equal

B. Interior Solid Core Doors:

1. Grade: Premium.
2. Faces: Veneer grades as noted below; veneer minimum 1/50-inch (0.5mm) thickness at moisture content of 12% or less.
  - a. Plain Rift Sawn Oak, AA grade faces stained as approved by architect.
3. Match between Veneer Leaves: Book match.
4. Assembly of Veneer Leaves on Door Faces:
  - a. Running Match.
5. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
6. Transom Match: Continuous match.
7. Vertical Edges: Matching same species as faces. Wood or composite material, one piece, laminated, or veneered. Minimum requirements per WDMA section P-1, Performance Standards for Architectural Wood Flush Doors.
8. Horizontal Edges: Solid wood or structural composite material meeting the minimum requirements per WDMA section P-1, Performance Standards for Architectural Wood Flush Doors
9. Construction: Five plies. Stiles and rails are bonded to core, then entire unit sanded before applying face veneers.
10. At doors over 40% of the face cut-out for lights and or louvers, furnish engineered composite lumber core.

## 2.5 LIGHT FRAMES AND GLAZING

- A. Wood Beads for Light Openings in Wood Doors up to and including 20-minute rating:
  1. Wood Species: Same species as door faces.
  2. Profile:
    - a. M1 Flush Bead.
    - b. At wood core doors with 20-minute fire protection ratings, provide wood beads and metal glazing clips approved for such use.
- B. Metal Frames for Light Openings in Fire Rated Doors over 20-minute Rating: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated.
  1. Manufacturers:
    - a. Air Louver.
    - b. All Metal Stamping.

- c. Anemostat.
- d. Pemko
- e. Or approved equal.

- C. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with the flush wood door manufacturer's written instructions.

## 2.6 FABRICATION

- A. Factory fit doors to suit frame opening sizes indicated.
  - 1. Comply with requirements in NFPA 80 for fire rated doors.
  - 2. Undercut: As required per manufacturer's templates and sill condition.
- B. Factory machine doors for hardware that is not surface applied. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
  - 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
  - 2. Metal Astragals: Factory machine astragals and formed steel edges for hardware for pairs of fire rated doors.
- C. Openings: Cut and trim openings through doors in factory.
  - 1. Light Openings: Trim openings with moldings of material and profile indicated.
  - 2. Glazing: Comply with applicable requirements in Division 08 Section "Glazing."
  - 3. Louvers: Factory install louvers in prepared openings.
- D. Electrical Raceways: Provide flush wood doors receiving electrified hardware with concealed wiring harness and standardized Molex™ plug connectors on both ends to accommodate up to twelve wires. Coordinate connectors on end of the wiring harness to plug directly into the electrified hardware and the through wire transfer hardware or wiring harness specified in hardware sets in Division 08 "Door Hardware". Wire nut connections are not acceptable.

## 2.7 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
  - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Transparent Finish: Provide a clear protective coating over the wood veneer allowing the natural color and grain of the selected wood species to provide the appearance specified. Stain is applied to the wood surface underneath the transparent finish to add color and design flexibility.
  - 1. Finish: Meet or exceed WDMA I.S. 1A TR8 UV Cured Acrylated Polyester finish performance requirements.
  - 2. Staining:

- a. As selected by Architect from manufacturer's full range.
  - b. Custom stain to match architect's sample.
3. Sheen: Satin.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine doors and installed door frames before hanging doors.
  1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
  2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Hardware: For installation, see Division 8 Section "Door Hardware."
- B. Installation Instructions: Install doors and frames to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
  1. Install fire rated doors in corresponding fire rated frames according to NFPA 80.
- C. Factory Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory Finished Doors: Restore finish before installation if fitting or machining is required at Project site.
- E. Field modifications to doors shall not be permitted, except those specifically allowed by manufacturer or fire rating requirements.

#### 3.3 ADJUSTING

- A. Operation: Re-hang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08 1416

## SECTION 081700 – INTEGRATED DOOR OPENING ASSEMBLIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Integrated door opening assemblies including metal frame, integrated door system with operating hardware, and associated door hardware as specified in this section.
  - 2. Factory fitting and hardware preparation for doors and frames.
- B. Standards: All hardware specified herein to comply with the current version year of the following industry standards:
  - 1. ANSI/BHMA Certified Product Standards, A156 Series.

#### 1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including integrated opening assembly construction and installation details, material descriptions, core descriptions, hardware reinforcements, profiles, anchorage, fire resistance rating, operational descriptions and finishes.
- B. Door Hardware Schedule: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Include the following information:
  - 1. Type, style, function, size, label, hand, and finish of each door hardware item.
  - 2. Manufacturer of each item.
  - 3. Fastenings and other pertinent information.
  - 4. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
  - 5. Explanation of abbreviations, symbols, and codes contained in schedule.
  - 6. Mounting locations for door hardware.
- C. Shop Drawings: Include the following:
  - 1. Elevations of each door design.
  - 2. Details of door and frames types including dimensioned profiles and metal thicknesses.
  - 3. Locations of reinforcement and preparations for hardware.
  - 4. Details of anchorages, joints, field splices, and connections.
  - 5. Details of accessories.

6. Details of moldings, removable stops, and glazing.
  7. Details of conduit and preparations for power, signal, and control systems.
  8. Provide all dimensions necessary required to complete recessed pockets.
- D. Keying Schedule: Reference Division 08 Section "Door Hardware" for keying requirements.
- E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete integrated assembly installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the installed assemblies and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.
- F. Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.
- 1.4 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products to the project site under provisions Division 01 Section "Product Storage and Handling Requirements". Inspect doors, frames, and hardware with representatives of the supplier to verify shipment is complete and to rectify discrepancies promptly.
1. Integrated door assembly systems to be delivered to the job site complete with necessary screws, miscellaneous parts, instructions, and installation templates. Each package legibly and properly labeled to correspond to the approved Door Schedule.
- B. Furnish integrated door opening assemblies with operating hardware flush to door skin, using protective wrappings and spacers between projecting hardware. Maintain and protect door assemblies using cardboard spacers and protective edge guards along the door edges, to reduce exposure to marring or damage during storage.
- C. Store integrated door opening assemblies in dry and secure area. Do not store electronic access control software, credentials, or accessories at Project site without prior authorization.
- 1.5 PROJECT CONDITIONS
- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.
- 1.6 COORDINATION
- A. Building Information Modeling (BIM) Support: Utilize designated BIM software tools and obtain training needed to successfully participate in the Project BIM processes. All technical disciplines are responsible for the product data integration and data reliability of their Work into the coordinated BIM applications.
- B. Electrical Connections: Coordinate the layout and installation of scheduled electrified hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- 1.7 WARRANTY
- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article will not deprive Owner of other rights Owner may have under other provisions of

the Contract Documents and are in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- B. Warranty Periods: Manufacturer's standard written form, with the exceptions noted below, warranting integrated door opening assemblies to be free of defect in material or workmanship under normal use for a period of five (5) years.
  - 1. Hollow Metal Doors: Lifetime.
  - 2. Hinges: Up to twenty-five (25) years based upon model and manufacturer.
  - 3. Continuous Hinges: Ten (10) years.
  - 4. Door Closers: Up to twenty-five (25) years based upon model and manufacturer.
  - 5. Electrical Products (except MLR exit devices): Three (3) years.
- C. Warranty includes the manufacturer, at their sole option, agreeing to repair or replace products or parts found to be defective in material or workmanship according to details contained in the warranty certificate.

#### 1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of integrated door opening assemblies.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Adams Rite Manufacturing (RD) - The RITE Door.
  - 2. Total Door systems
  - 3. Or approved equal

#### 2.2 STEEL MATERIAL REQUIREMENTS

- A. General:
  - 1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
  - 2. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- B. Hollow Metal Doors: Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
  - 1. Design: Flush panel.
  - 2. Core Construction: Manufacturer's standard vertical steel-stiffener core. Minimum 22 gauge steel-stiffeners at 6 inches on-center construction attached by spot welds spaced

not more than 5" on centers. Spaces between stiffeners filled with fiberglass insulation (minimum density 0.8#/cubic ft.).

- 1). Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated within the door schedule.
  3. Level/Model: Level 2 and Physical Performance Level B (Heavy Duty), Minimum 18 gauge (0.042-inch - 1.0-mm) thick steel, Model 2.
  4. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet.
  5. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
  6. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
- C. Steel Frames:
- Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M. Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
1. Fabricate frames with mitered or coped corners.
  2. Fabricate frames with "closed and tight" miter seams continuously welded on face, finished smooth with no visible seam unless otherwise indicated.
  3. Frames for openings up to 48 inches in width: Minimum 16 gauge thick steel sheet.
  4. Frames for openings 48 inches and wider in width: Minimum 14 gauge thick steel sheet.
  5. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.
  6. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.
  7. Provide suitable adjustable type anchors for wall condition, minimum 4 each per jamb.

### 2.3 DOOR HARDWARE MATERIAL REQUIREMENTS:

- A. Provide a complete integrated door opening assembly, including the installation and adjustment of the latching mechanism within the door construction.
- B. Door hardware to include the following minimum products for each integrated door opening assembly as specified in the Door Hardware Sets under Part 3.
  1. Hanging Device: Continuous Hinges (geared or pinned), Pocket Pivots, Offset/Intermediate Pivots, or Butt Hinges.
  2. Integrated Locking/Latching Hardware: Exit Devices, Lever Handle Trim, or Flush Push/Pulls.
- C. Integrated exit device hardware to be clean and unobtrusive in design with a minimal bar height of 2-7/16-inches. Push rails not exceed a projection of 1-1/8-inches when in the latched position and be made of heavy duty aluminum extrusion, available in anodized and architectural finishes



using metal cladding. Exit device end caps to be of metal construction, and should match the trim cover caps when available.

- D. Push and pull hardware to be clean and unobtrusive in design with a maximum projection of 1/4-inches on pull side and 5/8-inches on the push side. To be used on hollow metal doors only.
- E. Lever handles to be clean and unobtrusive in design with a maximum projection of 3-1/2-inches and match design of similar lever locking hardware furnished on project.
- F. Door hardware may include the following optional products for each integrated door opening assembly as specified in the Door Hardware Sets under Part 3:
  - 1. Door Closers: Surface Closer or Pocket Closer.
  - 2. Accessory Items: Magnetic Holders, Protection Plates, Edge Guards, Astragals, Smoke Seals.

## 2.4 FINISH REQUIREMENTS

- A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.
  - 1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.
- B. HPDL Wrapped: Color and pattern as selected by the architect.
- C. Embossed Wood Grain Pattern: Color and pattern as selected by the architect from the manufacturer's standard range.
- D. Hardware Finishes: As specified in Hardware Sets.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify the accuracy of dimensions given to the integrated door opening assembly manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Beginning of installation indicates acceptance of the existing conditions.
- D. Verify power supplies, as required, are available to power electrically operated devices.

### 3.2 INSTALLATION

- A. General: Install integrated door opening assemblies plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; integrated locking/latching devices; closing devices; and seals.
  - C. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
    1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
    2. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
    3. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
  - D. Coordinate installation and interface wiring with fire alarm and smoke detection systems.
  - E. Remove or protect furnished hardware accessories, prior to painting or finishing completed after the installation of the hardware accessories.
- 3.3 FIELD QUALITY CONTROL
- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
    1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.
- 3.4 ADJUSTMENT
- A. Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Remove and replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
- 3.5 CLEANING AND PROTECTION
- A. Protect all door opening assemblies and hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install hardware at the latest possible time frame.
  - B. Clean operating items as necessary to restore proper finish and provide final protection and maintain conditions that ensure integrated door and operating hardware is without damage or deterioration at time of owner occupancy.
  - C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer or finish paint.

**3.6 DEMONSTRATION**

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain integrated door opening assemblies and hardware.

**3.7 HARDWARE SETS**

- A. The integrated door opening hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

END OF SECTION 081700

## **SECTION 08 3110 - ACCESS DOORS AND FRAMES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Access doors and frames for walls and ceilings.

#### **1.2 SUBMITTALS**

- A. Product Data: For each type of access door and frame indicated. Include construction details, fire ratings, materials, individual components, profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details of access doors and frames for each type of substrate. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each door face material, at least 3 by 5 inches in size, in specified finish.
- D. Access Door and Frame Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.
- E. Ceiling Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including access doors and frames, lighting fixtures, diffusers, grilles, speakers, sprinklers, and special trim are shown and coordinated with each other.

#### **1.3 QUALITY ASSURANCE**

- A. Source Limitations: Obtain each type of access door and frame through one source from a single manufacturer.
- B. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
1. NFPA 252 for vertical access doors and frames.
  2. ASTM E 119 for horizontal access doors and frames.
- C. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

#### **1.4 COORDINATION**

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed plumbing, mechanical, or other concealed work, and indicate in the schedule specified in "Submittals" Article.

## **PART 2 - PRODUCTS**

### **2.1 STEEL MATERIALS**

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
  - 1. ASTM A 123/A 123M, for galvanizing steel and iron products.
  - 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
- B. Steel Sheet: Electrolytic zinc-coated, ASTM A 879/A 879M with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Steel Finishes: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Surface Preparation for Steel Sheet: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
    - a. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
  - 2. Factory-Primed Finish: Apply shop primer immediately after cleaning and pretreating.
- D. Drywall Beads: Edge trim formed from 0.0299-inch zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.

### **2.2 STAINLESS-STEEL MATERIALS**

- A. Rolled-Stainless-Steel Floor Plate: ASTM A 793, manufacturer's standard finish.
- B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 316. Remove tool and die marks and stretch lines or blend into finish.
  - 1. Finish: Directional Satin Finish, No. 4.

### **2.3 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Acudor Products, Inc.
  - 2. Babcock-Davis; A Cierra Products Co.
  - 3. Dur-Red Products.
  - 4. J. L. Industries, Inc.
  - 5. Karp Associates, Inc.
  - 6. Larsen's Manufacturing Company.
  - 7. Milcor Inc.
  - 8. Nystrom, Inc.
  - 9. Or approved equal
- B. Flush Access Doors and Trimless Frames: Fabricated from steel sheet at typical areas and from stainless-steel sheet at toilet and wet areas and in masonry.
  - 1. Locations: Wall and ceiling surfaces.
  - 2. Size: Minimum 18"x18" unless otherwise noted
  - 3. Door: Minimum 0.060-inch-thick sheet metal, set flush with surrounding finish surfaces.
  - 4. Frame: Minimum 0.060-inch-thick sheet metal with drywall bead flange.
  - 5. Hinges: concealed pivot
  - 6. Latch: screwdriver-

7. Lock: rim cylinder or mortise cylinder for small-format interchangeable cores (SFIC) to match facility keying or approved equal.
- C. Fire Rated, Uninsulated, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel at typical areas and from stainless-steel sheet at toilets and wet areas.
  1. Locations: Wall surfaces where located in fire-rated walls.
  2. Size: minimum 18"x18" unless otherwise noted
  3. Fire-Resistance Rating: Not less than that of adjacent construction.
  4. Door: Minimum 0.060-inch-thick sheet metal, flush construction.
  5. Frame: Minimum 0.060-inch-thick sheet metal with 1-inch-wide, surface-mounted trim.
  6. Hinges: concealed pivot.
  7. Automatic Closer: Spring type.
  8. Lock: Self-latching device with rim cylinder or mortise cylinder for small-format interchangeable cores (SFIC) to match facility keying or approved equal.

## **2.4 FABRICATION**

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
  1. For trimless frames with drywall bead, provide edge trim for gypsum board and gypsum base securely attached to perimeter of frames.
  2. For trimless frames with plaster bead for full-bed plaster applications, provide zinc-coated expanded metal lath and exposed casing bead welded to perimeter of frames.
  3. Provide mounting holes in frames for attachment of units to metal or wood framing.
  4. Provide mounting holes in frame for attachment of masonry anchors.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.
  1. For recessed doors with plaster infill, provide self-furring expanded metal lath attached to door panel.
- E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
  1. For cylinder lock:
    - a. Rim cylinder or mortise cylinder for small-format interchangeable cores (SFIC) to match facility keying or approved equal.
    - b. Furnish two keys per lock and key all locks alike.
  2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
- C. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

**3.2 ADJUSTING AND CLEANING**

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

**END OF SECTION 08 3110**

## SECTION 08 4313 - ALUMINUM ENTRANCES AND STOREFRONTS

### PART 1 GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### 1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment and services necessary to complete the aluminum entrances and storefronts as indicated on the drawings and/or specified herein including the following:
  - 1. Exterior storefront and entrance systems.

#### 1.3 RELATED SECTIONS

- A. Joint Sealants - Section 07 9200.
- B. Door hardware - Section 08 7100.
- C. glazing - Section 08 8000.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for each material used. Provide certifications that materials and systems comply with specified requirements.
- B. Shop Drawings: Provide large scale shop drawings for fabrication, installation and erection of all parts of work. Provide plans, elevations, and details of anchorages, connections and accessory items. Provide installation templates for work installed by others. Show interfaces and relationships to work of other trades.
- C. Field Measurements: Take necessary field measurements before preparation of shop drawings and fabrication. Do not delay progress of job. If field measurements are not possible prior to fabrication, allow for field cutting and fitting.
- D. Verification Samples: Submit representative samples of each material that is to be exposed in completed work. Show full color ranges and finish variations expected. Provide samples having minimum size of 144 sq. in.
- E. Calculations: Provide professionally prepared calculations and certification of performance of this work. Indicate how design requirements for loading and other performance criteria have been satisfied; refer to Article 1.5, paragraph D for further description.
- F. Test Reports: Provide certified test reports for specified tests.



**1.5 QUALITY ASSURANCE**

- A. Source: For each material type required for work of this Section, provide primary materials which are products of one manufacturer. Provide secondary or accessory materials which are acceptable to manufacturers of primary materials.
- B. Installer: A firm with a minimum of three years experience in type of work required by this Section and which is acceptable to manufacturers of primary materials.
- C. Design Criteria: Drawings indicate sizes, member spacings, profiles, and dimensional requirements of work of this Section. Minor deviations will be accepted in order to utilize manufacturer's standard products when, in the Architect's sole judgment, such deviations do not materially detract from the design concept or intended performances.
- D. Engineering: Provide services of a Professional Engineer, registered in the jurisdiction in which the Project will be built, to design and certify that work of this Section meets or exceeds performance requirements specified.

**1.6 TESTS AND PERFORMANCE REQUIREMENTS**

- A. Manufacturer's Standard Tests: Provide manufacturer's standard test data showing compliance with specified requirements.
- B. Testing and performance data applies to exterior assemblies.
- C. Test Sequence: Test sequence is optional, except that air infiltration tests shall precede water resistance tests.
- D. Air Infiltration Test: Test unit in accordance with ASTM E 283, as follows:
  - 1. Static Air Pressure Difference: 6.24 psf for fixed storefront units, and 1.567 psf for doors.
  - 2. Performance: Maximum air leakage shall not exceed the following:
    - a. Fixed Storefront Units: 0.06 cfm per sq. ft. of window area.
    - b. Door Units: 0.50 cfm per sq. ft. of single doors, 1.00 cfm per sq. ft. for doors hinged in pairs.
- E. Water Leakage Test: Test fixed framing system in accordance with ASTM E 331.
  - 1. Test Pressure: 6.24 psf.
  - 2. Performance: No leakage as defined in test method at specified test pressure.
- F. Uniform Load Deflection Test: Test units in accordance with ASTM E 330, at following static air pressure difference (Design Wind Pressure), or loads prescribed by code for this project site, whichever is greater. Apply pressure first to exterior side (positive) and then interior side (negative).
  - 1. Design Wind Pressure: 30 pounds per square foot minimum.
  - 2. Test Procedure: Procedure A as specified in ASTM E 330.

3. Performance: Deflection in each member measured at locations of greatest deflection shall not exceed  $L/175$  at specified Design Wind Pressure.
- G. Uniform Load Structural Test: Test units in accordance with ASTM E 330 at following static air pressure difference. Apply high pressure load first on one side and then on other side. At conclusion of test there shall be no glass breakage, permanent damage to fasteners, hardware parts, support arms or activating mechanisms.
  1. Static Air Pressure: Minimum 1.5 times the Design Wind Pressure.
  2. Permanent Deformation in Any Member: Not to exceed 0.2% of member span.
- H. Condensation Resistant Factor: Not less than 45 for fixed storefront units, and not less than 48 for doors; per AAMA 1502.7.
- I. Thermal Movement: Provide storefront systems that allow for expansion and contraction of members throughout an ambient temperature range of 120°F.
- J. Seismic Loads: Provide entrance and storefront systems, including anchorage, capable of withstanding the effects of earthquake motions calculated according to requirements of authorities having jurisdiction or ASCE 7, "Minimum Design Loads for Buildings and Other Structures", Section 9, "Earthquake Loads", whichever are more stringent.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Store under cover and protect from weather damage.
- B. Sequence deliveries to avoid delays, but minimize on-site storage.

#### 1.8 WARRANTIES

- A. Provide written warranty, signed by manufacturer, agreeing to repair or replace work that exhibits defects in materials or workmanship. "Defects" is defined to include, but not limited to, leakage of water, abnormal aging or deterioration, abnormal deterioration or fading of finishes, and failure to perform as required. Include requirement for removal and replacement of covering and connected adjacent work.
  1. Warranty Period: Three (3) years from date of Substantial Completion; except finish shall be warranted for a period of fifteen (15) years from date of Substantial Completion.

### PART 2 PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS/PRODUCTS

- A. Provide storefronts and entrance systems of one of the following manufacturers that meet or exceed requirements of these specifications:
  1. Kawneer Company, Inc – Trifab 451UT with AA425 entrance system.
  2. EFCO – Xtherm 403X with D502 entrance system.

3. YKK – YES 45 XT with Megatherm XT entrance system.
4. Or approved equal.

**B. Products:**

1. Exterior frame system shall be equal to Series 451UT utilizing a thermal strut (double thermal break), manufactured by Kawneer Company, Inc.; or approved equal manufacturer listed above.
  - a. Mullion size 2" x 4-1/2"
2. Doors shall be "AA425 wide stile thermal entrance system" with thermally broken doors manufactured by the Kawneer Co. Inc. or approved equal manufacturer listed above and be installed as part of a complete system by a single manufacturer with adjacent storefront framing.
  - a. 4-1/4" vertical stile, 4-1/4" top rail, 10" bottom rail

**2.2 MATERIALS AND ACCESSORIES**

- A. Aluminum Members: Provide 6063-T5 alloy and temper as recommended by manufacturer for strength, corrosion resistance, and application of required finish. Comply with ASTM B 221 for extrusions, and ASTM B 209 for sheet/plate. Provide 0.125 in. thick extrusions for door stiles and storefront framing. Provide 0.050 in. thick aluminum for glazing moldings.
  1. Structural aluminum shapes shall conform to ASTM B 308.
- B. Fasteners: Provide non-magnetic stainless steel fasteners, warranted by manufacturer to be non-corrosive and compatible with aluminum components.
- C. Concealed Flashing: Dead-soft stainless steel, 26 gage minimum, or extruded aluminum 0.062 in. minimum, of an alloy and type selected by manufacturer for compatibility with other components.
- D. Brackets and Reinforcements: Non-magnetic stainless steel or hot-dip galvanized steel complying with ASTM A 386.
- E. Concrete/Masonry Inserts: Cast-iron, malleable iron, or hot-dip galvanized steel complying with ASTM A 386.
- F. Bituminous Coatings: Cold-applied asphalt mastic compounded for 30-mil thickness per coat.
- G. Compression Weatherstripping: Manufacturer's standard replaceable stripping of molded neoprene or PVC gaskets complying with ASTM D 2287.
- H. Sliding Weatherstripping: Manufacturer's standard replaceable stripping of wool, polypropylene, or nylon woven pile, with nylon fabric or aluminum strip backing.

## 2.3 HARDWARE

- A. Provide hardware units as indicated, scheduled, or required for operation of each door. Refer to Section 087100, Finish Hardware for hardware description.

## 2.4 FABRICATION

- A. Sizes and Profiles: Required sizes for door and frame units, including profile requirements, are indicated on Drawings. Any variable dimensions are indicated, together with maximum and minimum dimensions required to achieve design requirements and coordination with other work.
- B. Prefabrication: To greatest extent possible, complete fabrication, assembly, finishing, hardware application, and other work before shipment to project site. Disassemble components only as necessary for shipment and installation.
  - 1. Preglaze door and frame units to greatest extent possible, in coordination with installation and hardware requirements.
  - 2. Do not drill and tap for surface-mounted hardware items until time of installation at project site.
  - 3. Perform fabrication operations, including cutting, fitting, forming, drilling and grinding of metal work in manner which prevents damage to exposed finish surfaces. For hardware, perform these operations prior to application of finishes.
- C. Welding: Comply with recommendations of American Welding Society to avoid discoloration; grind exposed welds smooth and restore mechanical finish.
- D. Reinforcing: Install reinforcing as necessary for performance requirements; separate dissimilar metals with bituminous paint or other separator to prevent corrosion.
- E. Continuity: Maintain accurate relation of planes and angles, with hairline fit of contacting members.
- F. Fasteners: Conceal fasteners.
- G. Provide EPDM/vinyl blade gasket weatherstripping in bottom exterior door rail, adjustable for contact with threshold.
- H. At interior doors and other locations without weatherstripping, provide neoprene silencers on stops to prevent metal-to-metal contact.
- I. Provisions shall be made in the framing for minimum edge clearance, nominal edge cover, and nominal pocket width for the thickness and type of glazing installed, and shall be in accordance with the FGMA Glazing Manual.
- J. Pocket glazed framing shall provide:

	<u>Single Glass</u>	<u>Ins. Glass</u>
1. Nominal edge cover (or bite) framing only	5/16"	1/2"
2. Min. nominal edge clearance	1/8"	1/4"
3. Min. face clearance	1/8"	5/32"

## 2.5 STOREFRONT FRAMING

- A. General: Provide inside-outside matched resilient flush glazed system with provisions for glass replacement. Shop fabricate and preassemble frame components where possible.
- B. Thermal-Break Construction: Fabricate exterior aluminum storefront framing system with integrally concealed, low conductance thermal barrier, located between exterior materials and exposed interior members, in manner which eliminates direct metal-to-metal contact. Provide manufacturer's standard construction which has been in use for similar projects for at least three years.
- C. For glass and glazing, refer to Section 088000.

## 2.6 ALUMINUM DOORS

- A. Aluminum entrance doors shall be wide stile thermally broken factory-glazed aluminum doors, manufactured by same manufacturer as storefront framing with optional 10" bottom rail.
- B. Aluminum entrance doors shall be stile and rail type swing doors. Aluminum shall be extruded aluminum conforming to ASTM B 221, 0.125 in. thick for door stiles and 0.050 in. thick for glazing molding.
  - 1. Sections shall be of sizes and profiles indicated; shall present straight, sharply defined lines and arrises; and shall be free from defects impairing strength, durability, and appearance.
  - 2. Fasteners where exposed shall be aluminum stainless steel or plated steel conforming to ASTM A 164.
- C. Each door shall be factory glazed set in neoprene glazing gasket, refer to Section 088000 for glass.
- D. Doors shall meet the following resistance to corner racking when tested by the Dual Moment Load Test.
  - 1. Test section shall consist of a standard top door corner assembly. Side rail section shall be 24" long and top rail section shall be 12" long.
  - 2. Anchor "top rail" positively to test bench so that corner protrudes 3" beyond bench edge.
  - 3. Anchor a lever arm positively to "side rail" at a point 19" from inside edge of "top rail". Attach weight support pad at a point 19" from inner edge of "side rail".
  - 4. Test section shall withstand a load of 245 lbs. On the lever arm before reaching the point of failure, which shall be considered a rotation of the lever arm in excess of 45 deg.
- E. Air Infiltration: (Applies only to single acting offset pivot or butt hung entrances).
  - 1. Air infiltration shall be tested in accordance with ASTM E 283, at a pressure differential of 1.567 psf. A single 3'-0" x 7'-0" entrance door and frame shall not

exceed .50 cfm per linear foot of perimeter crack. A pair of 6'-0" x 7'-0" entrance doors and frame shall not exceed 1.0 cfm per linear foot of perimeter crack.

- F. For door hardware, refer to Section 087100.
- G. Door bottom rail of exterior doors shall have an EPDM blade gasket sweep strip applied with concealed fasteners.
- H. Corner construction shall consist of mechanical clip fastening, SIGMA deep penetration and fillet welds. Glazing stops shall be hook-in type with EPDM glazing gaskets.
- I. The door weatherstripping on a single acting offset pivot or butt hung exterior door and frame (single or pairs) shall be thermoplastic elastomer weathering on a tubular shape with a semi-rigid polymeric backing.
- J. The door weatherstripping on a double acting, center pivoted door and frame (single or pairs) shall be pile cloth. The door bottom rail shall be weathered with an EPDM blade gasket sweep strip applied with concealed fasteners.
- K. The meeting stiles on pairs of doors shall be equipped with an adjustable astragal.

## 2.7 FINISH

- A. High- Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.
  - 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 2. Provide clear topcoat where required by coating manufacturer for color selected.
  - 3. Color and Gloss: As selected by the Architect from manufacturers full color range or indicated on the drawings.

## PART 3 EXECUTION

### 3.1 INSPECTION

- A. Examine the areas and conditions where aluminum entrances and storefronts are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

### 3.2 INSTALLATION

- A. Install aluminum entrance doors and storefront framing in openings prepared under other Sections plumb, square, level, in exact alignment with surrounding work, with proper clearances, and securely and positively anchored to building structure, to meet performance requirements specified herein, in accordance with manufacturer's published instructions and approved submittals.
- B. Use only skilled mechanics for erection, under supervision of manufacturer's representative.

- C. Provide protection against galvanic action. Isolate dissimilar materials with bituminous coating or non-absorptive dielectric tape.
- D. Install aluminum entrance doors, storefront frame, and finish hardware. Carefully fit and adjust doors and hardware to frames and weatherstripping. After erection check and adjust operating hardware for smooth and proper operation.
- E. Set continuous sill members and flashing in a full sealant bed to provide weathertight construction, unless otherwise indicated. Comply with requirements of Section 079200.
- F. Erection Tolerances: Install entrance and storefront systems to comply with the following maximum tolerances.
  - 1. Variation from Plane: Limit variation from plane or location shown to 1/8" in 12'; 1/4" over total length.
  - 2. Alignment: Where surfaces abut in line, limit offset from true alignment to 1/16". Where surfaces meet at corners, limit offset from true alignment to 1/32".
  - 3. Diagonal Measurements: Limit difference between diagonal measurements to 1/8".

### **3.3 PROTECTION AND CLEANING OF ALUMINUM**

- A. Protect finished metal surfaces from damage during fabrication, shipping, storage, and erection, and from then until acceptance by Owner.
- B. Clean metal surfaces promptly after installation, exercising care to avoid damage. Remove excess sealant, dirt, and other substances. Lubricate hardware and other moving parts.

### **3.4 PROTECTION AND CLEANING OF GLASS**

- A. Replace glass that is broken, cracked or chipped prior to time of final acceptance of Project by Owner.
- B. Clean glass surfaces promptly after installation, exercising care to avoid damage to same.
- C. Remove all labels, and label adhesive

**END OF SECTION 08 4313**

## SECTION 08 4413 GLAZED ALUMINUM CURTAIN WALLS

### PART 1-GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### 1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the aluminum and glass curtain wall as shown on the drawings and/or specified herein, including, but not limited to, the following:
  - 1. Aluminum and glass curtain wall assemblies.
  - 2. Glass and glazing in conjunction with the work of this Section.
  - 3. Spandrel insulation, fire separation, fire safing and smoke stop.
  - 4. All necessary steel or aluminum members where required to support, strengthen and/or reinforce aluminum members.
  - 5. Sealants, caulking, joint fillers, gaskets, fasteners, vents and weeps, weep tubes, bellows, closures, gutters, end dams, flashings, trim, as shown or as may be required in conjunction with the system or to joint the system to adjacent construction.
  - 6. Anchors, inserts and insert setting diagrams, furnishing of inserts and insert setting diagrams, support brackets, reinforcing, bracing, stiffeners, flashing.
  - 7. Shop drawings engineering calculations, erection drawings, samples and conformance test data.
  - 8. Field check for water leakage.
  - 9. Protection and cleaning, as defined herein.
  - 10. Field measurements of adjacent and/or supporting construction and verification of existing conditions.

#### 1.3 RELATED SECTIONS

- A. Aluminum Entrances and Storefronts - Section 084113.
- B. Glazing – Section 088000
- C. Insulated translucent fiberglass panel wall systems – Section 084523

#### 1.4 PERFORMANCE REQUIREMENTS



- A. General Performance: Comply with performance requirements specified, as determined by manufacturer's documented performance criteria and field testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
  - 1. Glazed aluminum curtain walls shall withstand movements of supporting structure and deflection from uniformly distributed and concentrated live loads.
  - 2. Failure also includes the following:
    - a. Thermal stresses transferring to building structure.
    - b. Glass breakage.
    - c. Noise or vibration created by wind and thermal and structural movements.
    - d. Loosening or weakening of fasteners, attachments, and other components.
    - e. Failure of operating units.
- B. Delegated Design: Design glazed aluminum curtain walls, including comprehensive engineering analysis by a qualified professional engineer licensed in the State of New Jersey, including, but not limited to story drift, twist, column shortening, long term creep, using performance requirements and design criteria indicated.
- C. Design Wind loads (unless greater by Code): See Structural Drawings.
- D. Structural-Test Performance: Test according to ASTM E 330 as follows:
  - 1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
  - 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
  - 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- E. Deflection of Framing Members: At design wind pressure, as follows:
  - 1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
  - 2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch, whichever is smaller.
  - 3. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.
- F. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
- G. Story Drift: 3/4" maximum.

- H. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft.
- I. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft.
  - 1. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.
- J. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
  - 2. Test Interior Ambient-Air Temperature: 75 deg F.
  - 3. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
- K. Energy Performance: Glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.
  - 1. Thermal transmittance simulation results using NFRC 100 or AAMA 507 are based upon argon-filled 1" (25.4 mm) or 1-3/4" (44.4 mm) clear low-emissivity coated glass with warm edge spacer
    - a. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U- factor of not more than 0.32 Btu/sq. ft. x h x deg F as determined according to NFRC 100 with u-value of glazing equal to 0.24 Center of glazing
  - 2. Solar Heat Gain Coefficient: See drawings.
  - 3. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 6.24/sq. ft.
  - 4. Condensation Resistance Frame: 79
  - 5. Condensation Resistance glass: 76
- L. Dimensional Tolerances: Provide glazed aluminum curtain wall system, including anchorage, that accommodates dimensional tolerances of building frame and other adjacent construction.

1.5 SUBMITTALS

- A. Submit Product Data for each product specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.
- B. Submit Shop Drawings showing fabrication and installation of glazed aluminum curtain wall system including plans, elevations, sections, details of components, and attachments to other units of Work.
  - 1. For installed products indicated to comply with certain design loadings, include structural analysis data signed and sealed by a professional engineer licensed in the State of New Jersey responsible for their preparation.
- C. Submit samples for verification of each type of exposed finish required in manufacturer's standard sizes. Where finishes involve normal color and texture variations, include Sample sets showing the full range of variations expected.
- D. Submit cutaway sample of each vertical-to-horizontal intersection of system, made from 12-inch lengths of full-size components and showing details of the following:
  - 1. Joinery.
  - 2. Anchorage.
  - 3. Expansion provisions.
  - 4. Glass and glazing.
  - 5. Flashing and drainage.
- E. Submit welder certificates indicating that welders comply with requirements specified in "Quality Assurance" Article.
- F. Submit installer certificates signed by manufacturer certifying that installers comply with requirements in "Quality Assurance" Article.
- G. Submit product test reports from a qualified independent testing agency evidencing compliance of glazed aluminum curtain wall system with requirements based on comprehensive testing of manufacturer's current system.
- H. Submit test reports, calculations, computer analysis and other necessary data from a qualified independent inspecting and testing agency retained by the Contractor indicating compliance with performance requirements of glazed aluminum curtain wall system.

#### **1.6 QUALITY ASSURANCE**

- A. **Testing Agency Qualifications:** To qualify for approval, an independent testing agency must demonstrate to Architect's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.
- B. **Professional Engineer Qualifications:** A professional engineer who is legally qualified

to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of glazed aluminum curtain wall systems that are similar to those indicated for this Project in material, design, and extent.

- C. **Installer Qualifications:** Engage an experienced installer to assume engineering responsibility and perform work of this Section who has specialized in installing glazed aluminum curtain wall systems similar to those required for this Project and who is acceptable to manufacturer.
  - 1. **Engineering Responsibility:** Engage a qualified professional engineer to prepare or supervise the preparation of data for glazed aluminum curtain wall systems, including drawings, testing program development, test-result interpretation, and comprehensive engineering analysis that shows systems' compliance with specified requirements.
- D. **Source Limitations:** Obtain each type of glazed aluminum curtain wall system from one source and by a single manufacturer.
- E. **Product Options:** Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sight lines and relationships to one another and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, or in-service performance.
  - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval and only to the extent needed to comply with performance requirements. Where modifications are proposed, submit comprehensive explanatory data to Architect for review.
- F. **Welding Standards:** Comply with applicable provisions of AWS D1.2, "Structural Welding Code--Aluminum."
  - 1. Engage welders who have satisfactorily passed AWS qualification tests for welding processes involved and who are currently certified for these processes.
- G. **Mockups:** Prior to installing glazed aluminum curtain wall system, construct mockups for each form of construction and finish required to verify selections made under Sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for Work.
  - 1. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Architect.
  - 2. Notify Architect 7 days in advance of the dates and times when mockups will be constructed.
  - 3. Demonstrate the proposed range of aesthetic effects and workmanship.

4. Obtain Architect's approval of mockups before start of Work.
  5. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
    - a. Approved mockups in an undisturbed condition may become part of the completed Work.
- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings." Review methods and procedures related to glazed aluminum curtain wall system including, but not limited to, the following:
1. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
  2. Review structural loading limitations.
  3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  4. Review required inspecting, testing, and certifying procedures.
  5. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions.
- 1.7 PROJECT CONDITIONS
- A. Field Measurements: Verify dimensions by field measurements before fabrication and show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions.
- 1.8 WARRANTY
- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Submit a written warranty executed by the manufacturer agreeing to repair or replace components of a glazed aluminum curtain wall system that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:
1. Structural failures including, but not limited to, excessive deflection.

2. Noise or vibration caused by thermal movements.
  3. Failure of system to meet performance requirements.
  4. Failure of operating components to function normally.
  5. Water leakage.
  6. Glazing breakage.
- C. Warranty Period: 10 years from date of Substantial Completion (except as noted below).
- D. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  2. Warranty Period: 20 years from date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kawneer Company, Inc. 1600UT with fiberglass pressure plate basis of design
    - 2-1/2" x 7" profile or as indicated on the drawings
  2. EFCO Corporation 5500X therm with fiberglass pressure plate.
  3. YKK – YCW 750XT with fiberglass pressure plate
  4. Architectural Windows 1800i series with fiberglass pressure plate.
  5. Or approved equal.

### **2.2 METALS**

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated, complying with the requirements of standards indicated below.
1. Sheet and Plate: ASTM B 209.

2. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221.
  3. Extruded Structural Pipe and Tubes: ASTM B 429.
  4. Structural Profiles: ASTM A 1008.
  5. Welding Rods and Bare Electrodes: AWS A5.10.
- B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
1. Structural Shapes, Plats, and Bars: ASTM A 36.
  2. Cold Rolled Sheet and Strip: ASTM A 1008.
  3. Hot Rolled Sheet and Strip: ASTM A 1011.

## 2.3 FRAMING

- A. Framing Members: Extruded or formed aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken.
  2. Glazing System: Retained mechanically with gaskets on four sides.
  3. Glazing Plane: Front.
- B. Brackets and Reinforcements: Manufacturer's standard high strength aluminum with non-staining, non-ferrous shims for aligning system components.
- C. Fasteners and Accessories: Manufacturer's standard corrosion resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
  2. Reinforce members as required to receive fastener threads.
  3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- D. Anchors: Three way adjustable anchors with minimum adjustment of 2" that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
1. Concrete and Masonry Inserts: Hot dip galvanized cast iron, malleable iron, or steel inserts complying with ASTM A 123 or ASTM A 153 requirements.

## **2.4 INSULATED METAL PANELS**

- A. Insulated Aluminum Panels: Manufacturer's standard laminated aluminum faced panels of 1" thickness. Panel shall be flat, with no deviation in any direction exceeding 1/16" in 2'-0", or 1/8" for the entire panel.
  - 1. Face Sheets: Not less than 0.0249" thick and finished to match curtain wall faming.
  - 2. Concealed Back Sheets: Aluminum or galvanized steel.
  - 3. Stabilizer Sheets: 1/8" thick tempered hardboard.
  - 4. Core Material: Rigid mineral wool.
  - 5. Edge Condition: Prepared for glazing into framing and either sealed or vented to the exterior only.
  - 6. Basis of Design Mapes R+ or approved equal.

## **2.5 PRESSURE PLATE:**

- A. Pressure plate shall be fiberglass.
- B. Fiberglass pressure plate shall be tested to ASTM D638, D790, D695, D953, D3846

## **2.6 GLASS & TRANSLUCENT FIBERGLASS WALL PANELS**

- A. Glass and translucent fiberglass wall panels shall be of the types and minimum thickness, as shown on the drawings and specified herein, and shall, in addition, meet the requirements of the following paragraphs.
- B. All glass shall be the manufactured product of one (1) company. All fabricated glass products shall be the fabricated and coated products of one (1) company. All glass shall be delivered to the site bearing the manufacturer's label, complete with glazing instructions where applicable.
- C. Refer to specification 088000 Glazing for additional criteria & specification 084523 Insulated translucent fiberglass panel wall systems

## **2.7 GASKETS/WEATHERSTRIPPING**

- A. All gaskets and weather stripping shall be neoprene, except where used in contact with a silicone sealant. In contact with silicone sealants, gaskets and spacers shall be preformed, heat-cured, silicone rubber, chemically compatible with the silicone sealant and suitable for the specific purpose intended or equal, as recommended by the sealant manufacturer and approved by the Architect. All gaskets, weather stripping, and spacers shall have continuous mechanical engagement to framing members; adhesive attachment is not acceptable. All weather strips and gaskets shall be continuous with vulcanized/molded corners where possible.
- B. Sponge gaskets/weatherstripping/spacers shall be extruded black neoprene or silicone



rubber (or equal as provided for in 2.4 A) with a hardness of 40 + 5 durometer Shore A and conform to ASTM C 509-79 (for neoprene). Sponge gaskets shall be compressed 20% to 35% in the final installed position.

- C. Dense gaskets/weatherstripping shall be extruded black neoprene conforming to NAAMM SG-1-70 or silicone rubber (or equal as provided for in 2.04 A) with a hardness of 75 + 5 durometer Shore A for hollow profiles and 60 + 5 for solid profiles.

## 2.8 SEALANTS (NON-STRUCTURAL)

- A. All joints, which are sealed with sealant as part of the fabrication or erection procedure, shall be sealed with an approved butyl (concealed) or low modulus silicone (exposed or concealed) sealant in color to match the adjoining surfaces or as may be required by the Architect. All perimeter sealant (metal to adjacent construction) shall be low or medium modulus silicone sealant. Silicone sealant shall be as manufactured by General Electric, Dow Corning, or Pecora. Butyl sealant shall be PTI 707.
- B. In using specified sealants, strictly observe the printed instructions of sealant manufacturer regarding joint size, limitations, backer rod, mixing, cleaning, surface preparation, priming and application. A primer shall be used, unless printed instructions advise to the contrary, and sealant manufacturer certifies that the use thereof will reduce its performance. Sealant shall not be applied when substrates are wet or when the temperature is below 40 deg. F.
- C. Care shall be exercised to insure against "Three Surface Adhesion." Bond breakers shall be provided where necessary.
- D. Contractor shall provide certification from sealant manufacturer that the sealant manufacturer has reviewed all sealant details and finds same suitable for the purpose intended, compatible with and will not stain the surfaces with which they are in contact. Statement as to compatibility, adhesion sufficiency and non-staining shall be accompanied by actual test results on production substrates performed in accordance with applicable ASTM procedures.

## 2.9 SEALANTS (STRUCTURAL)

- A. All components which are adhered with a structural silicone sealant/adhesive as part of the fabrication, glazing or erection procedure, shall be sealed/adhered with an approved structural silicone, as manufactured by General Electric, Dow Corning or Pecora and approved by the Architect. All glazing with structural silicone sealant/adhesive shall be accomplished in a shop wherever consistent with the design.
- B. In using specified sealants, strictly observe the printed instructions of sealant manufacturer regarding joint size, limitations, backer rod, mixing, cleaning, surface preparation, priming and application. A primer shall be used, unless printed instructions advise to the contrary. Sealant shall not be applied when substrates are wet or when the temperature is below 40 deg. F. Units shall not be moved until structural silicone seal has achieved full cure.
- C. Care shall be exercised to insure against "Three Surface Adhesion." Bond breakers shall be provided where necessary.

- D. Contractor shall provide certification from sealant manufacturer that the sealant manufacturer has reviewed all sealant details and tested all contact surfaces, and finds same suitable for use with proposed sealant, the purpose intended and compatible with the surfaces with which they are in contact. Sealant manufacturer's certification shall include the following based upon tests performed on production run materials:
1. Test data of adhesion to production samples of metal and glass, tested in accordance with ASTM C 794.
  2. Compatibility statement that the materials in contact with the sealant such as gaskets, spacers, setting blocks, are compatible with the sealant after 21 days exposure to ultra violet, 2000 - 4000 (micro watt UV radiation).
  3. Stress statement that when exposed to the specified wind load the stress in the silicone sealant of dimensions shown does not exceed 20 psi with a safety factor of 6:1.
- E. Where silicone bonds to a metal or glass surface, the weakest element in the line of stress must have a minimum strength of 120 psi. For each combination of substrates submit report from an independent laboratory for tests performed in the following manner:
1. Assemble and fully cure a minimum of 6 samples using actual substrates and a minimum sample length of 5".
  2. Subject sample to a tensile load such that nominal stress on silicone is 20 psi, hold for one minute and remove load. Repeat for additional loadings, increasing nominal silicone stress by 20 psi with each successive loading. Continue until failure occurs or until 200 psi is successfully applied.
  3. All 6 samples must successfully withstand at least 120 psi. Report maximum stress and mode of failure. If one or more samples do not meet this criterion, revise failed element and repeat tests with 6 new samples. Repeat until all 6 samples are successfully tested.
  4. Testing shall be performed in such a manner as to establish stress and safety factor over the temperature range described herein.
  5. Prepare an outline for a quality assurance program for evaluation of adhesion and other physical attributes of sealants and submit to Architect for review and approval.
  6. Program shall cover both initial testing of components for sealant adhesion/compatibility, etc., and also random testing of production run materials, etc. Include testing at full negative design pressure, one unit per one hundred units manufactured for the project. Also include methods which will be employed to monitor sealant application to insure full sealant contact. No sealant work shall be performed prior to approval of program.

## **2.10 GLAZING BLOCKS**

- A. Provide setting blocks at the sill quarter points of all glass lites. Setting blocks shall be black dense neoprene or heat cured silicone rubber with a hardness of 80 to 90 durometer, Shore A, a minimum length of 4", and a minimum width, which will permit full support of both panes of glass in an insulating glass unit or a monolithic unit no matter how positioned within the glazing rabbet.
- B. Shims used in conjunction with setting blocks must be of the same materials, hardness, length and width as the setting blocks.
- C. Provide side blocks within the upper half of both jambs of all glass lites. Side blocks shall be black dense neoprene or heat cured silicone rubber with a 60 to 70 durometer, Shore A, or as recommended by the selected glass manufacturer. Provide 1/8" clearance between block and bearing surface.

#### **2.11 MISCELLANEOUS MATERIALS**

- A. Provide straps, plates and brackets, built-in inserts, as required for support and anchorage of the fabricated items to adjacent surfaces.
- B. Where steel reinforcement of units is required for strength or other unavoidable necessity and concealed within (encased) in aluminum sections or employed in potentially wetted areas, hot dip galvanize the pieces after fabrication with 2.0 ounce zinc coating, complying with ASTM A 123. All other steel reinforcement shall be coated with two (2) heavy coats of zinc rich primer in differing colors.
- C. Slip Joint Linings/Sleeves: Provide stainless steel sleeve spacers and/or suitable bearing pads, as required, to insure free movement between surfaces where expansion and deflection movements are intended. Provide "Eel Slip," "Nylatron" or high impact polystyrene shims or pads or equivalent plastic units of sizes and thicknesses (minimum 1/16" except 1/8" for "Eel Slip") recommended by the manufacturer to permanently prevent "freeze up" of joints. All sleeves, spacers, bracing pads and shims must be incombustible and rated by UL.
- D. Flashing required within the system shall be 26 ga. stainless steel.
- E. Flashing required to join the system to adjacent construction shall be 26 ga. stainless steel.
- F. Back Pans: Provide 22 gauge aluminum backpans, insulated where shown on drawings, 4" depth.

#### **2.12 INSULATION AND FIRESAFING**

- A. Provide thermal and fire separation insulation where shown and where required. Use U.S. Gypsum Thermafiber CW 90 curtain wall insulation or approved equal with a minimum thickness of 4" (or thicker if required to meet specified thermal performance) and the foil vapor barrier (permeability not to exceed 0.020 perms) at interior surface and all edges. Provide insulation and "fire wrap" at mullions and/or stiffeners as required to meet overall thermal and condensation resistance requirements and as required by Code.

- B. Tape and seal all joints in vapor barrier and along edges and supports to insure continuous vapor barrier.
- C. Apply insulation utilizing welded or screw applied impaling pins and retaining clips. Adhesive attachment will not be accepted.
- D. Provide 5" thick (minimum) compacted four (4) PCF USG Thermafiber safing insulation or approved equal at full perimeter at each floor level between floor edge and curtain wall to meet requirements of Building Code. Provide hourly rating as required by Code. Seal all edges with an approved fire resistant sealant to provide a continuous fire/smoke barrier.
- E. Insulation and firesafing shall be suitably isolated/separated from direct contact with spandrel glass.

#### **2.13 THERMAL STRUT**

- A. Provide thermal strut construction, complying with the requirements of these Specifications and which have been in service on comparable installations for no less than ten (10) years. Submit data to prove structural sufficiency over full exterior thermal range specified, and anticipated wind loading. In the event a structural thermal break is employed, manufacturer shall establish structural properties over full thermal range.

#### **2.14 FABRICATION**

- A. General: Fabricate glazed aluminum curtain wall system according to Shop Drawings. Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.
- B. Forming: Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.
- C. Prepare components to receive concealed fasteners and anchor and connection devices.
- D. Fabricate components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.
- E. Welding: Weld components to comply with referenced standard and Shop Drawings, unless otherwise indicated. Weld before finishing components. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- F. Glazing Pockets: Provide minimum clearances for thickness and type of glass indicated according to GANA's "Glazing Manual."
- G. Glazing Pockets: Provide minimum clearances for thickness and type of plastic sheet

indicated according to plastic sheet manufacturer's recommendations.

- H. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- I. Frame Units: Factory assemble frame units according to Shop Drawings to greatest extent possible. Rigidly secure non-movement joints. Seal joints watertight, unless otherwise indicated. Assemble components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.
  - 1. Install glazing according to approved Shop Drawings.
- J. All machining, cutting and welding shall be done before finish is applied.

## 2.15 ALUMINUM FINISH

- A. High-Performance Organic Finish : AA-C12C42R1x (Chemical Finish: Cleaned with inhibited chemicals; Chemical Finish: Acid-chromate-fluoride-phosphate conversion coating; Organic Coating: As specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's written instructions.
  - 1. Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
  - 2. Color as indicated on the drawings or selected from manufacturers full range.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of glazed aluminum curtain wall system. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Comply with manufacturer's written instructions for protecting, handling, and installing glazed aluminum curtain wall system. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion. Rigidly secure non-movement joints. Seal joints watertight, unless otherwise indicated. Provide means to drain water to the exterior to produce a permanently weatherproof system.
- B. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape

recommended by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

- C. Install components to drain water passing joints, condensation occurring in glazing channels, condensation occurring within framing members, and moisture migrating within the system to the exterior.
- D. Install framing members plumb and true in alignment with established lines and grades.
- E. Install factory-assembled frame units plumb and true in alignment with established lines and grades.
- F. Install column covers plumb and true in alignment with established lines and grades.
- G. Anchorage: After system components are positioned, fix connections to building structure as indicated on Shop Drawings.
  - 1. Provide separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- H. Welding: Weld components to comply with referenced standard and Shop Drawings, unless otherwise indicated. Weld in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
- I. Install glazing according to approved Shop Drawings.
- J. Install sealant according to approved Shop Drawings. Comply with requirements of Section 079200, "Joint Sealants."
- K. Install firesafing in locations indicated. Comply with requirements of Section 078413, "Firestops and Smokes seals."
- L. Erection Tolerances: Install glazed aluminum curtain wall system to comply with the following maximum tolerances:
  - 1. Plumb: 1/16" in 10 feet; 1/8" in 40 feet.
  - 2. Level: 1/16" in 20 feet; 1/8" in 40 feet.
  - 3. Alignment: Where surfaces abut in line, limit offset from true alignment to 1/16"; where a reveal or protruding element separates aligned surfaces by less than 2", limit offset to 1/4".
  - 4. Location: Limit variation from plane or location shown on Shop Drawings to 1/8" in 12 feet; 1/4" over total length.

### **3.3 FIELD QUALITY CONTROL**

- A. Testing Agency: Contractor shall engage a qualified independent testing agency to perform testing indicated.

- B. Static air infiltration test(s) as well as the static pressure water test(s) shall be performed on 100 sq feet to determine if curtain wall meets performance requirements specified herein under Article 1.4.
- C. Test for water infiltration per AAMA 501.2. Test within the first 10% of work complete, area to be a minimum of 100 SF of wall and including a perimeter where CW adjoins masonry construction. Interior finishes must not interfere with observation of test area or be removed from test area. Not appropriate for operable windows and doors.
  - 1. This test (AAMA 501.2) shall be performed infield on new construction.
- D. Repair or remove Work that does not meet requirements or that is damaged by testing; replace to conform to specified requirements.

**3.4 PROTECTION**

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure glazed aluminum curtain wall system is without damage or deterioration at the time of Substantial Completion.

**END OF SECTION**

## SECTION 084523 INSULATED TRANSLUCENT FIBERGLASS PANEL WALL SYSTEM

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section includes the insulated translucent sandwich panel system and accessories, factory unitized, as shown and specified. Work includes providing and installing:
  - 1. Flat factory prefabricated structural insulated translucent sandwich panels for installation into curtainwall systems with 1" perimeter Curtainwall adaptor glazed into curtainwall system
  - 2. Flat factor prefabricated structural insulated translucent sandwich panels for installation into factory aluminum system
  - 3. Aluminum installation system
  - 4. Aluminum sill flashing
  - 5. Thermal break windows

#### 1.02 Related sections:

- A. 084413 Glazed Aluminum curtainwalls

#### 1.03 SUBMITTALS

- A. Submit manufacturer's product data. Include construction details, material descriptions, profiles and finishes of components.
- B. Submit shop drawings. Include elevations and details.
- C. Submit manufacturer's color charts showing the full range of colors available for factory-finished aluminum.
  - 1. When requested, submit samples for each exposed finish required, in same thickness and material indicated for the work and in size indicated below. If finishes involve normal color variations, include sample sets consisting of two or more units showing the full range of variations expected.
    - a. Sandwich panels: 14" x 28" units
    - b. Factory finished aluminum: 5" long sections
- D. Submit Installer Certificate, signed by installer, certifying compliance with project qualification requirements.
- E. Submit product reports from a qualified independent testing agency indicating each type and class of panel system complies with the project performance requirements, based on comprehensive testing of current products. Previously completed reports will be acceptable if for current manufacturer and indicative of products used on this project.
  - 1. Reports required are:
    - a. International Building Code Evaluation Report
    - b. Flame Spread and Smoke Developed (UL 723) – Submit UL Card



- c. Burn Extent (ASTM D 635)
- d. Color Difference (ASTM D 2244)
- e. Impact Strength (UL 972)
- f. Bond Tensile Strength (ASTM C 297 after aging by ASTM D 1037)
- g. Bond Shear Strength (ASTM D 1002)
- h. Beam Bending Strength (ASTM E 72)
- i. Insulation U-Factor (NFRC 100)
- j. NFRC System U-Factor Certification (NFRC 700)
- k. Solar Heat Gain Coefficient (NFRC or Calculations)
- l. Condensation Resistance Factor (AAMA 1503)
- m. Air Leakage (ASTM E 283)
- n. Structural Performance (ASTM E 330)
- o. Water Penetration (ASTM E 331)
- p. 1200°F Fire Resistance (SWRI)
- q. ASTM E1886/1996 or TAS 201, 202 and 203

#### 1.04 QUALITY ASSURANCE

##### A. Manufacturer's Qualifications

- 1. Material and products shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least ten consecutive years and which can show evidence of those materials being satisfactorily used on at least six projects of similar size, scope and location. At least three of the projects shall have been in successful use for ten years or longer.
- 2. Panel system must be listed by an ANSI accredited Evaluation Service, which requires quality control inspections and fire, structural and water infiltration testing of sandwich panel systems by an accredited agency.
- 3. Quality control inspections shall be conducted at least once each year and shall include manufacturing facilities, sandwich panel components and production sandwich panels for conformance with AC177 "Translucent Fiberglass Reinforced Plastic (FRP) Faced Panel Wall, Roof and Skylight Systems" as issued by the ICC-ES.

- B. Installer's Qualifications: Installation shall be by an experienced installer, which has been in the business of installing specified panel systems for at least two consecutive years and can show evidence of satisfactory completion of projects of similar size, scope and type.

#### 1.05 PERFORMANCE REQUIREMENTS

- A. The manufacturer shall be responsible for the configuration and fabrication of the complete unitized panel system. Testing shall include sill flashings and corner closures.

- 1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- 2. Standard panel system shall have less than 0.01 cfm/ft<sup>2</sup> air leakage by ASTM E 283 at 6.24 PSF (50 mph) and no water penetration by ASTM E 331 at 15 PSF; and structural testing by ASTM E 330.
- 3. Structural Loads; Provide system capable of handling the following loads per ASCE 7-16 for risk category III, exposure category B, basic wind speed 124mph.

- B. Windborne Debris Impact Resistance Performance: not required.

## 1.06 DELIVERY STORAGE AND HANDLING

- A. Deliver panel system, components and materials in manufacturer's standard protective packaging.
- B. Store panels on the long edge; several inches above the ground, blocked and under cover in accordance with manufacturer's storage and handling instructions.

## 1.07 WARRANTY

- A. Submit manufacturer's and installer's written warranty agreeing to repair or replace panel system work, which fails in materials or workmanship within one year of the date of delivery. Failure of materials or workmanship shall include leakage, excessive deflection, deterioration of finish on metal in excess of normal weathering, defects in accessories, insulated translucent sandwich panels and other components of the work.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURER

- A. Basis of Design:
  - 1. Kalwall Corporation
- B. Other manufacturers may bid this project provided they comply with all of the performance requirements of this specification and submit evidence thereof. Listing other manufacturers' names in this specification does not constitute approval of their products or relieve them of compliance with all the performance requirements contained herein.
  - 1. Kingspan, Unigrid
  - 2. Structures Unlimited Inc.
  - 3. Approved equal

### 2.02 PANEL COMPONENTS

- A. Face Sheets
  - 1. Translucent faces: Manufactured from glass fiber reinforced thermoset resins, formulated specifically for architectural use.
    - a. Thermoplastic (e.g. polycarbonate, acrylic) faces are not acceptable.
    - b. Face sheets shall not deform, deflect or drip when subjected to fire or flame.
  - 2. Interior face sheets:
    - a. Flame spread: Underwriters Laboratories (UL) listed, which requires periodic unannounced retesting, with flame spread rating no greater than 50 and smoke developed no greater than 250 when tested in accordance with UL 723.
    - b. Burn extent by ASTM D 635 shall be no greater than 1".
  - 3. Exterior face sheets:
    - a. Color stability: Full thickness of the exterior face sheet shall not change color more than 3 CIE Units DELTA E by ASTM D 2244 after 5 years outdoor South Florida weathering at 5° facing south, determined by the average of at least three white samples with and without a protective

- film or coating to ensure long-term color stability. Color stability shall be unaffected by abrasion or scratching.
- b. Strength: Exterior face sheet shall be uniform in strength, with panel meeting ASTM E1996 and ASTM E1886 or TAS 201, 202 and 203.
4. Appearance:
- a. Exterior face sheets: Smooth .070" thick and CRYSTAL in color.
  - b. Interior face sheets: Smooth .045" thick and WHITE in color.
  - c. Face sheets shall not vary more than  $\pm 10\%$  in thickness and be uniform in color.
- B. Grid Core
1. Thermally broken composite I-beam grid core shall be of 6063-T6 or 6005-T5 alloy and temper with provisions for mechanical interlocking of muntin-mullion and perimeter. Width of I-beam shall be no less than 7/16".
  2. I-beam Thermal break: Minimum 1", thermoset fiberglass composite.
- C. Laminate Adhesive
1. Heat and pressure resin type adhesive engineered for structural sandwich panel use, with minimum 25-years field use. Adhesive shall pass testing requirements specified by the International Code Council "Acceptance Criteria for Sandwich Panel Adhesives".
  2. Minimum tensile strength of 750 PSI when the panel assembly is tested by ASTM C 297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D 1037.
  3. Minimum shear strength of the panel adhesive by ASTM D 1002 after exposure to four separate conditions:
    - a. 50% Relative Humidity at 68° F: 540 PSI
    - b. 182° F: 100 PSI
    - c. Accelerated Aging by ASTM D 1037 at room temperature: 800 PSI
    - d. Accelerated Aging by ASTM D 1037 at 182° F: 250 PSI

## 2.03 PANEL CONSTRUCTION TYPE GL-04 AS DESIGNATED ON THE DRAWINGS

- A. Provide sandwich panels of flat fiberglass reinforced translucent face sheets laminated to a grid core of mechanically interlocking I-beams. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge.
1. Thickness: 2-3/4"
  2. Grid core insulation: Fiberglass Batt
  3. Light transmission: 30%
  4. Solar heat gain coefficient 0.25.
  5. Panel U-factor by NFRC certified laboratory: 2-3/4" thermally broken grid 0.23 "U".
  6. Complete insulated panel system shall have NFRC certified U-factor of 0.30 "U".
  7. Grid pattern: Nominal size 8" wide VertiKal pattern or approved equal.
  8. Provide 1" curtainwall adapter (CW-A) for panel to be installed into Curtainwall Framing system
- B. Standard panels shall deflect no more than 1.9" at 30 PSF in 10' 0" span without a supporting frame by ASTM E 72.
- C. Standard panels shall withstand 1200° F fire for minimum one hour without collapse or exterior flaming.

- D. Thermally broken panels: Minimum Condensation Resistance Factor of 80 by AAMA 1503 measured on the bond line.

#### 2.04 PANEL CONSTRUCTION TYPE GL-04A AS DESIGNATED ON THE DRAWINGS

- A. Provide sandwich panels of flat fiberglass reinforced translucent face sheets laminated to a grid core of mechanically interlocking I-beams. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge.
  - 1. Thickness: 2-3/4"
  - 2. Grid core insulation: Fiberglass Batt
  - 3. Light transmission: 30%
  - 4. Solar heat gain coefficient 0.25.
  - 5. Panel U-factor by NFRC certified laboratory: 2-3/4" thermally broken grid 0.23 "U".
  - 6. Complete insulated panel system shall have NFRC certified U-factor of 0.30 "U".
  - 7. Grid pattern: Nominal size 8" wide VertiKal pattern or approved equal.
- B. Standard panels shall deflect no more than 1.9" at 30 PSF in 10' 0" span without a supporting frame by ASTM E 72.
- C. Standard panels shall withstand 1200° F fire for minimum one hour without collapse or exterior flaming.
- D. Thermally broken panels: Minimum Condensation Resistance Factor of 80 by AAMA 1503 measured on the bond line.

#### 2.05 THERMALLY BROKEN ALUMINUM CLOSURE SYSTEM FOR USE WITH PANEL TYPE GL-04A

- A. Provide at locations where not installed into curtainwall system
- B. Closure system: Thermally broken with thermal strut standard extruded aluminum 6063-T6 and 6063-T5 alloy and temper clamp-tite screw type closure system.
- C. Sealing tape: Manufacturer's standard, pre-applied to closure system at the factory under controlled conditions.
- D. Fasteners: 300 series stainless steel screws for aluminum closures, excluding final fasteners to the building.
- E. Battens and extruded profiles finish:
  - 1. Manufacturer's factory applied finish, which meets the performance requirements of AAMA 2604. - Color as selected from manufacturers full standard range.

#### 2.06 ALUMINUM SILL FLASHING & CORNER CLOSURES FOR USE WITH PANEL TYPE GL-04A

- A. Provide at locations where not installed into curtainwall system
- B. .040 thickness aluminum 3105-H14 alloy, smooth as per ASTM B209-96.
- C. Two coat coil applied, baked-on full-strength (70% resin) fluorocarbon coating system (polyvinylidene fluoride, PVF2), applied by manufacturer's approved applicator.
- D. Finish to be provided in colors as specified on drawings as the following different locations
  - 1. Sill Color as selected from manufacturers full standard range to match framing system.

#### 2.07 WINDOWS (E-series or approved equal )

- A. Windows shall be designed specifically for inclusion in the translucent panel unit wall system and factory unitized to panels.
  - 1. Units shall be of the following type is sizes and locations shown in the drawings:
    - a. Fixed lite, with thermal strut
- B. Performance: Windows shall pass or exceed requirements of AAMA/WDMA/CSA-101/I.S.2/A440-05 (08).
  - 1. Fixed widows or approved equal: F-AW80; shall pass requirements at 120 psf uniform structural load with air infiltration  $< .01$  CFM/FT<sup>2</sup> at 6.24 PSF and no water penetration at 15 PSF. Poured and debridged thermal breaks are not acceptable.
- C. Construction: All window frame members and sash shall be of tubular extruded aluminum. Frame and sash to have enhanced thermal performance and mechanical strength using polyamide thermal strut construction. Frame sections shall be mitered and joined using heavy internal aluminum corner gussets that are mechanically staked and epoxy sealed. All openings are double sealed using continuous EPDM bulb, foam and wedge weather stripping to insure minimum air infiltration and maximum water resistance. Both project-out and fixed lites to have snap-in aluminum glazing bead for ease of field glazing.
- D. Glazing:
  - 1. windows shall be glazed with 1" double insulated glass with low-e coating and warm edge spacer matching assembly specified in the drawings and window schedule with outside lite = 1/4" clear tempered glass with solarban70 on #2 surface, air space = 1/2" argon filled, interior line 1/4" clear tempered
- E. Finish is to be coordinated with closure system.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Installer shall examine substrates, supporting structure and installation conditions.
- B. Do not proceed with panel installation until unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Metal Protection:
  - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
  - 2. Where aluminum will contact concrete, masonry or pressure treated wood, protect against corrosion by painting contact surfaces with bituminous paint or method recommended by manufacturer.

### 3.03 INSTALLATION

- A. Install the panel system in accordance with the manufacturer's suggested installation recommendations and approved shop drawings.
  - 1. Anchor component parts securely in place by permanent mechanical attachment system.
  - 2. Accommodate thermal and mechanical movements.
  - 3. Set perimeter framing in a full bed of sealant compound, or with joint fillers or gaskets to provide weather-tight construction.
- B. Install joint sealants at perimeter joints and within the panel system in accordance with manufacturer's installation instructions.

**3.04 CLEANING**

- A. Clean the panel system interior and exterior, immediately after installation.
- B. Refer to manufacturer's written recommendations.

END OF SECTION 08 45 23

## SECTION 08 5113 - ALUMINUM WINDOWS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes fixed and/or operable aluminum-framed windows for exterior locations.
- B. Related Sections include the following:
  - 1. Division 08 Section "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units.
  - 2. Division 08 Section "Glazing" for additional glazing requirements for aluminum windows.
  - 3. Division 08 Section "Glazed Aluminum Curtain Walls" for incorporating aluminum windows into glazed curtain walls and for coordinating finish among aluminum fenestration units.

#### 1.3 DEFINITIONS

- A. Performance class designations according to AAMA/WDMA/CSA 101/I.S.2/A440-08:
  - 1. AW: Architectural.
- B. Performance grade number according to AAMA/WDMA/CSA 101/I.S.2/A440-08:
  - 1. Design pressure number in pounds force per square foot (pascals) used to determine the structural test pressure and water test pressure.
- C. Structural Test Pressure: For uniform load structural test, is equivalent to 150 percent of the design pressure.
- D. Minimum Test Size: Smallest size permitted for performance class (gateway test size) or as specified elsewhere in this section, whichever is more stringent. Products must be tested at minimum test size or at a size larger than minimum test size to comply with requirements for performance class. Downsized test reports will not be considered acceptable.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. General: Provide aluminum windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified, and that are of minimum test size indicated below:
  - 1. Projected Windows: 60" x 144" (F/PO/F/PI). Down sized test reports will not be acceptable for this project

- B. Structural Performance: Provide aluminum windows capable of withstanding the effects of the following loads, based on testing units of the minimum test size specified herein that pass AAMA/WDMA/CSA 101/I.S.2/A440-08, Uniform Load Structural and Uniform Load Deflection Tests:
  - 1. Uniform Load Structural Test: 150 psf (positive and negative).
  - 2. Uniform Load Deflection Test: 100 psf (positive and negative).

## 1.5 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions for each type of aluminum window indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, installation details, and the following:
  - 1. Mullion details, including reinforcement and stiffeners.
  - 2. Joinery details.
  - 3. Weather-stripping details.
  - 4. Thermal-break details.
  - 5. Glazing details.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
  - 1. Include similar samples of hardware and accessories involving color selection.
- D. Maintenance Data: For operable window sash, operating hardware and finishes to include in maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

## 1.6 QUALITY ASSURANCE

- A. Product Qualifications: In order to confirm that the proposed product(s) conform to the material and performance requirements contained in these specifications, bidders shall include the following with their bid. Failure to comply with these requirements shall cause the bid to automatically be rejected.
  - 1. Bidder's Acknowledgement: Bidders shall include a letter in their bid stating the manufacturer and series (model) number of the product upon which its bid has been based. Changes in product (manufacturer or series) will not be permitted after the bid.
  - 2. Product Data: Bidders submitting bids based on products other than the Basis of Design product listed in Paragraph 2.1 must also include the following with their bid:
    - a. Comprehensive test reports not more than four years old prepared by a qualified testing agency for each product type being used on the project demonstrating compliance with the air, water and structural requirements outlined herein. Test reports based on the use of downsized test units will not be accepted.
    - b. Thermal simulations prepared by a qualified independent testing agency for each product type being used on the project demonstrating compliance with the thermal transmittance requirements outlined in Paragraph 2.3.



- c. Full size product details showing all frame and sash details, dimensions, thermal break construction, wall thicknesses and joinery. Details must accurately reflect all glazing and hardware options specified herein.
- B. Product Requirements: For maximum performance, windows for this project must meet both the testing requirements as contained herein and the minimum material requirements specified. Windows that carry the applicable AAMA rating but do not meet the material thicknesses, depths, etc. shall not be acceptable for use on this project.
- C. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.
- D. Source Limitations: Obtain aluminum windows through one source from a single manufacturer.
- E. Product Options: Drawings indicate size, profiles, and dimensional requirements of aluminum windows and are based on the specific system indicated. Do not modify size and dimensional requirements.
  - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- F. Fenestration Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440-08, "Standard/Specification for Windows, Doors, and Unit Skylights" for definitions and minimum standards of performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
- G. Glazing Publications: Comply with published recommendations of glass manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated.
- H. Preinstallation Conference: If requested, conduct conference at project site to review methods and procedures related to aluminum windows including, but not limited to, the following:
  - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components.
  - 3. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
  - 4. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

#### 1.7 PROJECT CONDITIONS

- A. Field Measurements: For retrofit installations, verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.
  - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating aluminum windows without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
    - a. Failure to meet performance requirements.
    - b. Structural failures including excessive deflection, water leakage, or air infiltration.
    - c. Faulty operation of movable sash and hardware.
    - d. Deterioration of metals or other materials beyond that which is normal.
    - e. Failure of insulating glass.
  2. Warranty Period:
    - a. Window: Ten years from date of Substantial Completion.
    - b. Insulated Glazing: Ten years from date of Substantial Completion.
    - c. Painted Metal Finishes:
      - 1) Ten years from date of Substantial Completion for AAMA 2603 Baked Enamel Finishes.
      - 2) Twenty years from date of Substantial Completion for AAMA 2605 Superior Performance Finishes.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: The basis of design for these specifications is the Series 3000i Projected/Fixed as manufactured by Architectural Window Manufacturing Corporation, Rutherford, New Jersey or approved equal .

### 2.2 MATERIALS

- A. Aluminum Extrusions: Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi (150-MPa) ultimate tensile strength, not less than 16,000-psi (110-MPa) minimum yield strength, and not less than 0.080-inch thickness at any location for the frame, sash or sill members.
- B. Frame/Sash Depth: 3 ½" minimum frame depth; 3 ½" minimum sash depth.
- C. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components.
1. All fasteners must be concealed except where unavoidable for application of hardware.
  2. For application of hardware, where required, use non-magnetic stainless steel phillips machine screws.
- D. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

- E. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action and for complete concealment when aluminum window is closed.
  - 1. Weather-Stripping Material: Manufacturer's standard system and materials complying with AAMA/WDMA/CSA 101/I.S.2/A440-08.
- F. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.
  - 1. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material. Comply with AAMA 701/702.
- G. Replaceable Weather Seals: Comply with AAMA 701/702.
- H. Sealant: For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, nonshrinking, and nonmigrating type recommended by sealant manufacturer for joint size and movement.

## 2.3 WINDOW

- A. Window Type: Projected Out/Fixed
- B. AAMA/WDMA Performance Requirements: Provide aluminum windows of performance indicated that comply with AAMA/WDMA/CSA 101/I.S.2/A440-08.
  - 1. Performance Class and Grade: AW-PG100.
- C. Condensation-Resistance Factor (CRF): Provide aluminum windows tested with insulating glass for thermal performance according to AAMA 1503, showing a minimum CRF of 56.
- D. Thermal Transmittance: Provide aluminum windows with whole-window U-factor and SHGC maximums indicated when simulated in accordance with NFRC 100 and NFRC 200 at an equal lite fixed/project-out model size of 48" x 72" and glazed with 1" Argon filled sputter coat Low-E (#2) insulated glass using a warm edge spacer.
  - 1. U-Factor: 0.31 Btu/sq. ft. x h x deg F or less.
  - 2. SHGC: 0.23.
- E. Air Infiltration: Maximum rate not more than indicated when tested according to AAMA/WDMA/CSA 101/I.S.2/A440-08, Air Infiltration Test.
  - 1. Maximum Rate: <0.01 cfm/sq. ft. of area at an inward test pressure of 6.24 lbf/sq. ft. (300 Pa).
- F. Water Resistance: No water leakage as defined in AAMA/WDMA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA 101/I.S.2/NAFS, Water Resistance Test.
  - 1. Test Pressure: 20 percent of positive design pressure, but not less than 20 lbf/sq. ft.
- G. Forced-Entry Resistance: Comply with Performance Grade 10 requirements when tested according to ASTM F 588.

- H. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/WDMA/CSA 101/I.S.2/A440-08.
- I. Operating Force and Auxiliary (Durability) Tests: Comply with AAMA/WDMA/CSA 101/I.S.2/A440-08 for operating window types indicated.

## **2.4 INSULATED GLAZING**

- A. Construction: All windows (except those receiving insulated panels) shall be factory glazed with hermetically sealed 1" insulating glass units with a dual seal of polyisobutylene and silicone and a desiccant filled spacer with warm edge black spacer. Insulated glass must be set into a continuous bed of two-part structural silicone sealant and held in place with removable extruded aluminum snap-in beads. Wrap around (marine) glazing which requires the removal and disassembling of the sash for re-glazing will not be acceptable. Units must be IGCC certified for a CBA rating level.
  - 1. Refer to glazing schedule in drawings for specific IGU makeup, tinted glass is used and is required to match storefront and fully-vision sectional door glazing provided by other trades/suppliers. General Contractor to coordinate between different trades if alternate tinted glass to be submitted by any one trade/supplier for its use at all locations.

## **2.5 HARDWARE: Not applicable**

## **2.6 ACCESSORIES**

- A. Rescue Labels: Not applicable.

## **2.7 FABRICATION**

- A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
- B. Fabricate aluminum windows that are reglazable without dismantling sash or framing.
- C. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed (products with exposed thermal barriers will not be acceptable), low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.
  - 1. All exterior aluminum shall be separated from interior aluminum by a rigid, structural thermal barrier. For purposes of this specification, a structural thermal barrier is defined as a system that shall transfer shear during bending and, therefore, promote composite action between the exterior and interior extrusions.
  - 2. No thermal short circuits shall occur between the exterior and interior.
  - 3. The thermal barrier shall be INSULBAR® or equal and shall consist of two glass reinforced polyamide nylon 6/6 struts mechanically crimped in raceways extruded in the exterior and interior extrusions.
  - 4. Poured and debridged urethane thermal barriers shall not be permitted.
- D. Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator.

- E. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
- F. Mullions: Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design loads of window units.
- G. Subframes and receptors: Provide subframes with anchors for window units as shown, of profile and dimensions indicated but not less than 0.093-inch thick extruded aluminum. Finish to match window units. Provide subframes capable of withstanding design loads of window units.
- H. Factory-Glazed Fabrication: Glaze aluminum windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 08 Section "Glazing" and with AAMA/WDMA/CSA 101/I.S.2/A440-08.
- I. Muntins: Where shown on drawings, muntins shall be 2-3/16" wide true divided lites extruded aluminum with beveled edges to match frame. Muntins must be thermally broken. The thermal barrier shall be INSULBAR® or equal and shall consist of two glass reinforced polyamide nylon 6/6 struts mechanically crimped in raceways extruded in the exterior and interior extrusions. Products using applied flat stock will not be accepted.
- J. Extruded Aluminum Sills: Provide extruded aluminum sills in profiles and depths shown on drawings, complete with fasteners and retainer clips of same material. Finish to match exterior window finish. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections.

## 2.8 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. Exterior of Window:
  - 1. Superior-Performance Organic Finish: AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturer's written instructions.
    - a. Fluoropolymer Two-Coat System: Manufacturer's standard two-coat thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
    - b. Color: as indicated on the window schedule and window finish schedule within the drawings.
- D. Interior of Window:
  - 1. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating;

Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.

- a. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603.
- b. Color: As selected by Architect from manufacturer's colors to match exterior color.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work. Verify rough opening dimensions, levelness of sill plate, and operational clearances. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight window installation.
  - 1. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
  - 2. Wood Frame Walls: Dry, clean, sound, well nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in opening and within 3 inches (76 mm) of opening.
  - 3. Metal Surfaces: Dry; clean; free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.
  - 4. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing windows, hardware, accessories, and other components.
- B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support.
- C. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.
- D. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

#### **3.3 FACTORY TESTING**

- A. One window for each seventy-five manufactured shall be randomly selected by the Owner and Architect to be tested at the manufacturer's facility for air and water infiltration in order to confirm compliance of the project's windows with the performance requirements contained in these specifications. Bidders are to include the cost of transportation, food, and lodging for four representatives of the Owner and/or Architect to witness these tests.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: If desired, Owner will engage and pay for a qualified testing agency to perform tests and inspections and prepare test reports.
  - 1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
  - 2. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502, Test Method A. Field test pressures and allowable limits shall be as factored by AAMA 502 from those minimums required to determine laboratory compliance with the applicable Performance Class and Grade pursuant to AAMA/WDMA/CSA 101/I.S.2/A440-08.
  - 3. Testing Extent: Three windows as selected by Architect and a qualified independent testing and inspecting agency. Windows shall be tested immediately after installation.
  - 4. Test Reports: Shall be prepared according to AAMA 502.
- B. Contractor Responsibility: coordinate with owner testing service during initial testing. If initial testing determines non-compliance at any of the tested locations, at contractor expense necessary work to remediate noncomplying windows and retest as specified above shall be performed. .
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of remediated doors or additional work with specified requirements.

### 3.5 ADJUSTING, CLEANING, AND PROTECTION

- A. Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
- B. Manufacturer shall clean all glass and aluminum prior to shipment.
- C. Protection of newly installed windows and/or final cleaning of glass and aluminum to remove any accumulations that may have occurred during the construction period is to be the responsibility of the General Contractor or Owner.
- D. Comply with manufacturer's written recommendations for final cleaning and maintenance.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain window operating system.

END OF SECTION 085113

## SECTION 087100 - DOOR HARDWARE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
  - 1. Swinging doors.
  - 2. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
  - 1. Mechanical door hardware.
  - 2. Electromechanical door hardware.
  - 3. Automatic operators.
  - 4. Cylinders specified for doors in other sections.
- C. Related Sections:
  - 1. Division 08 Section "Door Hardware Schedule".
  - 2. Division 08 Section "Hollow Metal Doors and Frames".
  - 3. Division 08 Section "Interior Aluminum Doors and Frames".
  - 4. Division 08 Section "Flush Wood Doors".
  - 5. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
  - 6. Division 08 Section "Integrated Door Assemblies".
  - 7. Division 28 Section "Access Control Hardware Devices".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
  - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
  - 2. ICC/IBC - International Building Code.
  - 3. NFPA 70 - National Electrical Code.
  - 4. NFPA 80 - Fire Doors and Windows.
  - 5. NFPA 101 - Life Safety Code.
  - 6. NFPA 105 - Installation of Smoke Door Assemblies.
  - 7. UL/ULC and CSA C22.2 - Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
  - 8. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:
  - 1. ANSI/BHMA Certified Product Standards - A156 Series.
  - 2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
  - 3. ANSI/UL 294 - Access Control System Units.
  - 4. UL 305 - Panic Hardware.



### 1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
  - 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
  - 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
  - 3. Content: Include the following information:
    - a. Type, style, function, size, label, hand, and finish of each door hardware item.
    - b. Manufacturer of each item.
    - c. Fastenings and other pertinent information.
    - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    - e. Explanation of abbreviations, symbols, and codes contained in schedule.
    - f. Mounting locations for door hardware.
    - g. Door and frame sizes and materials.
    - h. Warranty information for each product.
  - 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
  - 1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
    - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
    - b. Complete (risers, point-to-point) access control system block wiring diagrams.
    - c. Wiring instructions for each electronic component scheduled herein.
  - 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

- D. Proof of Certification: Provide copy of manufacturer(s) official certification or accreditation document indicating proof of status as a qualified and authorized provider of the primary Integrated Wiegand Access Control Products.
- E. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- F. Informational Submittals:
  - 1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.
- B. Project Record Documents: Provide record documentation of as-built door hardware sets in digital format (.pdf, .docx, .xlsx, .csv) and as required in Division 01, Project Record Documents.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
- C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
  - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
  - F. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.
  - G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
    1. Function of building, purpose of each area and degree of security required.
    2. Plans for existing and future key system expansion.
    3. Requirements for key control storage and software.
    4. Installation of permanent keys, cylinder cores and software.
    5. Address and requirements for delivery of keys.
  - H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
    1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
    2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
    3. Review sequence of operation narratives for each unique access controlled opening.
    4. Review and finalize construction schedule and verify availability of materials.
    5. Review the required inspecting, testing, commissioning, and demonstration procedures
  - I. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.
- 1.6 DELIVERY, STORAGE AND HANDLING
- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
  - B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
  - C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".
- 1.7 COORDINATION
- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check

Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

- B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

## 1.8 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
  - 1. Structural failures including excessive deflection, cracking, or breakage.
  - 2. Faulty operation of the hardware.
  - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 4. Electrical component defects and failures within the systems operation.
- C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 BUTT HINGES

- A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
  - 1. Quantity: Provide the following hinge quantity:
    - a. Two Hinges: For doors with heights up to 60 inches.
    - b. Three Hinges: For doors with heights 61 to 90 inches.
    - c. Four Hinges: For doors with heights 91 to 120 inches.
    - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
  - 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
    - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
    - b. Sizes from 3'1" to 4'0": 5" heavy weight.
  - 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

- a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
  - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
4. Hinge Options: Comply with the following:
- a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for all out-swinging lockable doors.
5. Manufacturers:
- a. McKinney (MK) - TA/T4A Series, 5-knuckle.
  - b. Or approved equal

## 2.2 CONTINUOUS HINGES

- A. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 continuous geared hinge. with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.
1. Where specified, provide modular continuous geared hinges that ship in two or three pieces and form a single continuous hinge upon installation.
  2. Manufacturers:..
    - a. Pemko (PE).
    - b. Or approved equal
- B. Pin and Barrel Continuous Hinges: ANSI/BHMA A156.26 Grade 1-600 pin and barrel continuous hinges with minimum 14 gauge Type 304 stainless steel hinge leaves, concealed stainless pin, and twin self-lubricated nylon bearings at each knuckle separation. Factory trim hinges to suit door height and prepare for electrical cut-outs.
1. Manufacturers:
    - a. Markar Products; ASSA ABLOY Architectural Door Accessories (MR).
    - b. Pemko (PE).
    - c. Or approved equal

## 2.3 POWER TRANSFER DEVICES

- A. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
1. Manufacturers:
    - a. Pemko (PE) - EL-CEPT Series.
    - b. Securitron (SU) - EL-CEPT Series.
    - c. Or approved equal

- B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
1. Provide one each of the following tools as part of the base bid contract:
    - a. McKinney (MK) - Electrical Connecting Kit: QC-R001.
    - b. McKinney (MK) - Connector Hand Tool: QC-R003.
    - c. Or approved equal
  2. Manufacturers:
    - a. McKinney (MK) - QC-C Series.
    - b. Or approved equal

#### 2.4 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.
1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
  2. Furnish dust proof strikes for bottom bolts.
  3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
  4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
  5. Manufacturers:
    - a. Rockwood (RO).
    - b. Or approved equal
- B. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
  2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
  3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
  4. Pulls, where applicable, shall be provided with a 10" clearance from the finished floor on the push side to accommodate wheelchair accessibility.
  5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets. When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.
  6. Manufacturers:

- a. Rockwood (RO).
- b. Or approved equal

## 2.5 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
  - 1. Manufacturers:
    - a. Match Existing, Field Verify.
- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
  - 1. Threaded mortise cylinders with rings and cams to suit hardware application.
  - 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
  - 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
  - 4. Tubular deadlocks and other auxiliary locks.
  - 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
  - 6. Keyway: Match Facility Standard.
- C. Keying System: Each type of lock and cylinders to be factory keyed.
  - 1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
  - 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
  - 3. Existing System: Field verify and key cylinders to match Owner's existing system.
- D. Key Quantity: Provide the following minimum number of keys:
  - 1. Change Keys per Cylinder: Two (2)
  - 2. Master Keys (per Master Key Level/Group): Five (5).
  - 3. Construction Keys (where required): Ten (10).
- E. Construction Keying: Provide construction master keyed cylinders.
- F. Key Registration List (Bitting List):
  - 1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
  - 2. Provide transcript list in writing or electronic file as directed by the Owner.

## 2.6 KEY CONTROL

- A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.
  - 1. Manufacturers:
    - a. Lund Equipment (LU).
    - b. MMF Industries (MM).

- c. Telkee (TK).
- d. Or approved equal

## 2.7 MORTISE LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): Provide ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed mortise locksets. Listed manufacturers shall meet all functions and features as specified herein.
  - 1. Provide locksets with functions and features as follows:
    - a. Heavy duty 12-gauge wrought steel case.
    - b. Stainless steel 3/4" one-piece anti-friction reversible latchbolt with a one-piece hardened stainless steel 1" projection deadbolt.
    - c. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.
    - d. Meets UL and CUL Standard 10C Positive Pressure, Fire Test of Door Assemblies with levers that meet A117.1 Accessibility Code.
    - e. Meets UL Certification Directory ZHLL.R21744 for products used in windstorm rated assemblies.
    - f. Extended cycle test: Locks to have been cycle tested in ordinance with ANSI/BHMA 156.13 requirements to 14.5 million cycles or greater.
    - g. Status indicators inside, outside, or on both sides of doors as specified; available with wording for "locked/unlocked", "vacant/occupied" or custom wording options. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status.
    - h. Ten-year limited warranty for mechanical functions.
  - 2. Manufacturers:
    - a. Corbin Russwin Hardware (RU) - ML2000 Series.
    - b. Or approved equal

## 2.8 DEADLOCKS AND LATCHES

- A. Mortise Deadlocks, Small Case: ANSI/BHMA A156.36, Grade 1, small case mortise type deadlocks constructed of heavy gauge wrought corrosion resistant steel. Steel or stainless steel bolts with a 1" throw and hardened steel roller pins. Deadlocks to be products of the same source manufacturer and keyway as other specified locksets.
  - 1. Manufacturers:
    - a. Corbin Russwin Hardware (RU) - DL4000 Series.
    - b. Or approved equal

## 2.9 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
  - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
  - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.



3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Short-lipped strikes: For locks at double doors.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.10 ELECTROMAGNETIC LOCKING DEVICES

- A. Surface Electromagnetic Locks (Heavy Duty): Electromagnetic locks to be surface mounted type conforming to ANSI A156.23, Grade 2 with minimum holding force strength of 1,200 pounds. Locks to be capable of either 12 or 24 voltage and be UL listed for use on fire rated door assemblies. Electronics are to be fully sealed against tampering and allow exterior weatherproof applications. As indicated in Hardware Sets, provide specified mounting brackets and housings. Power supply to be by the same manufacturer as the lock with combined products having a lifetime replacement warranty.

1. Manufacturers:
  - a. Securitron (SU) - M62 Series.
  - b. Or approved equal

2.11 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. Exit devices shall have a five-year warranty.
2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
4. Except on fire rated doors, provide exit devices with keyed cylinder dogging device to hold the pushbar and latch in a retracted position.
5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
6. Flush End Caps: Provide flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.
7. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
  - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
  - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

8. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
  9. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
  10. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
  11. Rail Sizing: Provide exit device rails factory sized for proper door width application.
  12. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed exit devices. Listed manufacturers shall meet all functions and features as specified herein.
1. Provide exit devices with functions and features as follows:
    - a. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.
    - b. Meets UL and CUL Standard 10C Positive Pressure, Fire Test of Door Assemblies with levers that meet A117.1 Accessibility Code.
    - c. Five-year limited warranty for mechanical features.
  2. Electromechanical exit devices shall have the following functions and features:
    - a. Universal Molex plug-in connectors that have standardized color-coded wiring and are field configurable in fail safe or fail secure and operate from 12vdc to 24vdc regulated.
    - b. EcoFlex or equivalent technology that reduces energy consumption up to 92% as certified by GreenCircle.
    - c. Options to be available for request-to-exit or enter signaling, latchbolt and touchbar monitoring.
    - d. Field configurable electrified trim to fail-safe or fail-secure that operates from 12-24VDC.
    - e. Five-year limited warranty for electromechanical features.
  3. Manufacturers:
    - a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
    - b. Or approved equal
- 2.12 TOUCH SENSE EXIT BARS
- A. Touch Sense Exit Bars: U.L. listed dual sense touch bar for use on magnetically locked, non-fire-rated metal, aluminum or wood doors requiring two independent switch circuits to release the locking device. Touching the bar or engaging mechanical movement (1/8") allows for free egress. Touch sensing and redundant movement activated switches to comply with current fire and life safety egress codes. Operates on either 12 or 24VDC with optional illuminated "Push to Exit" fiber optic strip.
1. Manufacturers:
    - a. Securitron (SU) - DSB Series.
    - b. Or approved equal

## 2.13 SURFACE DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
  2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
  3. Cycle Testing: Provide closers which have surpassed 15 million cycles.
  4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
  5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
  6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
  7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.
1. Large body cast iron surface mounted door closers shall have a 30-year warranty.
  2. Manufacturers:
    - a. Corbin Russwin Hardware (RU) - DC8000 Series.
    - b. Or approved equal

## 2.14 ELECTROMECHANICAL DOOR OPERATORS

- A. Electromechanical Door Operators (High Traffic, Door Mounted, Regenerative): Provide ANSI/BHMA A156.19 Certified Products Directory (CPD) listed low energy operators that are ETL tested to UL325 and UL10C certified and comply with requirements for the Americans with Disabilities Act (ADA). Operators shall be verified by GreenCircle to offer energy savings of 91% (plug-in) and 100% (wireless) when compared to similar products. Operators shall accommodate openings up to 250 pounds and 48" wide.
1. Provide operators with features as follows:
    - a. Non-handed with push and pull side mounting.
    - b. Regenerative drive or continuous duty operation.
    - c. Radio frequency stainless steel wall switches with integral radio frequency receiver.
    - d. Shock absorbing arm.
    - e. Auxiliary activation input port and 24VDC input port.
    - f. Two-year limited warranty.

2. Operators shall have the following functionality:
  - a. Adjustable Hold Open: Amount of time a door will stay in the full open position after an activation.
  - b. Dynamic Braking: Braking or slowing of the door if excessive door speed occurs resulting from a wind load or an abusive open condition.
  - c. Emergency Interface Relay: Door closes and ignores any activation input until signal is discontinued. Only available when used with Wireless Interface Module.
  - d. Latch Assist: At closed position, after an activation, the door is pulled in. After the door has closed, the door is pulled in to assist with latch release/engagement.
  - e. Obstruction Detection: Door closes if it hits an obstruction while opening. Door will stop once it hits an obstruction and will rest against the obstruction until obstruction is removed.
  - f. On/Off Switch: Disables operator activation.
  - g. Open Delay: Delays operator opening for locking hardware. Only available when used with Wireless Interface Module.
  - h. Outside Wall Switch Disable: When contact is closed, outside wall switch is disabled. Only available when used with Wireless Interface Module.
  - i. Power Close: Additional force to assist door closing between 90° and 70° and 10° and 0°.
  - j. Push & Go: As the door is manually opened, the operator "senses" movement and opens door to the full-open position.
  - k. Single Relay Output: Closes to indicate a valid activation. Only available when used with Wireless Interface Module.
3. Manufacturers:
  - a. Norton Rixson (NO) - 5800 Series.
  - b. Or approved equal

## 2.15 ARCHITECTURAL TRIM

### A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:
  - a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:

- a. Rockwood (RO).
- b. Or approved equal

## 2.16 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Stops should not be mounted any nearer to the hinge than One-half the width of the door. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
  - 1. Manufacturers:
    - a. Rockwood (RO).
    - b. Or approved equal
- C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
  - 1. Manufacturers:
    - a. Norton Rixson (RF).
    - b. Rockwood (RO).
    - c. Or approved equal

## 2.17 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
  - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
  - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
  - 1. Pemko (PE)
  - 2. Or approved equal

## 2.18 ELECTRONIC ACCESSORIES

- A. Switching Power Supplies: Provide power supplies with either single or dual voltage configurations at 12 or 24VDC. Power supplies shall have battery backup function with an integrated battery charging circuit and shall provide capability for power distribution, direct lock control and Fire Alarm Interface (FAI) through add on modules. Power supplies shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs.
  - 1. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.
  - 2. Manufacturers:
    - a. Securitron (SU) - AQD Series.
    - b. Or approved equal

## 2.19 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

## 2.20 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

### 3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

### 3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
  - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
  - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
  - 2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
  - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
  - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Push Plates and Door Pulls: When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.
- E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- F. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

### 3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.

1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

### 3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

### 3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

### 3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

### 3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
  1. Quantities listed are for each pair of doors, or for each single door.
  2. The supplier is responsible for handing and sizing all products.
  3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
- B. Refer to Section 080671, Door Hardware Sets, for hardware sets.

END OF SECTION 087100



## **SECTION 08 8000 – GLAZING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Work Included: The Work of this Section shall include:
  - 1. Insulated glazing units with low-e coating
  - 2. Insulated spandrel glazing units with low-e coatings and ceramic frit
  - 3. Tempered safety glazing at interior locations
  - 4. Mirrored Glass
  - 5. Acid-Etched Glass

#### **1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples: Submit 12-inch square samples of each type of glass indicated, and 12-inch long samples of each color of gasket.
- C. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### **1.3 INFORMATIONAL SUBMITTALS**

- A. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- B. Certificates: Submit certificates from respective manufacturers attesting that glass and glazing materials furnished for Project comply with requirements of agencies having jurisdiction.
  - 1. Separate certification will not be required for glazing materials bearing manufacturer's permanent labels that represent a quality control program of a certification agency or independent testing laboratory acceptable to authorities having jurisdiction.
  - 2. Submit certification that tempered glass intended for use on the project has been heat soaked.
- C. Compatibility and Adhesion Test Report: Submit statement from sealant manufacturer that glass and glazing materials have been tested for compatibility and adhesion with glazing sealants and interpreting test results, with recommendations for primers and substrate preparation.
- D. Suitability and stress statements from sealant manufacturer.

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

- B. Mockups: Build mockups to demonstrate aesthetic effects and match to existing curtainwall.

- 1. Provide glazing in integrated exterior mockup specified in Division 01 Section "Quality Requirements" to match glazing systems required for Project, including glazing methods.

#### 1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

- 1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
  - 2. Use ASTM C794 for adhesion testing.
  - 3. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
  - 4. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
  - 5. Schedule enough time for testing and analyzing results to prevent delaying the Work.
  - 6. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect glass and glazing materials during delivery, storage and handling to comply with manufacturer's directions and to prevent damage to glass and glazing materials from moisture, temperature changes, direct exposure to sun, and from other causes.

#### 1.7 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with glazing when air and substrate temperatures are outside the limits permitted by glazing material manufacturer or when joint substrates are wet or dirty.

#### 1.8 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass and Acid Etched Products: Manufacturer agrees to replace coated-glass and Acid-etched units that deteriorate within specified warranty period. Deterioration of coated glass and etched glass is defined as defects developed from normal use that are not interpreting test results, with recommendations and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

- 1. Warranty Period: 10 years from date of Substantial Completion.

- B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that are found to be defective or deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust,

moisture, or film on interior surfaces of glass or glazing spacer migration.

1. Warranty Period: 10 years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
1. Warranty Period: 10 years from date of Substantial Completion

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide products as indicated in Part 2 articles or by one of the following:
1. Basis of design manufacturer: Vitro (formerly PPG Industries, Inc.)
  2. Other manufacturers:
    - a. Guardian Glass; SunGuard.
    - b. Vetrotech Saint-Gobain.
    - c. Oldcastle Building Envelope™.
    - d. Or approved equal.
- B. Source Limitations for Glass: Obtain all tinted and insulated glass type from single source from single manufacturer.
- C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

### 2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined per the IBC and ASTM E 1300.
1. Design Wind Pressures: As indicated on Structural Drawings.
    - a. Risk category III
    - b. Exposure category B

- c. Basic wind speed 124mph
- 2. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.
- 3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/60 times the short-side length or 1 inch, whichever is less.
- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
  - 1. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
  - 2. U-Factors: Center-of-glazing values, per NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
  - 3. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, per NFRC 200 and based on LBL's WINDOW 5.2 computer program.
- 4. Visible Reflectance: Center-of-glazing values, per NFRC 300

### 2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
  - 1. NGA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
  - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IgCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered

float glass.

## 2.4 PRIMARY GLASS PRODUCTS

- A. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or class 2 (tinted) as indicated, Quality-Q3.
  - 1. Fully tempered glass shall be heat soaked and tested in accordance with BS EN 14179 “Glass in Buildings-Heat Soaked Thermally Toughened Soda Lime Silicate Safety coat.
- B. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Quality-Q3.
- C. Acid-Etched Glass: Acid-etched glass with decorative pattern evenly etched into glass
  - 1. ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Quality-Q3.
- D. Ceramic Frit Spandrel Glass
  - 1. Heat-treated glass with ceramic coating complying with ASTM C 1048, Condition B (spandrel glass, one surface ceramic-coated), Type 1 (transparent, flat), Quality Q3 (Glazing Select), with other requirements as specified.
  - 2. GANA/GTA 66-9-20, Specification for Heat-Strengthened or Fully Tempered Ceramic Enamel Spandrel Glass Used for Building Window/Curtain Walls.
  - 3. Custom color selected by the Architect.
  - 4. Install as part of insulated unit as specified in glazing schedule
- E. Silicone-Coated Spandrel Glass: ASTM C1048, Type I, Condition C, Quality-Q3.
  - 1. Spandrel glass installed as part of Insulated glazing unit where specified with silicone coating on #4 surface
  - 2. Coating as manufactured by ICD High Performance Coating or approved equal

## 2.5 COATED GLASS PRODUCTS

- A. Low Emissivity (Low 'E') Coated Glass: Factory- applied coating complying with ASTM C1376 and resulting in a stable, uniform, nearly invisible coating which imparts average maintained insulating performance of at least R equal to 3.5.
  - 1. Basis-of-Design, Product: Subject to compliance with requirements, provide the following:
    - a. Solarban 70 as supplied by Vitro (formerly PPG Industries, Inc.) or approved equal

## 2.6 LAMINATED GLASS

- A. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear, or transparent as indicated by glazing type

## 2.7 SEALED INSULATING GLASS UNITS

- A. General: Provide insulating glass units qualified per ASTM E 2190, and complying with other requirements specified below, unless otherwise indicated.
- B. Insulating glass (IGUs): Units shall consist of the following, unless otherwise required to meet project performance requirements:
  1. Glass thickness as indicated on drawings or thicker as required by calculations and delegated design
  2. Air spaces in dimension indicated on drawing filled with 95% argon gas
  3. All Insulating glass shall be dual seal and certified for compliance with seal classification "CBA" by the Insulating Glass Certification Council (IGC) and tested in accordance with the following ASTM Test methods.
    - a. ASTM E2188 Test Method for Insulating Glass Unit Performance
    - b. ASTM E2189 Test Method for Testing Resistance to Fogging in Insulating Glass Units.
  4. Perimeter Spacer: Manufacturer's warm edge spacer construction, color black
  5. Sealing System: Dual seal, with manufacturer's standard polyisobutylene and silicone primary and secondary sealants.
    - a. Secondary seal on structural silicone glazed units shall be a special silicone edge seal certified for use in structural silicone glazing applications over the temperature range and structural loading.
  6. Provide accurate and straight edge deletions of coatings at areas of insulating glass assemblies where Low "E" coatings, metallic coating or other decorative coatings are applied to surfaces scheduled to be in contact with the primary seal of insulating glass units.
  7. Minimum insulated glazing performance: as indicated on the drawings for each glass type
  8. Units shall be certified for compliance with seal classification "CBA" by the Insulating Glass Certification Council (IGCC) or by IGMA, and tested in accordance with the above ASTM Test Methods.
  9. Insulating glass shall conform to the following tolerances:
    - a. Length and Width: + 3.0 mm/ -2.0 mm.
    - b. Diagonal: +/- 3.0 mm.
    - c. Thickness: As agreed +/- 1.0 mm.
    - d. Edge-Deletion of Coating: Minimum 8 mm wide. Width of deletion must be more

- than the width of the secondary seal. Silver layer(s) must be completely removed. Appearance must be uniform.
- e. Primary PIB Seal: Must be complete with no breaks. Appearance must be uniform. PIB bead must overlap coating. No visible bright line when glass is viewed in transmission. The width of the PIB bead shall be  $4.0 \text{ mm} + 3.0/-1.5 \text{ mm}$ .
  - f. Secondary Seal: Nominal  $6 \text{ mm} + 3.0/-1.5 \text{ mm}$ . The minimum width of the secondary silicone seal for IG units that are glazed structurally must be determined according to ASTM C 1249. The secondary seal must be uniformly applied without bubbles, cavities or gaps. Avoid excess sealant that will need to be trimmed off later.
10. Additional requirements and properties for primary and secondary insulating glass seals and spacers:
- a. All glass units shall comply with IGMA Guidelines which limits the dimension of the visible edge seal encroachment into the vision area to be no greater than the "sightline infringement of 3mm (0.12").
  - b. Insulating glass unit hermetic seal to consist of butyl primary and silicone secondary seals with bent, welded, or soldered interpane spacer corners; keyed corners are not acceptable unless also soldered or welded. Spacers shall be aluminum or stainless steel. Locate spacer joint at the top or sides of the units, but in no instances at the sill. Design units to minimize the number of spacer joints. Provide solid keys, embedded in butyl sealant on all four sides, at spacer joints.
  - c. Hermetic seals must be continuous and intimately bonded to both lites of glass. Provide primary seal of uniform depth with a nominal width of  $1/8$  to  $3/16$  in. Hermetic seals shall not be contaminated with debris, fingerprints, or other foreign matter and shall not contain voids or air pockets that decrease the width of the seal below the minimum widths listed in these Specifications, or that breach the seal. The width of the primary seal shall not be less than  $1/16$  in., and the total cumulative length of the primary seal between  $1/16$  in. and  $1/8$  in. shall be less than 12 in. in any one insulating glass unit. The primary seal shall not have a reduced thickness at the corners. An increased thickness of the primary seal at the corners is acceptable.
  - d. Provide secondary seal of uniform depth with a nominal width of  $1/4$  in. Provide a total width of the primary and secondary seal of  $1/2$  in. Units shall meet SIGMA 65-7-2, latest edition. Units shall not contain breather or capillary tubes or similar penetrations.

## 2.8 GLAZING SEALANTS

- A. Glazing sealants shall comply with ASTM C 920 for the specific Type, Grade, and Use, and shall be marked on Shop Drawings.
- B. General:
  - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
  - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

3. Stress: When exposed to wind load the stress in the silicone sealant of dimensions shown shall not exceed 20 psi with a safety factor of 5:1.
4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

## 2.9 GLAZING GASKETS

- A. Dense Gaskets: Extruded one piece gaskets of neoprene, complying with ASTM C 864, of profile required for a watertight seal, with a Shore A hardness of 75 plus 5 for hollow profiles and 60 plus 5 for solid profiles.
- B. Cellular Gaskets: Preformed cellular neoprene gaskets of profile required for a watertight seal; complying with ASTM C 509, with a Shore A hardness of 40 plus 5, to provide 20 to 35 percent compression.

## 2.10 MISCELLANEOUS GLAZING MATERIALS

- A. Compatibility: Provide materials with proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers and Sealers: Type recommended by gasket manufacturer.
- C. Setting Blocks: As per ASTM C864; Neoprene, EPDM or silicone blocks as required for compatibility with glazing sealants, 80 to 90 Shore A durometer hardness, 4-inch minimum length by width to suit glass thickness.
- D. Shims: As per ASTM C864; shims used with setting blocks shall be of the same material, hardness, length and width as the setting blocks.
- E. Edge Blocks: Same material as setting blocks, of 50-60 Shore A durometer, of size to limit lateral movement of glass.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify compliance with applicable tolerances; for functioning of weep system; for face and edge clearances; and for effective sealing of joinery. Report conditions detrimental to glazing work. Perform glazing work after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean glazing channels immediately before glazing. Remove coatings which are not firmly bonded to substrates.

### 3.3 GLAZING, GENERAL

- A. Comply with recommendations of glass manufacturers, of manufacturers of gaskets and other glazing materials, except where more stringent requirements are indicated by referenced glazing standards.



- B. Comply with combined written instructions of manufacturers of glazing materials, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publication.
  - 1. Remove burrs and other projections from glazing channel surfaces.
  - 2. Protect glazing surfaces from abrasion and other damage during handling and installation.
  - 3. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
  - 4. Install elastomeric setting blocks in sill channels, sized and located to comply with referenced glazing publication, unless otherwise instructed by plastic glazing manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
  - 5. Provide edge blocking to comply with referenced glazing publication unless otherwise instructed by glazing manufacturer.
- C. Glazing channels are intended to provide for necessary bite on glass, minimum edge and face clearances, with reasonable tolerances.
- D. Protect glass from damage. Remove and dispose of glass units with damage or imperfections of kind that impairs performance or appearance.

### 3.4 GLAZING

- A. Install setting blocks one quarter of glass width from each corner but with edge nearest corner not closer than 6 inches from corner or 0.125 times glass width, whichever is greater. Install blocks to prevent movement.
- B. Provide edge blocking to comply with referenced glazing standard. Install edge blocks securely, between the midheight and top of glass.
- C. Set units of glass in each series with uniformity of appearance.
- D. Install sponge and dense gaskets to protrude slightly out of channel, to eliminate dirt and moisture pockets.
- E. Provide adequate anchorage to ensure that gaskets will not "walk" out.

### 3.5 PROTECTION AND CLEANING

- A. Promptly protect installed glass from breakage with crossed streamers attached to framing and held away from glass. Do not apply markers on glass. Remove nonpermanent labels and clean glass.
- B. Protect glass from contact with contaminating substances. If contaminating substances do come into contact with glass, remove immediately as recommended by glass manufacturer.
- C. Examine glass adjacent to or below exterior concrete and masonry at least once a month, for build-up of dirt, scum, alkali deposits or staining. Remove residue as recommended by glass manufacturer.

- D. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents and vandalism.
- E. Wash glass on both faces not more than 4 days prior to date scheduled for inspections to establish date of Substantial Completion in each area of Project. Wash glass as recommended by glass manufacturer.
- F. Glass to be cleaned according to:
  - 1. GANA Glass Information Bulletin GANA 01-0300 – “Proper Procedure for Cleaning Architectural Glass Products”.
  - 2. GANA Glass Informational Bulletin GANA TD-02-0402 – “Heat Treated Glass Surfaces are Different”.
- G. Do not use razor blades, scrapers or metal tools to clean glass.

### 3.6 GLAZING SCHEDULE

- 1. Refer to drawings.

**END OF SECTION 08 8000**

## SECTION 088300 -ATHLETIC MIRRORS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes the following types of silvered flat glass mirrors:
  - 1. Annealed glass mirrors with safety backing qualifying as safety glazing.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
- B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.
- C. Samples: For each type of the following:
  - 1. Mirrors: 12 inches (300 mm) square, including edge treatment on two adjoining edges.
  - 2. Mirror Clips: Full size.
  - 3. Mirror Trim: 12 inches (300 mm) long.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of mirror, safety backing, mirror mastic, and aluminum trim channels.
- B. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing and substrates on which mirrors are installed.
- C. Sample Warranty: For special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For mirrors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing.
  - 1. Testing is not required if data are submitted based on previous testing of mirror mastic products and mirror backing matching those submitted.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
  - 1. Warranty Period: Five

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Basis of Design Manufacturer:
  - a. Guardian Ultra Mirror
  - b. Pilkington Mirrorpane Chrome
  - c. Or approved Equal
- B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.

- C. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.
- D. Silvered Flat Glass Mirrors:
  - 1. ASTM C1503 manufactured using copper-free, low-lead mirror coating process
  - 2. Annealed monolithic glass mirrors of mirror select glazing quality, clear
  - 3. Nominal Thickness: 6.0 mm
- E. Safety Glazing Products: For film-backed mirrors, provide products that comply with 16 CFR 1201, Category II and ANSI Z97.1.

## 2.2 MISCELLANEOUS MATERIALS

- A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- C. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint, as certified by mirror manufacturer and mastic.
  - 1. Basis of Design:
    - a. CRL category 2 shatterproof safety tape for mirrors
    - b. Or approved equal
- D. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed. Mastic is to be tested for compatibility with safety backing with written approval provided by film manufacturer.
  - 1. Basis of Design :
    - a. CRL Gunther Premier Plus Mirror Mastic
    - b. Or approved Equal

## 2.3 MIRROR HARDWARE

- A. Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.
  - 1. Bottom Trim and side: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch in height, respectively, and a thickness of not less than 0.04 inch
    - a. Basis of Design Manufacturer:
      - 1) CRL Standard “J” channel
      - 2) Or approved Equal
  - 2. Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch in height, respectively, and a thickness of not less than 0.04 inch .
    - a. Basis of Design Manufacturer:
      - 1) CRL Deep “J” Channel
      - 2) Or approved Equal

3. Finish: Clear bright anodized.

- B. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
- C. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield, expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

## 2.4 FABRICATION

- A. Fabricate mirrors in the shop to greatest extent possible.
- B. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.
- C. Mirror Edge Treatment: Flat polished
  - 1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
  - 2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.
- D. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint, as recommended in writing by film-backing manufacturer, to produce a surface free of bubbles, blisters, and other imperfections.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
- B. Verify compatibility with and suitability of substrates, including compatibility of existing finishes or primers with mirror mastic.
- C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

### 3.2 PREPARATION

- A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

### 3.3 INSTALLATION

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
  - 1. GANA Publications: "Laminated Glazing Reference Manual," "Glazing Manual" and "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
- B. Provide a minimum airspace of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
- C. Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
  - 1. Aluminum J-Channels: Provide setting blocks 1/8 inch thick by 4 inches long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch wide by 3/8 inch long at bottom channel.
  - 2. Install mastic as follows:
    - a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
    - b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
    - c. After mastic is applied, align mirrors and press into place while maintaining a minimum airspace of 1/8 inch between back of mirrors and mounting surface.

### 3.4 CLEANING AND PROTECTION

- A. Protect mirrors from breakage and contaminating substances resulting from construction operations.
- B. Do not permit edges of mirrors to be exposed to standing water.
- C. Maintain environmental conditions that prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
- D. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer.

END OF SECTION 088300

## SECTION 089000 - LOUVERS

### PART 1 GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### 1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the louvers as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:
  - 1. Aluminum louvers.
  - 2. Blank off panels.
  - 3. Bird screens.

#### 1.3 RELATED SECTIONS

- A. Masonry - Section 042000.
- B. Sealant work - Section 079200.
- C. Louvers in metal doors - Section 081113.
- D. Louvers connected to ductwork - Division 23.

#### 1.4 QUALITY ASSURANCE

- A. Structural Performance: Provide exterior metal louvers capable of withstanding the effects of loads and stresses from wind and snow and normal thermal movement without evidencing permanent deformation of louver components including blades, frames, and supports; noise or metal fatigue caused by louver blade rattle or flutter or permanent damage to fasteners and anchors.
  - 1. Wind Load: ASCE-7-16 or greater if required by applicable Building Code.
- B. Thermal Movements: Provide louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, and other detrimental effects.
  - 1. Temperature Change (Range): 120 deg. F., ambient; 180 deg. F, material surfaces.
- C. Comply with SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details and installation procedures, except as otherwise indicated.



- D. Field Measurements: Verify size, location and placement of louver units prior to fabrication.
- E. Shop Assembly: Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Preassemble units in shop to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- F. Louvers shall be tested and certified in accordance with AMCA 500-L

#### 1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications, certified test data, where applicable, and installation instructions for required products, including finishes.
- B. Shop Drawings: Submit shop drawings for fabrication and erection of louver units and accessories. Include plans, elevations and details of sections and connections to adjoining work. Indicate materials, finishes, fasteners, joinery and other information to determine compliance with specified requirements.
- C. Samples: Submit six (6) inch square samples of each required finish. Prepare samples on metal of same gauge and alloy to be used in work. Where normal color and texture variations are to be expected, include two (2) or more units in each sample showing limits of such variations.

#### 1.6 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.
- B. Replacements: In the event of damage, immediately make all repairs and replacements necessary.

#### 1.7 WARRANTY

- A. Finish shall be warranted for a period of 20 years, starting from date of Substantial Completion of the Project.

### PART 2 PRODUCTS

#### 2.1 Louvers:

- A. **FOR LOUVERS installed within a wall provide:** 4" storm-resistant fixed horizontal Louver Model RS-4700 as manufactured by Construction Specialties, Inc. or other approved equal model by Air Performance, Airolite, American Warming or approved equal and Ventilating meeting these performance specifications.
  - 1. **Material:** Heads, sills, jambs and mullions to be one-piece structural aluminum members with integral caulking slot and retaining beads. Mullions shall be sliding

interlock type. Blades to be one-piece aluminum extrusions with front lip gutter and multiple secondary gutters designed to catch and direct water to sill. Louvers to be supplied with 4" (101.6mm) high by full depth sill flashings formed from minimum 0.050" (1.27mm) thick aluminum. Sill flashings to have welded side panels. Louvers and sill flashings to be installed in accordance with the manufacturer's recommended procedures to ensure complete water integrity performance of the louver system.

2. Material minimum thickness to be as follows:
  - a. Heads, sills, jambs and mullions: 0.075"
  - b. Fixed blades: 0.060"
3. AMCA Performance: A 4' x 4' unit shall conform to the following:
  - a. Free Area: 8.25 sq. ft. min 51.6% free area or greater.
  - b. Free area velocity at beginning point of water penetration: 1250ft/min
  - c. Intake Pressure drop must not exceed 0.37" in. WG. at 1050 fpm free area velocity.
  - d. Exhaust pressure drop must not exceed 0.50 in WG at 1357 fpm free area velocity
4. Wind Driven Rain performance: The louver test was based on a 39.370"(1.00m) x 39.370" (1.00 m) core area. Unit tested at a rainfall rate of 3.0 inches per hour (75 mm/hr) and with a wind directed to the face of the louver at a velocity 29.1-mph (13 m/s). The test data shall show the water penetration effectiveness rating at each corresponding ventilation rate

Core Ventilation Rate (m/s):	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Core Ventilation Rate (ft/min):	0	132	197	287	377	469	600	684	773	880	985
Free Area Velocity (ft/min):	0	231	344	502	659	820	1049	1195	1351	1538	1721
Rating Effectiveness @ 29 & 3:	A	A	A	A	A	A	A	B	C	D	D
Effectiveness Ratio @ 29 & 3:					99.6	99.5	99.0	95.7	86.3	78.1	66.4
Core Ventilation Rate (m/s):	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Core Ventilation Rate (ft/min):	0	94	197	290	399	499	570	686	796	879	968
Free Area Velocity (ft/min):	0	164	344	507	697	872	996	1199	1391	1536	1692
Rating Effectiveness @ 50 & 8:	A	A	A	A	B	B	B	C	C	D	D
Effectiveness Ratio @ 50 & 8:		99.4	99.2	99.0	98.4	97.1	95.1	89.5	81.2	75.7	68.5
Effectiveness Rating:	A = 1 to 0.99		B = 0.989 to 0.95		C = 0.949 to 0.80		D = 0.80 to 0				

5. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: Cleaned with inhibited chemicals; Chemical Finish: Acid-chromate-fluoride-phosphate conversion coating; Organic Coating: As specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's written instructions.
  - a. Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and

fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.

- b. Custom color and gloss as selected by the Architect.

6. Insect Screen

- a. All louvers to be furnished with insect screens, finish to match louvers.
- b. Frames to have mitered corners and corner locks.

- 7. Blank-off panels to be 2" (50.8mm) thick and to be faced on both sides with 0.032" (0.81 mm) thick aluminum sheet. Panels to be fabricated with a mineral wool core (#6 density) having an R-value of 8 (0F\*ft<sup>2</sup>\*h/Btu). Panel perimeter frame to be 0.050" (1.27mm) thick-formed aluminum channels. Panel frame to be mitered at the corners. Panels to be finished black, unless otherwise noted.

- B. Fastenings: Fasteners for exterior application shall be stainless steel. Provide types, gauges and lengths to suit unit installation conditions. Use Phillips flat head machine screws for exposed fasteners, unless otherwise indicated.

- C. Anchors and Inserts: Use non-ferrous metal or hot dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use steel or lead expansion bolt devices for drilled in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

- D. Fastenings: Fasteners for exterior application shall be stainless steel. Provide types, gauges and lengths to suit unit installation conditions. Use Phillips flat head machine screws for exposed fasteners, unless otherwise indicated.

- E. Anchors and Inserts: Use non-ferrous metal or hot dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use steel or lead expansion bolt devices for drilled in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

- F. Bituminous Paint: SSPC-Paint 12 (cold applied asphalt mastic).

2.2 FABRICATION, GENERAL

- A. Fabricate frames including integral sills to suit adjacent construction with tolerances for installation, including application of sealants in joints between louvers and adjoining work.

- B. Include supports, anchorages, and accessories required for complete assembly.

- C. Provide sill extensions made of same material as louvers, where indicated, or required for drainage to exterior and to prevent water penetrating to interior.

- D. Join frame members to one another and to stationary louver blades by welding or mechanical fasteners as is standard for manufacturer, except where indicated otherwise or where field bolted connections between frame members are necessary by size of louvers. Maintain equal blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

## **PART 3 EXECUTION**

### **3.1 INSPECTION**

- A. Examine the areas and conditions where louvers are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

### **3.2 PREPARATION**

- A. Coordinate setting drawings, diagrams, templates, instructions and directions for the installation of anchorages which are to be embedded in masonry construction. Coordinate the delivery of such items to the project site.

### **3.3 INSTALLATION**

- A. Comply with manufacturer's instructions and recommendations for installation of the work.
- B. Verify dimensions of supporting structure at the site by accurate field measurements so that the work will be accurately designated, fabricated and fitted to the structure.
- C. Anchor louvers to the building substructure.
- D. Erection Tolerances:
  - 1. Maximum variation from plane or location shown on the approved shop drawings: 1/8" per 12 feet of length, but not exceeding 1/2" in any total building length or portion thereof (non-cumulative).
  - 2. Maximum offset from true alignment between two members abutting end to end, edge to edge in line or separated by less than 3": 1/16" (shop or field joints). This limiting condition shall prevail under both load and no load conditions.
- E. Cut and trim component parts during erection only with the approval of the manufacturer or fabricator, and in accordance with his recommendations. Restore finish completely. Remove and replace members where cutting and trimming has impaired the strength or appearance of the assembly.
- F. Do not erect warped, bowed, deformed or otherwise damaged or defaced members. Remove and replace any members damaged in the erection process as directed.
- G. Set units level, plumb and true to line, with uniform joints.

### **3.4 PROTECTION**

- A. Protect installed materials to prevent damage by other trades. Use materials that may be easily removed without leaving residue or permanent stains.

### 3.5 ADJUSTING AND CLEANING

- A. Immediately clean exposed surfaces of the louvers to remove fingerprints and dirt accumulation during the installation process. Do not let soiling remain until the final cleaning.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to the material finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers and accessory components damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by the Architect, remove damaged materials and replace with new materials.
  - 1. Touch up minor abrasions in finishes with a compatible air-dried coating that matches the color and gloss of the factory applied coating.

END OF SECTION

## **SECTION 09 2216 - NON-STRUCTURAL METAL FRAMING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
  - 2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Evaluation Reports: For equivalent gauge steel studs and runners and firestop tracks, submit evaluation reports certified under an independent third-party inspection program administered by an agency accredited by IAS to ICC-ES AC98 accreditation criteria for inspection agencies, from ICC-ES, or other qualified testing agency acceptable to authorities having jurisdiction.

#### **1.4 QUALITY ASSURANCE**

- A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified in accordance with the product-certification program of the Steel Framing Industry Association (SFIA) or a similar organization that provides a verifiable code-compliance program.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Framing."

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E

413 by an independent testing agency.

- C. For framing systems the gage specified is the minimum gage.
  - 1. Increase gage as required to limit the deflection of partitions with painted finish to 1/240 without increasing the thickness of the partition
  - 2. Increase gage as required to limit the deflection of partitions with tiled or other hard finish to 1/360 without increasing the thickness of the partition
  - 3. Lateral loading of 5psf should be used except where higher pressures are indicated.
- D. Design framing systems in accordance with AISI S220, "North American Specification for the Design of Cold-Formed Steel Framing - Nonstructural Members," unless otherwise indicated.

## 2.2 FRAMING SYSTEMS

- A. Provide all framing components from a single source manufacturer
  - 1. Manufacturers:
    - a. ClarkDietrich
    - b. MarinoWare
    - c. SCAFCO
    - d. Or approved equal
- B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
  - 1. Steel Sheet Components: Comply with AISI S220 requirements for metal unless otherwise indicated.
  - 2. Protective Coating: Comply with AISI S220; ASTM A653/A653M, G40 (Z120) hot-dip galvanized; or coating with equivalent corrosion resistance, unless otherwise indicated. Galvannealed products are unacceptable.
    - a. Coating shall demonstrate equivalent corrosion resistance with an evaluation report acceptable to authorities having jurisdiction.
- C. Studs and Runners: AISI S220. Use either steel studs and runners or steel studs and runners of equivalent minimum base-steel thickness.
  - 1. Steel Studs and Runners:
    - a. Minimum Base-Steel Thickness: .0296 inch typical, 0.0329 inch at tiled walls.
    - b. Depth: As indicated on Drawings.
  - 2. Equivalent Gauge Steel Studs and Runners, not acceptable at tiled walls:
    - a. Minimum Base-Steel Thickness: 0.0181 inch.
    - b. Depth: As indicated on Drawings.

D. Slip-Type Head Joints: Where indicated, provide one of the following:

1. Single Long-Leg Runner System: AISI S220 top runner with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
2. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

E. Firestop Tracks: not allowed.

F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Steel Thickness: 0.0566 in (16 ga.)

G. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-steel thickness, with minimum 1/2-inch- wide flanges.

1. Depth: 1-1/2 inches.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

H. Hat-Shaped, Rigid Furring Channels: AISI S220.

1. Minimum Base-Steel Thickness: 0.0296 inch.
2. Depth: 7/8 inch.

I. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical or hat shaped.

J. Cold-Rolled Furring Channels: 0.053-inch base-steel thickness, with minimum 1/2-inch- wide flanges.

1. Depth: 3/4 inch.
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum base-steel thickness of 0.0296 inch.
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

K. Z-Shaped Furring: With slotted or non-slotted web, face flange of 1-1/4 inches, wall attachment flange of 3/4 inch, minimum base-steel thickness of 0.018 inch, and depth required to fit insulation thickness indicated.

## 2.3 SUSPENSION SYSTEMS

A. Size ceiling support components to comply with the requirements of ASTM C 754.



- B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- C. Hanger Attachments to Concrete:
  - 1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
    - a. Type: Post-installed, expansion anchor.
  - 2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
- D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.
- E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.053 inch and minimum 1/2-inch- wide flanges.
  - 1. Depth: 1-1/2 inches.
- F. Furring Channels (Furring Members):
  - 1. Cold-Rolled Channels: 0.053-inch base-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
  - 2. Steel Studs and Runners: AISI S220.
    - a. Minimum Base-Steel Thickness: 0.0296 inch.
    - b. Depth: 2-1/2 inches.
  - 3. Equivalent Gauge Steel Studs and Runners: AISI S220.
    - a. Minimum Base-Steel Thickness: 0.0181 inch.
    - b. Depth: 2-1/2 inches.
  - 4. Hat-Shaped, Rigid Furring Channels: AISI S220, 7/8 inch deep.
    - a. Minimum Base-Steel Thickness: 0.0296 inch.
  - 5. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.
    - a. Configuration: Asymmetrical or hat shaped.
- G. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
  - 1. Products: Subject to compliance with requirements, products that may be incorporated into

the Work include, but are not limited to, the following:

- a. Armstrong World Industries, Inc.; Drywall Grid Systems.
- b. Chicago Metallic Corporation; Drywall Grid System.
- c. USG Corporation; Drywall Suspension System.
- d. Or approved equal

## 2.4 SOUND ISOLATION CLIP

- A. Where noted provide resilient sound isolation clips.
- B. Basis of design: IsoMax Resilient Sound Isolation Clip by Kinetics Noise Control.
  1. Alternate option: Sound Clip (CDSC) by ClarkDietrich
  2. Or approved equal

## 2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
  1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
  1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), non- perforated.
  2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
  1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim,

grab bars, toilet accessories, furnishings, or similar construction.

- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

### 3.3 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
  - 1. Single-Layer Application: 24 inches o.c. unless otherwise indicated.
  - 2. Multilayer Application: 24 inches o.c. unless otherwise indicated.
  - 3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
  - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
  - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
    - a. Install two studs at each jamb unless otherwise indicated.
    - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
  - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
  - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
    - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
  - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Z-Furring Members:

1. Erect insulation, specified in Division 07 Section "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

G. Sound Isolation Clips shall be spaced at 16 inches on center, vertical and horizontal in accordance with manufacturer testing and written recommendations.

H. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.4 INSTALLING SUSPENSION SYSTEMS

A. Install ceiling support components to comply with the local Building Code and with requirements of ASTM C 754.

B. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches o.c.
2. Carrying Channels (Main Runners): 48 inches o.c.
3. Furring Channels (Furring Members): 16 inches o.c.

C. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

D. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
  - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings

that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

- a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
- 3. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 2216

## **SECTION 09 2900 - GYPSUM BOARD**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Work Included:** The Work of this Section includes:

1. Gypsum board wall and ceiling applications screw-attached to steel systems.
2. Tile Backing Panels.
3. Finishing with joint tape-and-compound.
4. Acoustical batt insulation (SAFB).
5. Acoustical sealants
6. Electrical and low-voltage box acoustical pads in acoustical walls and other places where acoustical seal is required.
7. Metal trim.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data:** Submit manufacturer's specifications and installation instructions for materials for gypsum board and tile backer panels. Submit other data as required to show compliance with requirements.
- B. Samples:** Full-size Sample in 12 inch long length for each trim accessory indicated.

#### **1.3 INFORMATION SUBMITTALS**

- A. Product Certificates:** Submit manufacturer's certificates showing compliance with performance requirements for each type of gypsum board product from manufacturer.
- B. Maintenance Data:** Submit manufacturer's maintenance instructions or recommendations for gypsum board products to include in maintenance manuals.

#### **1.4 QUALITY ASSURANCE**

- A. Gypsum Board Terminology Standard:** GA-505 by Gypsum Association.
- B. Fire-Resistance-Rated Assemblies:** For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- C. STC-Rated Assemblies:** For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

1. STC Ratings: As indicated within the Partition Types on the Drawings.
- D. Mockups: Before beginning gypsum board installation, install mockups of at least 10 sq ft of perforated gypsum board with surrounding drywall border to demonstrate aesthetic effects and set quality standards for materials and execution.
  1. Apply or install final painting, on exposed surfaces for review of mockups.
  2. Simulate finished lighting conditions for review of mockups.
  3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.5 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

## 1.6 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
  1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

## PART 2 - PRODUCTS

### 2.1 INTERIOR GYPSUM BOARD

- A. General: Complying with ASTM C 1396, as applicable to type of gypsum board indicated.
  1. Use: Typical areas indicated.
  2. Core: 5/8 inch, Type X.
  3. Long Edges: Tapered.
- B. Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
  1. Use: At toilet room walls without tile, janitor closets and other areas as indicated
  2. Core: 5/8 inch, Type X.
  3. Long Edges: Tapered.

- C. Impact-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to GYPSUM BOARD

ASTM C 1629/C 1629M.

1. Locations:
  - a. All corridors & within lobby, outer layer only where multiple layers to be used
2. Products: Subject to compliance with requirements, provide the following:
  - a. USG Corporation; USG Sheetrock® Brand Mold Tough® VHI (Very High Impact) Firecode® Core or approved equal.
3. Other Products:
  - a. Continental Building Products, LLC; Protecta HIR 300 Type X with Mold Defense.
  - b. National Gypsum Company; eXP Interior Extreme IR or Hi-Impact Brand XP Fire- Shield Wallboard.
  - c. Temple-Inland Building Products by Georgia-Pacific; Comfort Guard IR.
  - d. Or approved equal.
4. Core: 5/8 inch, Type X, unless otherwise indicated.
5. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements, unless otherwise indicated..
6. Indentation: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements, unless otherwise indicated..
7. Soft-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements, unless otherwise indicated..
8. Hard-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 1 Level 2 Level 3 requirements according to test in Annex A1, unless otherwise indicated..
9. Long Edges: Tapered.
10. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

## 2.2 TILE BACKING PANELS

- A. Provide cementitious backer units complying with ANSI A118.9 in maximum lengths available to minimize end-to-end butt joints.
  1. Use: Substrate to tile.
  2. Products: Subject to compliance with requirements, provide one of the following to suit project application:
    - a. Gold bond: eXP tile backer
    - b. CertainTeed Corporation; GlasRoc tile backer
    - c. Georgia Pacific: denshield tile backer
    - d. USG Corporation: durock glass-mat tile backerboard.
    - e. Or approved equal.
  3. Width: Manufacturer's standard width, but not less than 32 inches.
  4. Thickness: 5/8 inch , unless otherwise indicated.
  5. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

## 2.3 TRIM ACCESSORIES



- A. Interior Trim: ASTM C 1047.
    - 1. Material: paper faced or structural laminate.
    - 2. Shapes:
      - a. Cornerbead. Structural laminate.
        - 1) Basis of Design, Product: Subject to compliance with requirements, provide the following:
          - a) Nocoat as supplied by CERTAINTEED (formerly Structus Building Technologies or approved equal.
          - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
          - c. L-Bead: L-shaped; exposed long flange receives joint compound.
          - d. Expansion (control) joint.
- B. Aluminum Trim: Extruded type of profiles, dimensions and trim height as indicated with integrated taping flange.
  - 1. Basis of Design, Product: Subject to compliance with requirements, provide the following:
    - a. Compäso™ Elite for Drywall as supplied by USG Corporation or approved equal.
  - 2. Other Trim/ Reveal Manufacturers:
    - a. Fry Reglet Corporation.
    - b. Gordon, Inc.
    - c. Pittcon Industries.
    - d. Or approved equal.
  - 3. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
  - 4. Finish: Manufacturers standard, compatible with joint compound and finish materials indicated.

## 2.4 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Joint Tape:
  - 1. Interior Gypsum Wallboard: Paper.
  - 2. Tile Backing Panels: fiberglass mesh tape or as recommended by panel manufacturer
- C. Joint Compound:
  - 1. Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

- a. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.

## 2.5 ACOUSTIC BATT INSULATION (SAFB):

- A. ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from slag wool or rock wool
- B. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly
- C. Manufacturers
  - 1. Roxul, AFB
  - 2. Thermafiber, SAFB
  - 3. John Mansville, MinWool SAFB .
  - 4. Or approved equal

## 2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Steel Drill Screws: ASTM C 1002. Provide galvanized screws, unless otherwise indicated.
  - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
- C. Leveling and Patching Compound: Latex cement as recommended by gypsum board manufacturer.
- D. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Pecora Corporation; AC-20 FTR or AIS-919.
    - b. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
    - c. USG Corporation; SHEETROCK Acoustical Sealant.
    - d. Or approved equal.
- E. Refer to Division 07 Section "Joint Sealants" for other requirements.

## 2.7 ELECTRICAL & LOW-VOLTAGE BOX PADS:

- A. Provide at outlet, switch , low-voltage, and all junction boxes in walls with STC value of 50 or higher.
  - 1. Electrical Box Pad Manufacturers for Non-Fire Rated Partitions:
    - a. Harry A. Lowry & Associates (800.772.2521)/Lowry's Electrical Box Pads.

- b. Tremco Sheet Caulking (650.572.1656).
- c. Fire rated partition material manufacturers.
- d. Or approved equal.

2. Electrical Box Pad Manufacturers for Fire Rated Partitions:

- a. Hevi-Duty Nelson (800.331.7325)/Fire Rated FSP Firestop Putty Pads.
- b. Specified Technologies, Inc. (800.992.1180)/Fire Putty Pads.
- c. Hilti, Corp./Hilti Box Pads.
- d. Or approved equal.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 APPLYING AND FINISHING PANELS, GENERAL**

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Form control and expansion joints with space between edges of adjoining gypsum panels.
- E. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
- F. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- H. No drywall layers shall be continuous between two adjacent rooms. Interrupt drywall panels at all partition intersections, and close through perimeter fascia to the base building construction.
- I. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

- J. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- K. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

### 3.3 APPLYING INTERIOR GYPSUM BOARD

#### A. Single-Layer Application:

- 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing.
- 2. On partitions/walls, apply gypsum panels vertically (parallel to framing or required by fire-resistance-rated assembly, and minimize end joints.
  - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
- 3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
- 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

#### B. Multilayer Application:

- 1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches minimum, from parallel base-layer joints.
- 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints.
- 3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
- 4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.
- 5. Stagger joints for multiple layers of drywall.

- C. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with ASTM C 919 requirements or with manufacturer's written instructions, whichever are more stringent.

- D. In shafts where gypsum board shaft-wall assemblies cannot be positioned within 4 inches of the shaft face of structural beams, floor edges, and similar projections into shaft, install 5/8-inch thick, gypsum board cants covering tops of projections.
  - 1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches o.c. with screws fastened to shaft-wall framing.
  - 2. Where steel framing is required to support gypsum board cants, install framing at 24 inches o.c. and extend studs from the projection to shaft-wall framing.
- E. Apply acoustical sealant as follows:
  - 1. Gap equal to 1/4 inch: Acoustical sealant or similar non-hardening caulking compound.
  - 2. Gap from 1/4 inch up to 1 inch: Compressed backer rod with acoustical sealant or similar non-hardening caulking compound.

### 3.4 INSTALLING TRIM ACCESSORIES

- A. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by the Architect for visual effect.

### 3.5 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
  - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
  - 2. Level 2: Panels that are substrate for tile, and where indicated.
  - 3. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.
    - a. Primer and its application to surfaces are specified in other Division 09 Sections.

### 3.6 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

## SECTION 09 3100 - TILING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Work Included: The Work of this Section includes:
  - 1. Porcelain floor tile.
  - 2. Ceramic floor and wall tile.
  - 3. Simulated stone thresholds.
  - 4. Epoxy grout
  - 5. Waterproof membrane for thin-set tile installations, including flood- testing prior to tile installation.
  - 6. Metal Transitions installed as part of tile installations
  - 7. Shower Systems:
    - a. Mortar Bed Shower Basins installed as part of shower system with flanged drain and waterproofing.
    - b. pre-cast terrazzo basins installed as part of shower subsystem

#### 1.2 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Module Size: Actual tile size, minor facial dimension as measured per ASTM C 499 plus joint width indicated.
- C. Facial Dimension: Actual tile size, minor facial dimension as measured per ASTM C 499.
- D. Facial Dimension: Nominal tile size as defined in ANSI A137.1.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Verification:
  - 1. Full-size units of each type and composition of tile and for each color and finish required.
  - 2. Assembled samples with grouted joints for each type and composition of tile and for each color and finish required, at least 24x48 inches and mounted on rigid panel. Use grout of type and in color or colors approved for completed work.
  - 3. Full-size units of each type of trim and accessory.
  - 4. thresholds in 6-inch lengths.
  - 5. Metal edge strips in 6-inch lengths.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product, signed by product manufacturer.
- D. Qualification Data: For Installer.
- E. Material Test Reports: For each tile-setting and -grouting product.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations for Tile: Obtain all tile of same type and color or finish from one source or producer.
  - 1. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Liquid Waterproofing, Setting and Grouting Materials: Obtain ingredients of a uniform quality for all mortar, adhesive, grout, and liquid waterproofing/crack isolation components from a single manufacturer and each aggregate from one source or producer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:
  - 1. thresholds.
  - 2. Joint sealants.
  - 3. Cementitious backer units.
  - 4. Metal edge strips.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
- E. Flood Testing requirements and procedures:
  - 1. Flood testing per ASTM D5957-98(2013) to be performed in each space, room and location waterproofing membrane is installed.
  - 2. Testing is to occur a minimum of 24 hours after installation of membrane to allow full curing and prior to tile installation.
  - 3. Procedures:
    - i. Dams to be fabricated from a 2x6 board or scrap of gypsum board or cement board. Seal dams with waterproofing membrane or sealant to allow testing area to be fully immersed.
    - ii. Each space to be filled for a duration of 24 hours minimum at a minimum depth of 4" measured from tile substrate
    - iii. Water level to be marked at start of testing and compared at end of test period. If drop in water detected or a leak is visible, membrane is to be repaired and retested until it can be passed.
    - iv. Architect or owner's representative is to observe testing prior to draining. Provide minimum of 72 hours notice prior to start of testing.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement in ANSI A137.1 for labeling sealed tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Store liquid latexes and emulsion adhesives in unopened containers and protected from freezing.
- E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

**1.7 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

**1.8 EXTRA MATERIALS:**

- A. Provide minimum 2% area installed but not less than one unopened box in full-size units including special shapes and profiles
- B. Provide one additional threshold

**PART 2 - PRODUCTS**

**2.1 PRODUCTS, GENERAL**

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
  - 1. Provide tile complying with Standard grade requirements, unless otherwise indicated.
  - 2. For facial dimensions of tile, comply with requirements relating to tile sizes specified in Part 1 "Definitions" Article.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting and Grouting Materials" Article.
- C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:
  - 1. As indicated on drawings and Finish Schedules.



- D. Factory Blending: For tile exhibiting color variations within ranges selected during Sample submittals, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- E. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless otherwise indicated.
  - 1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.
- F. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

## 2.2 MANUFACTURERS

- A. Products: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include the following:
  - 1. Porcelain and Ceramic Tile: Refer to the drawings Finish Schedules for tile products and manufacturers or approved equal.
  - 2. Setting and Grout Manufacturers:
    - a. Laticrete International, Inc.
    - b. Bostik, Inc.
    - c. MAPEI Corporation.
    - d. Schluter
    - e. Or approved equal

## 2.3 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
  - 1. Bevel edges at 1:2 slope for 1/4", Max vertical edge to be 1/4" with max overall height above adjacent floor finish to be 1/2".
- B. Simulated Stone Thresholds: solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with ICPA SS-1, except for composition.
  - 1. Description: see finish schedule.

## 2.4 WATERPROOFING MEMBRANES FOR THIN-SET TILE INSTALLATIONS

- A. General: Manufacturer's standard product that complies with ANSI A118.10.

- B. Latex Rubber Waterproofing: Manufacturer's standard factory- prepackaged, job-mixed, proprietary two-part formulation consisting of liquid latex rubber and powder for trowel application and glass fiber fabric reinforcing.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "hydroban xp" as manufactured by Laticrete, with reinforcing fabric
    - b. "Bostik Gold Plus Waterproofing" as manufactured by Bostik Inc. with reinforcing fabric
    - c. "Mapelastic Aqua defense" as manufacturers by Mapei with reinforcing fabric
    - d. "redguard" as manufacturers by Custom inc. with reinforcing fabric
    - e. "Kerdi" as manufacturers by Schluter
    - f. or approved equal
- C. Locations: Install in locations per architectural drawings and as follows:
  - 1. At Tiled floors Floors including for full extent of the room and to include wrapping up wall surface a minimum of 6" to create continuous pan and wrapped onto drain flanges
  - 2. At walls within showers full height and within fortified mortar shower basins as part of complete shower system

## 2.5 SETTING AND GROUTING MATERIALS

- A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

## 2.6 SETTING MATERIALS

- A. Latex-Portland Cement Mortar (Thin Set) for use with large and heavy tiles: ANSI A118.4.
  - 1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
  - 2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4
  - 3. Suitable for submerged applications.
  - 4. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Multimax light" by Laticrete
    - c. or approved equal
- B. Fortified Mortar Bed for use in shower pans where precast terrazzo not specified:
  - 1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or polymer additive to which only water must be added at Project site.
  - 2. Exceeds requirements of ASTM C270
  - 3. Suitable for submerged applications.
  - 4. Slurry coat to be used to bond to substrate with manufacturer's recommended product.
  - 5. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Fortified 3701 Mortar Bed" by Laticrete

c. or approved equal

## 2.7 GROUT MATERIALS

- A. Multi-component, Chemical resistant, water cleanable, 100 percent epoxy grout.
  - 1. Location for use: All tiled floors and walls
  - 2. Physical properties when tested per ANSI A118.3:
    - a. Compression: Greater than 5000psi
    - b. Water Absorption: 0 percent
  - 3. Products: "Spectralok Pro" by Laticrete, Inc. or approved equal

## 2.8 ELASTOMERIC SEALANTS

- A. General: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements in Division 7 Section "Joint Sealants."
- B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.
- C. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.

## 2.9 CEMENTITIOUS BACKER UNITS

- A. Refer to Section 092900 – Gypsum Board.

## 2.10 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayment and Patching Compounds: Latex-modified, Portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Temporary Protective Coating: Either product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.
- C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

## 2.11 METAL TILE TRANSITIONS

- A. Metal Edge Strips: L-shape and cove, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring and wall applications, white zinc alloy exposed-edge material.

- a. Manufacturer endcaps, inside corners and outside corners to be provided.
- 1. Basis of design: By Schluter as noted on the drawings or approved equal, see finish schedule and details

## 2.12 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

## 2.13 FABRICATION

- A. Facial Dimensions of Stone Tiles with Polished Faces: Do not vary facial dimensions from specified dimensions by more than plus or minus 1/64 inch.
- B. Joint Surfaces: Except for specified beveled or eased edges, if any, dress joint surfaces square for full depth of tile.

## 2.14 SHOWER SYSTEMS

- A. All Showers with ADA sloped fortified mortar basins and integrated flanged drains shall be installed as part of a complete shower system with waterproofing, thin-set, fortified bonded mortar basin, trim flashings and integrated flanged drain by a single manufacturer. At locations where pre-cast terrazzo basin specified: complete shower wall waterproofing, thin-set, trims and trim flashings shall be by a single manufacturer and installed as a complete system excluding the pre-cast basin.
  - Products: Subject to compliance with requirements, provide one of the following:
    - a. "Hydroband Shower System" by Laticrete
    - b. "Kerdi Shower System" by Schluter
    - c. Mapeiguard Shower System" by Mapei
    - d. or approved equal
- B. Where occurs: 36"x36" fortified mortar bed with minimum 1-1/2" to 2" thickness formed and sloped as a shower basins meeting ANSI A118.10 required and IAPMO approved with slope complying with ADA requirements maximum of 1/4" per foot.
- C. Membrane to be tested approved for steam showers with maximum 0.06 perms.
- D. Accessories: Provide manufacturer's accessories required for warranty and the following:
  - a. a membrane drain collar for adapting to standard bonding flange drains where bonding flange drains are not specified by plumbing drawings.
  - b. Interior and exterior corners as required
  - c. Shower trim flashings
  - d. Manufacturer's recommended adhesives and sealants
- E. Warranty: system warranty of 25 years to be provided, contractor to schedule onsite inspections and submit documentation as needed to achieve warranty.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
  - 1. Verify that substrates for setting tile are firm; dry; clean; free of oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
  - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
  - 3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.
- B. Provide concrete substrates for tile floors installed with adhesives or thin-set mortar that comply with flatness tolerances specified in referenced ANSI A108 Series of tile installation standards.
  - 1. Fill cracks, holes, and depressions with trowelable leveling and patching compound according to tile-setting material manufacturer's written instructions. Use product specifically recommended by tile-setting material manufacturer.
  - 2. Remove protrusions, bumps, and ridges by sanding or grinding.
- C. Blending: For tile exhibiting color variations within ranges selected during Sample submittals, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

### **3.3 INSTALLATION, GENERAL**

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
- B. Installation Guidelines: TNCA's "Handbook for Ceramic, Glass, and Stone Tile." Comply with TNCA installation tile installation schedules.
- C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for

straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

- E. Jointing Pattern: As indicated on drawings. Align joints when adjoining tiles on floor, base, walls, and trim are same size.
  - 1. Lay out tile work and center tile fields in both directions in each space or on each area and provide uniform joint widths.
  - 2. Adjust layout to minimize tile cutting, as approved by the Architect,
  - 3. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
- F. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
  - 1. Locate joints in tile surfaces directly above joints in concrete substrates.
  - 2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."
- G. Large Format Tile general installation requirements (tile with one dimension larger than 15 inch:
  - 1. Spread adhesive at minimum 80 percent of substrate area with 1/2 by 1/2-inch notched trowel for tile sizes 13 to 20 inch and 3/4 by 3/4-inch notched trowel for tile sizes larger than 20 inch.
  - 2. Backbutter tile prior to installation.
  - 3. Maximum lippage - 1/8 inch in 10 feet and no more than 1/16-inch variation in 24 inches when measured from high point
- H. Grout tile to comply with requirements of the following tile installation standards:
  - 1. comply with ANSI A108 and manufacturers written instructions, including product technical bulletins and product package instructions:
    - A. Lightly dampen tile before grouting
    - B. Spread grout over face of tile using the type of float or sponge recommended by tile manufacturer
    - C. Work grout back and forth at 45 degree angle to the face of tile to ensure complete filing of joints
    - D. On completion of grouting, clean surfaces according to manufacturer's written instructions so they are free of foreign matter. Special care to be provided for textured tiles to maintain clean surface.
    - E. Allow to cure

### 3.4 WATERPROOFING MEMBRANE INSTALLATION

- A. Install waterproofing to comply with ANSI A108.13 and waterproofing manufacturer's written instructions to produce waterproof membrane of uniform thickness bonded securely to substrate.
- B. Install crack-suppression membrane and reinforcing at corners and joints to comply with manufacturer's written instructions to produce membrane of uniform thickness bonded securely to substrate.

- C. Wrap up wall surfaces as recommended by manufacturer but not less than 6"
- D. Do not install tile over waterproofing until waterproofing has cured and been flood- tested to determine that it is watertight.

### 3.5 WALL TILE INSTALLATION

- A. Install types of wall tile designated to comply with requirements indicated below for setting bed methods, and TNCA installation methods related to subsurface and grout.
  - 1. Interior TCNA W244C-19 at stud and tile backer board locations not within showers
    - a. Cement Backer Board
    - b. Cementitious bond coat
    - c. Grout: 100% epoxy
  - 2. Interior TCNA B412-19 at stud and tile backer board locations within showers with receptor
    - a. Cement Backer Board
    - b. Latex-Portland Cement Mortar, Thin Set
    - c. Waterproofing Membrane, full coverage
    - d. Grout: 100% epoxy

### 3.6 FLOOR TILE INSTALLATION

- A. Install tile to comply with requirements in the finish Installation Schedule, including those referencing TNCA installation methods and ANSI A108 Series of tile installation standards.
  - 1. Interior Slab on Grades: TCNA F122-19 tiled floor with waterproofing membrane
    - a. Concrete Subfloors on-grade, Interior:
    - b. Latex-Portland Cement Mortar, Thin Set
    - c. Waterproofing Membrane, full coverage
    - d. Grout: 100% epoxy
  - 2. Interior Concrete Decks above grade: TCNA F122A-19 tiled floor with waterproofing membrane
    - e. Concrete Subfloors on-grade, Interior:
    - f. Latex-Portland Cement Mortar, Thin Set
    - g. Waterproofing Membrane, full coverage
    - h. Grout: 100% epoxy
- B. Thresholds: Install thresholds at locations indicated; set in same type of setting bed as abutting field tile.
  - 1. Set thresholds in modified cement mortar where mortar bed would otherwise be exposed above adjacent no tile floor finish.
- C. Metal Edge Strips: Install metal edge strips at locations indicated to include top of wainscot, wall/floor intersection, outside corners between two tiled walls; set according to manufacturer's recommendations.

### 3.7 SHOWER RECEPTOR WHERE PRECAST TERRAZZO NOT SPECIFIED.

- A. Install tile to comply with requirements in the finish Schedule, including those referencing TNCA installation methods and ANSI A108 Series of tile installation standards.
  - 1. Mortar bed shower receptors: TCNA B422C-19 tiled floor with waterproofing membrane and integrated flanged drain
    - i. Recessed blockout in Concrete Subfloors on-grade; bonded slurry coat
    - j. Fortified Mortar bed with 2" thickness sloped to 1-1/2" min thickness
    - k. Waterproofing Membrane, full coverage
    - l. Latex-Portland Cement Mortar, Thin Set
    - m. Grout: 100% epoxy
- B. Metal Edge Strips: Install metal edge strips at locations indicated to include top of wainscot, wall/floor intersection, outside corners between two tiled walls; set according to manufacturer's recommendations.

### 3.7 EXPANSION AND MOVEMENT JOINTS

- A. Install tile to comply with requirements in the drawings and TNCA installation methods and ANSI A108 Series of tile installation standards
  - 1. Contraction joints: EJ171B-19 at all saw-cut control joints
  - 2. Perimeter Joints: EJ171G-19 at all perimeter joints

### 3.8 CLEANING AND PROTECTING

- A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
  - 1. Remove Latex-Portland cement grout residue from tile as soon as possible.
  - 2. Clean grout smears and hazes from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
  - 3. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent it from clogging drains.
- B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with Kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
- C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

END OF SECTION 09 3100



## **SECTION 09 5000 SUSPENDED WOOD GRILLE CEILING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

Drawings and general conditions of Contract, including General and Supplementary Conditions and Divisions-1 Specification sections apply to work of this section.

#### **1.2 SUMMARY**

- a) Section Includes:
  - 1. Veneered Wood Ceiling Panels with Centered Notched and Flat Backers
  - 2. Exposed grid suspension system.
  - 3. Wire hangers, fasteners, main runners, cross tees, wall angle moldings and accessories.
  - 4. Torsion spring mounted access panels

#### **1.4 SUBMITTALS**

- a) Shop Drawings: Layout and details of ceilings. Show locations of items that are to be coordinated with or supported by the ceilings. Identify locations of all access panels and attachment methods
- b) Installation Instructions: Submit manufacturer's installation instructions as referenced in Part three, Installation.
- c) Product Data: Submit manufacturer's technical data for each type of ceiling unit and suspension system required.
- d) Samples: 12" X 12" panel showing size, finish specified
- e) Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards.

#### **1.5 QUALITY ASSURANCE**

- a) Single-Source Responsibility: Provide ceiling panel units and grid components by a single manufacturer.
- b) Fire Performance Characteristics: Identify ceiling components with appropriate markings of applicable testing and inspecting organization.
  - 1. Surface Burning Characteristics: As follows, tested per ASTM E-84 and complying with ASTM E 1264 for Class A products.
  - 2. HPVA (Hardwood Plywood and Veneer Association) certification and audit program per ASTM E-84 tunnel test.
- c) Woodworking Standards: Manufacturer must comply with specified provisions of Architectural Woodworking Institute quality standards.

- d) Coordination of Work: Coordinate ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- a) Store ceiling components in a dry interior location in their cartons prior to installation to avoid damage. Store cartons in a flat, horizontal position. The protectors between the panels should not be removed until installation.
- b) Do not store in unconditioned spaces with humidity greater than 55 percent or lower than 25 percent relative humidity and temperatures lower than 50 degrees F or greater than 86 degrees F. Panels must not be exposed to extreme temperatures, for example, close to a heating source or near a window with direct sunlight.
- c) Handle ceiling units carefully to avoid chipped edges or damage to units in any way.

#### **1.7 PROJECT CONDITIONS**

- a) Wood ceiling materials should be permitted to reach room temperature and have a stabilized moisture content for a minimum of 72 hours before installation. (Remove plastic wrap to allow panels to climatize).
- b) The wood panels should not be installed in spaces where the temperature or humidity conditions vary from the temperatures and conditions that will be normal in the occupied space.
- c) As interior finish products, the veneered panels are designed for installation in temperature conditions between 50 degrees F and 86 degrees F, in spaces where the building is enclosed, and HVAC systems are functioning and will be in continuous operation. Relative humidity should not fall below 25 percent or exceed 55 percent.

#### **1.8 WARRANTY**

- a) Veneered Wood Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to:
  - 1. Veneered Wood Panels: Defects in materials or factory workmanship.
  - 2. Grid System: Rusting and manufacturing defects.
- b) Warranty Period:
  - 1. Veneered Wood panels: One (3) year from date of installation.
  - 2. Grid: Ten years from date of installation.
- c) The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

## **1.9 MAINTENANCE**

- a) Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.
  - 1. Ceiling Units: Furnish quality of full-size units equal to 2.0 percent of amount installed.
  - 2. Exposed Suspension System Components: Furnish quantity of each exposed suspension component equal to 1.0 percent of amount installed.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- a) Basis of Design
  - a. Armstrong Word Industries Inc, WoodWorks Grille - Forte' Veneered Ceilings Panels & suspension systems
- b) Other Manufacturers subject to performance requirements
  - a. Certainteed
  - b. Rockfon
  - c. Or approved equal

### **2.2.0 WOOD CEILING UNITS (AC-1)**

- a) Ceiling Panels:
  - 1. Surface Texture: Smooth
  - 2. Composition: Real wood veneer on fire rated particle board
  - 3. Finish: Real Wood Veneer
    - Plain Slice White Oak (NOK)
  - 4. Panel Width: 12-inch x 72inch with 1" reveal panel to panel (actual size 12" x 71")
  - 5. Slat Width: 3/4"
  - 6. Height: 2-1/4", 5 slates per panel (69% open) 6335L\_S14
  - 7. Acoustical Performance Infill Options:
    - 1) Black BioAcoustic Infill Panes - NRC 0.75, CAC N/A or approved equal
  - 8. Flame Spread:  
Class A: ASTM E84 surface burning characteristics. Flame Spread Index 25 or less. Smoke Developed Index 50 or less.
- b) Accessories:

1. Backer Clip - item 5687 or approved equal
2. Flat Backer Kit - item 7920GBL or approved equal
3. Heavy Duty Wall Anchor – item 7100 or approved equal
4. Torsion springs and brackets for removeable access panels made to match the ceiling panels.

### **2.2.1 SUSPENSION SYSTEMS**

- c) Components: All main beams and cross tees shall be commercial quality hot dipped galvanized steel as per ASTM A653. Main beams and cross tees are double-web steel construction with 15/16-inch type exposed flange design. Exposed surfaces chemically cleansed, capping prefinished galvanized steel in baked polyester paint. Main beams and cross tees shall have rotary stitching.
  1. Structural Classification: ASTM C635 (Heavy Duty).
  2. Color: Tech Black.
  3. 15/16" Exposed Tee Main beam item as manufactured by Armstrong World Industries, Inc or approved equal.
- d) Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.
- e) Wire for Hangers and Ties: ASTM A641, Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least times-three design load, but not less than 12 gauge.
- f) Accessories/Edge Moldings and Perimeter Trim:
  - a. 7/8" Angle Wall Molding
  - b. Replacement Trim Clip
  - c. Adjustable Trim Clip
  - d. WoodWorks Edgebanding for cut panels where edge exposed.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- a) Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out.
- b) Proper designs for both supply air and return air, maintenance of the HVAC filters and building interior space are essential to minimize soiling. Before starting the HVAC system, make sure supply air is properly filtered and the building interior is free of construction dust.

### **3.2 PREPARATION**

- a) Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at

borders and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures.

- b) WoodWorks ceiling materials should be permitted to reach room temperature and have a stabilized moisture content for a minimum of 72 hours before installation. (Remove plastic wrap to allow panels to climatize).

### **3.3 INSTALLATION**

- a) Veneered wood panels are designed for installation in temperature conditions between 50 degrees F and 86 degrees F, in spaces where the building is enclosed, and HVAC systems are functioning and will be in continuous operation. Relative humidity should not fall below 25 percent or exceed 55 percent.
- b) Install suspension system and panels in compliance with ASTM C636, ASTM E580, with the approval of the authorities having jurisdiction, and in accordance with the manufacturer's Installation Instructions.
- c) Apply Edgebanding at all exposed cut edges
- d) Provide access panels at all locations indicated in drawings and as required to maintain equipment above the ceiling.

### **3.4 ADJUSTING AND CLEANING**

- a) Replace damaged and broken panels.
- b) Clean exposed surfaces of ceilings panels, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage.

**END OF SECTION**

## SECTION 09 5113 - ACOUSTICAL PANEL CEILINGS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Work Included: Work of this Section includes:

1. Acoustic ceiling panels. (ACT1, ACT1A, ACT2, ACT3, ACT4)
2. Wood-look acoustic ceiling panels (AC2)
3. Suspension systems.
4. Edge trim and installation accessories.

#### 1.2 PREINSTALLATION MEETINGS

A. Prior to the start of ceiling installation, conduct a conference at the Project Site with the installers of related work, including lighting, ductwork and similar work in the ceiling plenum.

1. Review areas of potential interference and resolve conflicts before proceeding with the work.
2. Coordinate ceiling layout with the layout of other work which penetrates or is supported by the ceiling.

#### 1.3 ACTION SUBMITTALS

A. Manufacturer's Data: Manufacturer's product specifications and installation instructions for acoustical ceiling material, and for suspension system, including certified laboratory test reports and other data as required showing compliance with this Section.

1. Indicate structural classification of suspension system.

B. Shop Drawings: Submit shop drawing details and reflected ceiling plans of each type of suspension systems and ceiling required by this Section. Show location of ceiling units and other items of general construction, equipment, mechanical and electrical work which are to be coordinated with the ceilings. Indicate framing and support details for work supported by the suspension system.

1. Ceiling suspension members.
2. Locations and method of attaching hangers to building structure.
3. Ceiling-mounted items including light fixtures, air outlets and inlets, speakers, sprinkler heads, moldings at walls, column penetrations, and other junctures with adjoining construction,
4. Indicate quantity of "extra material" to be provided as required per article below.

C. Coordination Drawings: Reflected ceiling plans, mechanical ductwork plans, mechanical equipment, stormwater and other non-pressurized piping, Fire sprinkler piping, drawn to scale, and coordinated with each other, using input from installers of the items involved.

D. Samples:

1. Acoustical Panels: Submit full size samples of each acoustic panel unit specified. Samples shall show the full range of exposed color and texture to be expected in the completed work.
2. Suspension System: Submit 12" long samples of each trim molding of suspension system.

**1.4 QUALITY ASSURANCE**

- A. Single-Source Responsibility for Ceiling Units: Obtain each type of acoustical ceiling unit from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.
- B. Single-Source Responsibility for Suspension System: Obtain each type of suspension system from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.
- C. Qualifications of Installer: Work under this Section shall be performed by an experienced specialty installer who is regularly engaged in the type of work required herein and acceptable to selected product manufacturer.

**1.5 DELIVERY, STORAGE AND HANDLING**

- A. Deliver all acoustical units and suspension system components in manufacturer's original unopened packages fully identified with type, finish, performance data and compliance labels.
- B. Handle and store in accordance with manufacturer's instructions and recommendations. Store in a place protected from damage, exposure to the elements and high humidity.
- C. Acoustical ceiling panels are to be stored per manufacturer's recommendations for allowable temperature and humidity range. Products shall not be allowed to become damp.

**1.6 COORDINATION**

- A. Coordinate layout and installation of acoustical ceiling units and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components, and partition system.

**1.7 ENVIRONMENTAL CONDITIONS**

- A. Do not install ceilings until wet work in the space has been completed and is nominally dry, and until work above ceilings has been completed, and until ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

**1.8 EXTRA MATERIALS**

- A. General: Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Acoustical Ceiling Panels: Full-size panels equal to 5% of each different tile/panel installed; but not less than one unopened carton.
  - 2. Suspension System Components: Quantity of each exposed component equal to 2% of quantity installed.
  - 3. Touchup Paint: provide manufacturer's standard touchup paint in minimum 2 containers 8oz each with brush in cap.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis-of-Design, Products: Subject to compliance with requirements, provide products, scheduled on the drawings Finish Schedules for each ceiling type and suspension system as supplied by the following:
  - 1. Armstrong World Industries, Inc, or approved equal.
- B. Other Manufacturers:
  - 1. USG Interiors, Inc.
  - 2. Chicago metallic
  - 3. Rockfon.
  - 4. Or approved equal.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.
- B. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 – category A and installed in conformance with ASTM C636.
  - 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    - a) Flame-Spread Index: Class A (25 or less) according to ASTM E1264.
    - b) Smoke-Developed Index: 50 or less.

### **2.3 ACOUSTICAL CEILING UNITS, GENERAL**

- A. Standard for Acoustical Ceiling Units: Provide manufacturers' standard units of configuration indicated that comply with ASTM E 1264 classifications as designated by reference to types, patterns, acoustical ratings, and light reflectance, unless otherwise indicated.
- B. Acoustical Ceiling System (ACT1):
  - 1. Basis of design: Armstrong Ultima HIGH NRC 2082 with Armstrong 9/16" suprafine grid or approved equal
  - 2. Size: 24inch x 24inches x 1inches thick
  - 3. Classification: Type IV, Form 2, Pattern E.
  - 4. Color: White
  - 5. LR: Not less than 0.88.
  - 6. NRC: Not less than 0.85.
  - 7. CAC: not less than 35
  - 8. AC: Not less than 170
  - 9. Edge Detail, Exposed Face: Reveal sized to fit flange of exposed suspension-system members (beveled-regular).
  - 10. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.
  - 11. Grid Type: 9/16" face width, color white subject to requirements listed below.
  - 12. Note: all visible cut edges to be painted with manufacturer touch-up paint to match finish
- C. Acoustical Ceiling System (ACT1A):
  - 1. Basis of design: Armstrong CALLA 2482 to be installed into grid of ACT1
  - 2. Size: 24inch x 24inches x 1inches thick



3. Classification: Type IV, Form 2, Pattern E.
  4. Color: custom color, refer to finish schedule
  5. LR: Not less than 0.88.
  6. NRC: Not less than 0.85.
  7. CAC: not less than 35
  8. AC: Not less than 170
  9. Edge Detail, Exposed Face: Reveal sized to fit flange of exposed suspension-system members (beveled-tegular).
  10. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.
  11. Note: all visible cut edges to be painted with manufacturer touch-up paint to match finish
- D. Acoustical Ceiling System (ACT2):
1. Basis of design: Armstrong Ultima health zone high nrc 1446 with Armstrong 9/16" suprafine grid or approved equal
  2. Size: 24inch x 24inches x 7/8inches thick
  3. Classification: Type IV, Form 2, Pattern E.
  4. Color: White
  5. LR: Not less than 0.88.
  6. NRC: Not less than 0.80.
  7. CAC: not less than 35
  8. AC: Not less than 170
  9. Edge Detail, Exposed Face: Reveal sized to fit flange of exposed suspension-system members (beveled-tegular).
  10. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.
  11. Grid Type: 9/16" face width, color white subject to requirements listed below.
  12. Note: all visible cut edges to be painted with manufacturer touch-up paint to match finish
- E. Acoustical Ceiling System (ACT3):
1. Basis of design: Armstrong Ultima HIGH NRC 2085 with Armstrong 9/16" suprafine grid or approved equal
  2. Size: 24inch x 48inches x 1inches thick
  3. Classification: Type IV, Form 2, Pattern E.
  4. Color: White
  5. LR: Not less than 0.88.
  6. NRC: Not less than 0.85.
  7. CAC: not less than 35
  8. AC: Not less than 170
  9. Edge Detail, Exposed Face: Reveal sized to fit flange of exposed suspension-system members (beveled-tegular).
  10. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.
  11. Grid Type: 9/16" face width, color white subject to requirements listed below.
  12. Note: all visible cut edges to be painted with manufacturer touch-up paint to match finish
- F. Acoustical Ceiling System (ACT4):
1. Basis of design: Armstrong Ultima HIGH NRC 1437 with Armstrong 9/16" suprafine grid or approved equal
  2. Size: 24inch x 72inches x 7/8inches thick
  3. Classification: Type IV, Form 2, Pattern E.
  4. Color: White
  5. LR: Not less than 0.88.
  6. NRC: Not less than 0.80.
  7. CAC: not less than 35
  8. AC: Not less than 170
  9. Edge Detail, Exposed Face: Reveal sized to fit flange of exposed suspension-system members (beveled-tegular).
  10. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.
  11. Grid Type: 9/16" face width, color white subject to requirements listed below.
  12. Note: all visible cut edges to be painted with manufacturer touch-up paint to match finish

- G. Wood-Look Acoustical Ceiling System (AC2):
1. Basis of design: Armstrong Lyra PB in a wood-look color or approved equal
  2. Size: 24inch x 48inches x 1inches thick
  3. Color: Honey Oak (WH) with edge color (SW6115)
  4. NRC: Not less than 0.95.
  5. CAC: n/a
  6. Edge Detail, Exposed Face: Reveal sized to fit flange of exposed suspension-system members (tegular).
  7. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.
  8. Grid Type: 9/16" face width in color SHY
  9. Note: all visible cut edges to be painted with manufacturer touch-up paint to match finish

## 2.4 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILINGS

- A. Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, pre-painted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation, with prefinished metal caps on flanges.
1. Structural Classification: Intermediate-duty system.
  2. Construction: double web
  3. End Condition of Cross Runners: Override (stepped) type.
  4. Face Design: Flat, flush.
  5. Face width: 9/16"
  6. Cap Material: Steel or aluminum cold-rolled sheet.
  7. Cap Finish: White at ACT1 locations; Black at CC1 locations.

## 2.5 MISCELLANEOUS MATERIALS

- A. Provide manufacturer's standard molding for edges and penetrations of ceiling units which fit with type of edge detail and suspension system indicated.
- B. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant, complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- D. Seismic Clips, where required by project application: Manufacturer's standard seismic clips designed and spaced to secure acoustical panel's in-place.
- E. Impact Clips, where required by project application: Where indicated, provide manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.
- F. Leveling splines and attachment clips, where required by project application: Manufacturer's standard material.
- G. Hold-Down Clips, where required by project application: Manufacturer's standard hold-down clips spaced as standard with manufacturer and with key hole slot., where required.
- H. Touch-up Paint: manufacturer's standard type and color to match acoustical and grid units.

## **2.6 METAL EDGE MOLDINGS AND TRIM**

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
- B. Perimeter Moldings: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
  - 1. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member. Extend reveal edge all around room where edge is indicated or required to accommodate tile layout indicated.
- C. Extruded Aluminum Exposed Edge Suspension Trim: Subject to compliance with requirements from same manufacturer as suspension grid, provide one of the following where indicated on drawings:
  - 1. Armstrong World Industries, Inc.; Axiom in depth indicated.
  - 2. CertainTeed Ceilings;.
  - 3. USG Interiors, Inc.; Compasso.
  - 4. Or approved equal

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

### **3.3 INSTALLATION, GENERAL**

- A. Install materials in accordance with manufacturer's printed instructions, in accordance with approved Shop Drawings.
  - 1. Comply with governing regulations and fire resistance rating requirements, and industry standards applicable to the work.
- B. Arrange panels in manner shown by reflected ceiling plans in accordance with approved Shop Drawings. Install units with uniform joints and with pattern running in one direction, unless

otherwise indicated.

- C. Suspended Ceiling Installation: Comply with ASTM C-636 as applicable to acoustical panel ceilings, except to the extent more stringent requirements are indicated or required.
- D. Suspend ceiling hangers from building's structural members and as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacing that interfere with location of hangers at spacing required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  - 4. Comply with one of the following techniques, as indicated and required by Building Code:
    - a. Secure wire hangers to ceiling-suspension members and to supports above. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
    - b. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
  - 5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
  - 6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  - 7. Do not attach hangers to steel deck tabs.
  - 8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  - 9. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
  - 10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
- E. Install edge moldings and reveal moldings of the type indicated at edges of acoustical panel ceiling areas, and at locations where edge of tile would otherwise be exposed after completion of the work.
  - 1. Apply continuous ribbon or tape of acoustical sealant on back of vertical leg before fastening to vertical surface. Locate so that sealant will not be exposed after installation is completed.
  - 2. Secure moldings to building construction by fastening through holes drilled in vertical leg. Space holes not more than 3" from each end and not more than 16" o.c. between end holes.
    - a) Draw-up fasteners for tight set against vertical surfaces. Fasten with toggle bolts, or similar self-expanding screw anchors.
  - 3. Miter corners of moldings accurately to provide hairline joints.
  - 4. Level moldings with ceiling suspension system, to a level tolerance of 1/8" in 12'-0".
  - 5. All joints in moldings shall be cut accurately and installed with tight neat joint; all corners shall be mitered. Field applied tape and excess drywall compound shall be removed from moldings immediately.

- 6. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- F. Install exposed spline acoustical panel systems in coordination with suspension system and according to ASTM C-636 "Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels".
- G. Furnish and install a minimum of four (4) hangers at all light fixture locations in accordance with manufacturer's standards.
- H. Install the frames supplied by Electrical, Heating and Ventilation and Plumbing installers for their respective diffusers, grilles, access doors or electrical lighting fixtures.
- I. Where tiles are tegular or have reveals, cut tiles are to be kerfed with reveal cut to match factory edges and lay fully within the ceiling grid. Apply touchup paint to exposed cut edges.
- J. Install hold-down, impact clips in areas indicated; space according to panel manufacturer's written instructions unless otherwise indicated.

#### **3.4 CLEANING AND PROTECTION**

- A. Clean exposed surfaces of acoustical panels and edge moldings; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage
- B. Protect acoustical panel ceilings so that the work will be without damage and deterioration at the time of acceptance by the Owner.

END OF SECTION 09 5113

## **SECTION 095446 - FELT CEILING SYSTEM**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

Drawings and general conditions of Contract, including General and Supplementary Conditions and Divisions-1 Specification sections apply to work of this section.

#### **1.2 SUMMARY**

a) Section Includes:

1. Non-Woven layered and formed Polyester felt fiber ceiling panels designated as FSC1 on the finish schedule and drawings
2. Wire hangers, fasteners, main runners, cross tees, wall angle moldings and accessories.

#### **1.3 SUBMITTALS**

- a) Shop Drawings: Provide layout including panel type and components used in the assembly of the ceiling. Show locations of items that are to be coordinated with the ceiling.
- b) Installation Instructions: Submit manufacturer's installation instructions as referenced in Part three, Installation.
- c) Samples: Minimum 6 inch x 6 inch sample of the colors selected in the ceiling design, include manufacturer sample of suspension components.
- d) Product Data: Submit manufacturer's technical data for each type of ceiling unit and suspension system required.
- e) Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards.

#### **1.4 QUALITY ASSURANCE**

- a) Single-Source Responsibility: Provide ceiling panel units and suspension components by a single manufacturer.
- b) Fire Performance Characteristics: Identify ceiling components with appropriate markings of applicable testing and inspecting organization.
  1. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with Class A products.
    - i. Flame Spread: 25 or less
    - ii. Smoke Developed: 450 or less
- c) Coordination of Work: Coordinate ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- a) Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- b) Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.
- c) White gloves recommended for handling to avoid marring, especially on light color panels.

### 1.6 PROJECT CONDITIONS

- a) Space Enclosure:
  - I. Building areas to receive ceilings shall be free of construction dust and debris and fully enclosed.

### 1.7 WARRANTY

- a) Acoustical Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period.
- b) Warranty Period:
  - I. Acoustical panels and Suspension: five (5) years from date of substantial completion

### 1.8 MAINTENANCE

- a) Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.
  - 1. Ceiling Units: Furnish quality of full-size units equal to 2.0 percent of amount installed but not less than one box.
  - 2. Exposed Suspension System Components: Furnish quantity of each exposed suspension component equal to 1.0 percent of amount installed but not less than one box.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- a) Basis of Design Armstrong world industries inc or approved equal
  - a. Product: FELTWORKS Ebbs & Flows open Cell or approved equal

### 2.2 CEILING UNITS

- a) Ceiling Panel:
  - 1. Surface Texture: Soft
  - 2. Composition: Non-woven layered and formed Polyester felt (PET) fiber
  - 3. Color: as designated on the finished schedule
  - 4. Edge Profile: Square

5. Light Reflectance (LR): ASTM E 1477; 0.80
6. Green Guard Gold Certified
7. Acoustical Performance: tested per ASTM C423 and mounted in accordance with ASTM E795. NRC of 0.80
8. Sizes: 96"x96"x9",
  - i. Item no: 6532KOE09S8 or approved equal
  - ii. S8 Ebbs & Flows Open Cell Kit or approved equal
9. Flame Spread: Class A
10. Dimensional Stability: HumiGuard Plus

#### 2.2.1 SUSPENSION SYSTEMS

- a) Aluminum Suspension System:
  - i. Blades Hanging Kit, Item 6655 or approved equal
    1. Each kit includes 4 hanging assemblies, use one kit for each suspension

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- a) Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out.
- b) Proper designs for both supply air and return air, maintenance of the HVAC filters and building interior space are essential to minimize soiling. Before starting the HVAC system, make sure supply air is properly filtered and the building interior is free of construction dust.

#### 3.2 PREPARATION

- a) Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders, and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures.

#### 3.3 INSTALLATION

- a) Install suspension system and blades in compliance with the approval of the authorities having jurisdiction, and in accordance with the manufacturer's FELTWORKS Open Cell Installation Instructions.

#### 3.4 ADJUSTING AND CLEANING

- a) Replace damaged and broken panels.
- b) Clean exposed surfaces of ceilings panels, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage.

END OF SECTION



## **096263 – STAINLESS STEEL WALL BASE**

### **PART 1 GENERAL**

#### **1.01 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections apply to this Section.

#### **1.02 SUMMARY**

A. This Section includes stainless steel wall base and installation accessories of the following type:

1. Stainless steel cove base.

#### **1.03 SUBMITTALS**

A. Product Data: Submit manufacturer's product data for each type of wall base specified, including the following:

1. Installation accessories.
2. Installation instructions.

B. Shop Drawings: Submit shop drawings showing mounting details. Include corner details showing pre-formed corners, and end conditions.

C. Samples: Submit samples to the Architect for review prior to [constructing job-site mock-ups,] delivering materials to the site or commencing the work in this Section.

1. Stainless Steel Base: Submit full size samples, minimum 4 inches in length, of each type of stainless steel base required with specified finish.

#### **1.04 DELIVERY, STORAGE AND HANDLING**

A. Packing and Shipping: Deliver materials to site in manufacturer's original unopened packaging with labels intact. Protect finished surfaces with removable wrapping or protective plastic film which will not bond when exposed to sunlight.

B. Storage: Store wall base in manufacturer's original packaging, off ground and under cover away from direct sunlight, protected from weather, extreme temperature, moisture or other damage.

C. Handling: Handle materials so that surfaces are protected. Prevent distortion or damage to fabricated pieces.

#### **1.05 PROJECT/SITE CONDITIONS**

A. Environmental Requirements: Areas to receive wall base shall be enclosed with HVAC in operation and maintaining temperatures within range expected during building occupancy to avoid thermal dimensional change in lengths of material after installation.

#### **1.07 SCHEDULING AND SEQUENCING**

A. Coordination: Coordinate installation of stainless steel base with associated wall coverings, corner guards, ceramic tile floor and wall finishes and other adjacent

floor and wall finishes.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Approved Distributor/Manufacturer:
  - a. Inpro Corporation
  - b. Protek Systems
  - c. Pitcon
  - d. Or approved equal

### **2.02 MATERIALS**

- A. Stainless Steel Sheet: ASTM A240, Type 304.
  - 1. Gauge: 18 gauge.
  - 2. Finish: No. 4 Brushed in accordance with ASTM A480, horizontal grain.

### **2.03 MANUFACTURED WALL BASE**

- A. Type 304 Stainless Steel Wall Base (MTB1 as indicated on finish schedule):
  - 1. 4 inch Cove Base
- B. Preformed Corner Units: Provide preformed inside and outside corner units.

### **2.04 INSTALLATION ACCESSORIES**

- B. Adhesive: Manufacturer's standard polyurethane adhesive

### **2.05 FABRICATION**

- A. Stainless steel wall base and corners shall be factory formed from stainless steel sheet with directional polish grain oriented parallel with length.
  - 1. Edges shall be free of burrs.
  - 2. Standard Length: 8'-0"
  - 3. Fabricate exposed ends with filler to match profile of cover base.
  - 4. Preformed corners shall be 90 degree, or as otherwise required to suite corner degree indicated on Drawings. Fabricate preformed corners with minimum 4 inch legs.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect. Commencement of Work will be construed as acceptance of subsurfaces.
  - 1. Painted walls shall be dry and thoroughly cured prior to application of stainless steel wall base.
  - 2. Perform adhesion test on painted drywall or plaster walls to receive stainless steel wall base in accordance with manufacturer's installation instructions to verify proper adhesion.
  - 3. Verify floors within areas where stainless steel wall base is to be installed

are level to within 1/8 inch in 10'-0".

B. Coordination: Coordinate with other work which affects, connects with, or will be concealed by this Work.

1. Coordinate installation of base with application of wall finishes.
2. Where stainless steel base is installed after application of wall finish, verify application is completed and ready for installation of base.
3. Install wall base prior to application of finishes installed after installation of stainless steel wall base, such as wall tile, stainless steel wall sheeting, FRP, etc.

### 3.02 PREPARATION

A. Surface Preparation: Surfaces to receive stainless steel wall base shall be cleaned to remove all dust, debris, and other contaminants that would interfere with adhesive bond.

B. Place stainless steel base and accessory units in locations/rooms where material is to be installed and acclimate to building conditions as specified herein in Project/Site Conditions article for a minimum period of 24 hours prior to installation.

### 3.03 INSTALLATION

A. Adhesive Installation: Install stainless steel wall base with adhesive in strict accordance with manufacturer's printed installation instructions.

B. Install base accurately placed in proper location, level, and in proper alignment with adjoining work and applied finishes.

1. Fit field connections accurately together to form hairline joints.

C. Where necessary to provide secure attachment at corners, end terminations, or where higher abuse is anticipated, supplement adhesive installation with two (2) countersunk #10 stainless steel screws (installer supplied) placed in pre-drilled and countersunk holes located within 1 inch of each exposed end or corner. Set screw heads flush in countersunk hole.

D. Field Fabricated Corners: Where preformed corners are not utilized, field fabricate corners by V-notching back of base to 1/2 depth maximum of thickness of material and bend to form tightly to corner substrate.

### 3.04 DAMAGE AND REPAIR

A. Upon completion of the installation, visually check exposed surfaces of the work of this Section, and touch up scratches and damaged surfaces by field polishing so they are completely invisible to the unaided eye from a distance of five feet.

### 3.05 CLEANING

A. Upon completion of installation of stainless steel walls base, promptly clean exposed surfaces in accordance with recommendations of the stainless steel base manufacturer to remove all traces of dust, dirt, adhesive, and other foreign materials.

B. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition.

END OF SECTION

## SECTION 096516 SHEET VINYL FLOORING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Work Included: Provide labor, materials and equipment necessary to complete the installation of safety resilient sheet vinyl flooring and accessories Designated as SV1 on the finish schedule, including but not limited to the following:
  - 1. substrate preparation.
  - 2. moisture and pH testing.
  - 3. Coordination of plumbing fixtures for connections with flooring accessories.
  - 4. Floor installation and heat welding of all seams, horizontal and vertical.

#### 1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's current printed product literature, specifications, and installation instructions, including the Wet Area Installation Practices Guide and Kitchen Detailing Guide.
- B. Certificate of recommendation for installer from manufacturer stating installer's completion of Manufacturer approved training course. Certificate must be for individual who will be installing or directly on-site overseeing installation of product.
- C. Shop Drawings: Submit shop drawings indicating materials, details, and accessories including but limited to the following:
  - 1. Floor plans indicating seam locations and roll direction.
  - 2. Floor plans including notations at each drainage protrusion (drains, cleanouts, grease traps, and similar items) as to the method of connection.
  - 3. Wall caps and transition to adjacent materials.
- D. Operations and Maintenance Data: Submit manufacturer's operation and maintenance data for each installed product.
- E. Warranty: Submit executed copy of manufacturer's standard limited warranty.
- F. Field Quality Control Reports: Submit reports indicating results of moisture testing, substrate preparation procedures and installation methods employed.
- G. Extra Stock Materials: Provide 2 percent extra materials and store where directed, properly packaged and labeled.

- H. Samples: submit duplicate 8" x 10" sample pieces of sheet material, 6" long gulley edge, cap strip, AND cove former, in accordance with section 01330 - submittal procedures.

### 1.3 QUALITY ASSURANCE

- A. Manufacturer: To the greatest extent practical, provide each type of resilient flooring and accessories by a single manufacturer, including recommended primers, adhesives, sealants, finish accessories, and leveling compounds.
- B. Installer Qualifications: Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
  - 1. Training: Installers who have attended a Manufacturer's Installation Clinic and is recommended installer.
- C. Regulatory Requirements: Provide slip resistant sheet vinyl safety flooring in compliance with the following:
  - 1. Americans with Disabilities Act Architectural Guidelines (ADAAG)
  - 2. Occupational Safety and Health Administration (OSHA).

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store rolls of sheet goods in a secured upright position. Store materials in dry spaces protected from the weather, with ambient temperatures not less than 68 deg F or more than 80 deg F and floor temperature 65 degrees or higher.

### 1.5 PROJECT CONDITIONS

- A. Comply with manufacturer's requirements for project conditions including the following:
  - 1. Maintain ambient temperatures of 68 deg F (18 deg C) and 80 deg F (26 deg C) in spaces to receive resilient products for 72 hours before installation, during installation and 24 hours after installation.
  - 2. Maintain the ambient relative humidity between 40 percent and 60 percent during installation.
  - 3. Close spaces to traffic during resilient flooring installation until the the adhesive has set.
  - 4. Verify permanent HVAC is operational. If temporary heat is required, use electric or indirect heat sources. Do not use kerosene or propane in direct contact with the ambient air.
  - 5. Verify other finishing operations, including painting, have been completed.
  - 6. Food service casework, counters and other items are to be installed on top of sheet resilient flooring material, install flooring material before these items are to be installed.
  - 7. Coordinate with plumbing subcontractor surface membrane clamping drainage connections will be used, including but not limited to, surface clamping round drains, surface clamping trench drains, surface clamping floor sinks, surface clamping grease traps. Where specified product does not contain flashing lamp, provide flooring manufacturer's Angle/Edge that turned down into drain.

1.6 WARRANTY

- A. Warranty: Provide manufacturer's standard limited warranty, but not less than 10 years from date of substantial completion.
- B. Labor warranty period of 2 years to be supplied by installer.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Basis-of-Design Manufacturer: Altro USA, Inc.,
- B. Other manufacturers:
  - 1. Forbo, Flooring systems
  - 2. Or approved equal

2.2 SHEET VINYL FLOORING

- A. Sheet Vinyl Flooring designated as SV1 on the finish schedule and plans: Basis of design: Altro Aquarius by Altro USA, Inc. or approved equal complying with the following:
  - 1. ASTM F1303: Type II, Grade 1, Class A with moisture resistant backing
  - 2. Wear Layer/Overall Thickness: 2.0 mm (0.12 inches), with non-directional pattern and slip retardant particulate suspended evenly throughout the product thickness.
  - 3. Roll/Sheet Width & Length: 6 feet 7 inches (2 m) x 66 feet
  - 4. Backing: non-woven polyester/cellulose, glass fiber reinforcement.
  - 5. Slip Resistance: ADA compliant, ASTM D 2047 James Machine, SCoF Dry .88 / Wet 1.03 DIN 51130 Ramp Test - R 11
  - 6. Static Load Limit: ASTM F 970, Standard Test Method for Static Load Limit, Modified – 2000 psi.
  - 7. Fire Performance: ASTM E 648, Standard Test method for Critical Radiant Flux of 0.45 watts/cm<sup>2</sup> or greater, Class I, ASTM E662 Smoke Development.
  - 8. Sustainable Properties: Phthalate-free, contains rapidly renewable bio-based content, 100 percent recyclable, SCS FloorScore Certified, meets CAL Section 01350, contributes to LEED credits for recycled content, adhesives, low VOC emitting material. EPD Environmental Product Declaration and HPD Health Product Declaration Available.
  - 9. Colors: As indicated on the Drawings.
- B. System Accessories
  - 1. Vinyl Welding Rod:
    - a. Weld Rod (in matching color): to be used at seams, corners, drains, & transitions including with Angle/Edge transitions

2. Cover Former:, sized to suit application:
  - a. Manufacturer's Cove Former 0.75" radius: to be used at base of walls for coving of the flooring. Cove Former and Cove should be installed using manufacturer Double-Sided Contact Tape
  - b. Cove to be minimum 4" height or as indicated on drawings.
3. Drains & Penetrations: flooring MUST be mechanically fastened to all drain outlets and cleanouts to ensure a permanent watertight installation.
  - a. New Construction, Round Drain Covers and floor sinks with clamping flanges: anchor flooring in clamping flange of drain.
    - 1) Where non-clamping drains are specified, flooring sub contractor shall modify the drain covers to mechanically fasten flooring to drain outlets
  - b. Rectangular Drains, Clean Outs, Trench Drains, Floor Sinks without clamping flanges:
    - 1) Manufacturer recommended angle or edge transition installed as part of system. Provide around every square/rectangular drain, floor sink, and cleanout without a clamping flange. Refer to plumbing drains for drain specifications.
      - a) Basis of Design: Altro Gulley Angle or approved equal: Provide in color as selected by architect.
  - c. Pipes & Penetrations:
    - 1) Manufacturers recommended sealant installed as part of system:
      - a) Basis of Design: AltroMastic or approved equal (color coordinating): To be used at around any pipe or penetration through the flooring (with the exception of drains)
4. Perimeters/Edging: Acceptable Material, vinyl, sized to suit application:
  - a. Manufacturer's recommended edge transition with vertical leg and flange to overlap adjacent flooring. Provide as all transitions to other flooring types.
    - 1) Basis of design: Altro Gulley Edge GE 35RE or GE25RE or approved equal
      - a) provide in color as selected by architect.
5. Cap Strip: Acceptable material, sized to suit application:
  - a. Color/material: Stainless steel
6. Subfloor Filler and Leveler: Use only gray Portland cement-based "moisture tolerant" underlayments, and patching compounds with a 3000 PSI. Use for filling cracks, holes, or leveling. White gypsum materials may not be acceptable.

C. Installation Materials:



1. Leveling and Patching Compounds: Latex-modified, moisture resistant, silicate free, Portland cement based or blended hydraulic-cement-based formulation with a 3000 PSI
2. Adhesives:
  - a. Manufacturer recommended 2 part polyurethane for use with heavy rolling loads and surface water.
    - 1) Basis of design: Altrofix 30 or approved equal
3. The installation of floor is a system installation. All circular drain covers must be modified in the field where no Surface-Membrane Clamping Style Drains provided and installed per the instructions in the manufacturer Flooring installation guide.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, with installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. The general contractor shall test, substrate moisture content and field conditions to verify conditions are suitable for installation. Submit written reports in a timely manner and indicate remedial actions taken.

#### 3.2 PREPARATION

- A. Prepare substrates in accordance with manufacturer's written instructions including the following:
  1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  2. Remove substrate paint, coatings and other substances that are incompatible with adhesives or contain soap, wax, oil, solvents, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
  3. Mechanically remove contamination on the substrate that may cause damage to the resilient flooring material. Permanent and non-permanent markers, pens, crayons, and paint shall not be used to write on the back of the flooring material or used to mark the substrate as they could bleed through and stain the flooring material.
  4. If chemical adhesive removal is used, comply with regulations of authorities having jurisdiction. If hazardous materials in existing conditions are present or suspected, notify the Owner in writing and stop work in that area until notified by Owner of actions to be taken.

- B. Concrete Subfloors: Testing by methods specified below to determine moisture content in concrete, for all concrete regardless of age or grade level:
1. Comply with recommendations of ASTM F 2170 Standard Test Method for Determining Relative Humidity in Concrete Slab Using in-situ probes. This test method covers the quantitative determination of percent relative humidity in concrete slabs for field or laboratory test.
  2. The readings shall not exceed 90%.
  3. Alkalinity Testing per ASTM F710 with an acceptable range of 7-9.9 pH.
  4. Comply with ASTM and ACI Standards as listed in References.
- C. Contingency for High Moisture Readings in Concrete: If at the time of installation the moisture readings are in excess of Altro's recommendations, the General Contractor shall employ a means of Moisture Mitigation. This includes, but is not limited to, the following methods:
1. Temporary use of dehumidification equipment.
  2. Postponing of the flooring installation start time.
- D. Additional Preparation Requirements:
1. Fill cracks, holes, depressions and irregularities in the substrate with underlayment leveling and patching compounds; remove bumps and ridges to produce a uniform and smooth substrate.
  2. Allow minimum 24 hours curing time after leveling/patching compound has been applied.
  3. Do not install floor covering over expansion joints.
  4. Do not install resilient products until they are similar to the temperature as the space where they are to be installed. Move resilient products and installation materials into spaces where they will be installed at least 24 hours in advance of installation.
  5. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.
  6. When installing over existing floor coverings, completely degrease using a power washer and a high pH degreaser. Rinse repeatedly with clean water until runoff is clear and allow sufficient dry time.

### 3.3 INSTALLATION

- A. Install products in strict accordance with manufacturer's instructions and approved submittals. Use installation method suitable for substrate and project conditions.
- B. Coved Installation: Where flooring is coved up wall surfaces and other abutments, installation shall be in accordance with safety flooring Installation Practices using the following accessories:
1. At ceramic tile, Use Altro C8 Vinyl Captile Strip or C4 cap, respectively or approved equal. Substituted products should provide a similar installation detail.
  2. Provide 0.75" (19.1 mm) radius coving at juncture of vertical and horizontal surfaces: Use Altro Vinyl Cove Former 20R or approved equal. Substituted products should provide a similar installation detail.
  3. Top set cove base: Install in accordance with manufacturer's instructions.

4. Any outside corners should be created using a butterfly cut or a V cut. Heat welds shall not be created along the corner of the coved material as it runs up the wall.
- C. Proceeding with the installation means the installer's acceptance that substrates are acceptable for installation of resilient flooring.
- D. Install with manufacturer's adhesive recommended for the site conditions.
- E. Install rolls in sequential order following roll numbers on the labels.
- F. Do not reverse sheets unless instructed otherwise by manufacturer's technical representative.
- G. Immediately place the flooring into the wet adhesive. Roll spread adhesive with acceptable nap paint roller before setting flooring into adhesive.
- H. Roll the flooring in both directions using a 100-150 lb 3 section roller.
- I. Heat-weld all seams, vertical and horizontal. Allow 12 hours cure time before heat-welding.
- J. When flash-coving, use manufacturer's recommended accessories for cove former, cap, edging and other details.

### 3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of resilient products. Perform the following operations immediately after completing resilient product installation:
  1. Remove adhesive and other blemishes from exposed surfaces.
  2. Sweep and vacuum surfaces thoroughly.
  3. Damp-mop surfaces to remove marks and soil.
- B. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
  1. Never use tapes on the surface on the finish flooring
  2. Never use Sharpies, pens, crayons or construction markers on either the finish flooring or the substrate.
  3. No traffic for 24 hours after installation, unless approved by Altro technical.
  4. No heavy traffic, rolling loads, or furniture placement for 72 hours after installation.
- C. Wait 72 hours after installation before performing initial cleaning. Start a regular maintenance program after the initial cleaning as recommended by manufacturer.

END OF SECTION

## SECTION 09 6519 - RESILIENT TILE FLOORING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Luxury Vinyl Tile (LVT).
  - 2. Resilient Rubber Base
  - 3. Resilient transition strips.
  - 4. Installation accessories.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sample for verification. For each exposed product and for each color and pattern specified.
  - 1. Full size tile in each color and pattern
  - 2. Resilient base: minimum 12" long in each color and type specified.
- C. Moisture Testing results, see moisture testing requirements below.
- D. Submit manufacturer's warranty as noted herein.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Maintenance data.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

#### 1.6 PROJECT CONDITIONS:

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:
  - 1. 1. 48 hours before installation.
  - 2. During installation.

3. 48 hours after installation.
  - B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
  - C. Close spaces to traffic during floor tile installation, and for 48 hours after floor tile installation or as recommended by manufacturer.
  - D. Install floor tile after other finishing operations, including painting, have been completed.
- 1.7 EXTRA MATERIALS:
- A. Provide minimum 5% area installed in full-size units for each type of flooring and base material from same lot as installed product but not less than 1 unopened box.
    1. If multiple lots are used in separate spaces, identify locations and provide extra material in amount indicated above for each lot.
- 1.8 WARRANTY
- A. Provide manufacturers 5 year limited warranty.

## PART 2 - PRODUCTS

- 2.1 LUXURY VINYL TILE (LVT-1, LVT-2, LVT-3, LVT-4, LVT-5)
- A. MANUFACTURERS
    1. Luxury Vinyl Tile Products: Subject to compliance with requirements, provide products as scheduled on the drawings Finish Schedule, or approved equal. Evaluation of equals will be reviewed for similar aesthetics, appearance, and meet or exceed performance requirements
      - a. Refer to drawings for Basis of Design Manufacturers and products, or approved equal from
        - 1) Patcraft
        - 2) Armstrong World Industries, Inc
        - 3) Mohawk Floors
        - 4) Mannington Mills
        - 5) or approved equal.
  - B. PERFORMANCE REQUIREMENTS FOR ALL LVT TYPES
    1. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
      - a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
    2. ASTM F1914 RESIDUAL INDENTATION: Pass, less than 10%
    3. ASTM F970 MODIFIED FOR MAX WEIGHT: 1000lbs
    4. ASTM E662 (NFPA 258) SMOKE DENSITY: Passes, less than 450
    5. ASTM D2047 SLIP RESISTANCE: ASTM D2047 SLIP RESISTANCE: <0.5 (DRY)
    6. FLOOR SCORE CERTIFIED
  - C. LUXURY VINYL FLOOR TILE (LVT-1, LVT-2, LVT-3, LVT-4)
    1. Tile Standard: ASTM F1700.

- a. Class: Class III, Printed Film Vinyl Tile.
- b. Type: B, Embossed Surface.
2. Flor-Score Certified
3. Wear thickness: 22mil
4. Total Thickness: 5.0mm.
5. Size, color and patterns: as indicated on the drawings in the finish schedule
6. Attachment: full spread glue-down
7. 22 year commercial warranty

D. LUXURY VINYL FLOOR TILE (LVT-5)

1. Tile Standard: ASTM F1700.
  - a. Class: Class III, Printed Film Vinyl Tile.
  - b. Type: B, Embossed Surface.
2. Flor-Score Certified
3. Wear thickness: 20mil
4. Total Thickness: 5.0mm.
5. Size, color and patterns: as indicated on the drawings in the finish schedule
6. Attachment: full spread glue-down
7. 20 year commercial warranty

2.2 RESILIENT BASE (RB1, as noted on finish schedule)

A. MANUFACTURERS

1. Subject to compliance with requirements, provide products as scheduled on the drawings Finish Schedule, or approved equal product. Evaluation of equals will be reviewed for similar aesthetics, appearance and meet or exceed performance requirements
  - a. Basis of Design
    - 1) Roppe
  - b. Other Manufacturers:
    - 1) Johnsonite Tarkett group
    - 2) Armstrong World Industries, Inc
    - 3) Or approved equal

A. Base Standard: ASTM F 1861, Type TS (rubber, thermoset).

1. Group: I (solid, homogeneous).
2. Style as follows, unless otherwise indicated on the drawings:
  - a. Style B, Cove toe
3. Minimum Thickness: 0.125 inch.
4. Height: 4 inches, unless otherwise as indicated on Drawings.
5. Length: 100-foot roll length.
6. Colors: As indicated on drawings Finish Schedule.
7. Provide with preformed factory inside corners and preformed factory outside corners.

2.3 RESILIENT FLOOR TRANSITIONS

1. Subject to compliance with requirements, provide products as scheduled on the drawings Finish Schedule, or approved equal product. Evaluation of equals will be reviewed for similar aesthetics, appearance and meet or exceed performance requirements
  - a. Basis of design:
    - 1) Johnsonite (Tarkett group)
  - b. Other manufacturers:

- 1) Armstrong World Industries, Inc
  - 2) Roppe
  - 3) Or approved equal
2. Solid composition, color and profile as selected by architect where metal transition strip has not been specified.

## **2.4 INSTALLATION MATERIALS**

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- C. Concrete Slab Primer: Non-staining type recommended by the tile manufacturer
- D. Leveling Compound: Latex/Portland cement flash patching and leveling compound equal to No. DSP-520 made by H.B. Fuller or No. 226 with 3701 admixture made by Laticrete or approved equal made by Mapei, Bostik, or approved equal.
- E. Edging Strips: 1/8" thick, homogeneous vinyl or rubber composition, tapered or bullnose edge, color as selected by the Architect from manufacturer's standards
- F. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. Examine the areas and conditions where resilient tile flooring is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

### **3.2 CONDITION OF SURFACES**

- A. Allowable Variations in Substrate Levels (Floors):  $\pm 1/8"$  in 10'-0" distance and 1/4" total maximum variation from levels shown.
- B. Grind or fill concrete substrates as required to comply with allowable variation.

### **3.3 PREPARATION**

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
  3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 10 pH.
  4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement or as recommended by tile and adhesive product requirements.
    - b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

### 3.4 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
1. Lay tiles square with room axis and in pattern indicated.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
1. Lay tiles in pattern of colors and sizes indicated.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.



- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- H. Install resilient transition strips at differences in flooring heights, and transitions between flooring types. Provide profiles as scheduled on drawings and to meet ANSI A117.1-2009 accessibility requirements.
- I. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- J. Stair Treads
  - 1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
  - 2. Tightly adhere to substrates throughout length of each piece.
  - 3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

### 3.5 Cleaning and Protection

- A. Remove any excess adhesive or other surface blemishes from tile, using neutral type cleaners as recommended by the tile manufacturer. Protect installed flooring from damage by use of heavy Kraft paper or other covering.

END OF SECTION 09 6519

## SECTION 09 6560 SYNTHETIC SPORTS FLOORING

### PART 1 – GENERAL

#### 1.1 SECTION INCLUDES

- A. Supply and installation of the indoor resilient multipurpose surfacing defined as “SSF1” on the finish schedule
- B. Application of the game lines, painted logos, lettering, and out-of-bounds and key field areas.
- C. References for the correct construction and preparation of concrete slabs to receive resilient flooring.
- D. Second story volleyball net sleeves specified under section 116600 to be installed under this section.

#### 1.2 RELATED SECTIONS:

- A. Athletic Equipment – 116600

#### 1.3 SUBMITTALS

- A. Product Data:
  - 1. Manufacturer’s promotional brochures, specifications and installation instructions
- B. Manufacturer Certifications:
  - 1. Provide certification that accurately identifies the Original Equipment Manufacturer (OEM) of flooring furnished for this project including manufacturer’s name, address and factory location.
  - 2. Suppliers of private label flooring for this project must identify themselves as such and fully disclose the OEM information listed above.
  - 3. All “manufacturer” requirements in these specifications must be complied with by the OEM, including warranties, certifications, qualifications, product data, test results, environmental requirements, performance data, etc.
- C. Samples:
  - 1. Submit for selection and approval of the indoor resilient multipurpose surfacing, manufacturer’s brochures, samples or sample boards of all of the available colors, textures and styles.
  - 2. Submit color samples of all the available game line paint colors for selection and approval.
- D. Closeout Submittals:
  - 1. Submit the indoor resilient multipurpose surfacing and manufacturer’s maintenance instructions.
  - 2. Submit the material and installation warranties as specified.

#### 1.4 QUALITY ASSURANCE

A. Qualifications:

1. The indoor resilient multipurpose surfacing shall have been actively marketed for a minimum of ten (10) years.
2. The indoor resilient multipurpose surfacing shall be manufactured in an ISO 9001 OR 14001 certified plant.
3. The indoor resilient multipurpose surfacing supplier shall be an established firm, experienced in the field, and competent in the techniques required by the manufacturer.
4. The installer of the indoor resilient multipurpose surfacing shall have a minimum of five (5) years of experience in the field installing indoor resilient multipurpose surfacing and have worked on at least five (5) projects of similar size, type and complexity.

B. Certifications:

1. Installer to submit the indoor resilient athletic surfacing manufacturer's certification attesting that they are a trained installer of the indoor resilient multipurpose surfacing.
2. The indoor resilient multipurpose surfacing manufacturer to submit official ISO 9001 certification for the facility in which the indoor resilient multipurpose surfacing is manufactured.

C. Testing:

1. Tests shall be relative for multi-purpose use with certificates from independent testing resources to be made available upon request.
2. Test results shall be no more than 5 years old and performed according to ASTM standard testing procedures.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery:

Material shall not be delivered until all related work is in place and finished and/or proper storage facilities and conditions can be provided and guaranteed stable according to manufacturer recommendations.

B. Storage:

1. Store the material in a secure, clean and dry location.
2. Maintain temperature between 55° and 85° Fahrenheit.
3. Store the indoor resilient athletic surfacing rolls in an upright position on a smooth flat surface immediately upon delivery to jobsite.
4. Rolls shipped in rigid protective cardboard containers can be laid horizontally prior to unpacking and installation.

1.6 PROJECT/SITE CONDITIONS

- A. It is the responsibility of the general contractor/construction manager to maintain project/site conditions acceptable for the installation of the indoor resilient multipurpose flooring.
- B. The area in which the indoor resilient multipurpose surfacing will be installed shall be dry and weather tight. Permanent heat, light and ventilation shall be installed and operable.

- C. All other trades shall have completed their work prior to the installation of the resilient athletic flooring. The general contractor or construction manager shall maintain a secure and clean working environment before, during and after the installation.
- D. Maintain a stable room temperature of at least 65°F for a minimum of one (1) week prior to, during and thereafter installation.
- E. An effective low-permeance vapor barrier is placed directly beneath the concrete subfloor. For “on” or “below grade” installations, it is recommended to provide a permanent vapor barrier resistant to long term hydrostatic pressure/moisture exposure. Protrusions should be sealed to prevent moisture migration into the slab. Moisture should not be allowed to enter the slab after the completed construction.
- F. Concrete subfloor surface pH level within the 7 to 11 range dependent upon installation type.
- G. Concrete subfloor should be no greater than 1/8" within a 10 ft diameter. This tolerance can be measured in accordance with ASTM E1155. A specified ( $F_F$ ) of 50 and an ( $F_L$ ) of 30 should reach this degree of floor flatness and floor level. There is no numerical correlation between F numbers and the deviation from the straight edge. However, the above specified numbers should achieve a flat floor with minimal deviation in the slab. Reference ACI 117 and ACI 302.1R. The general contractor should provide a certificate of compliance with the above recommendations.
- H. Concrete subfloor must be clean and free of all foreign materials or objects including, but not limited to, curing compounds and sealers.
- I. Fill cracks, grooves, voids, depressions, and other minor imperfections. Follow the manufacturer’s directions. Moveable joints must be treated utilizing specific transition joint devices depending upon the architect’s recommendations. Follow current ASTM F710 guidelines for the preparation of concrete slabs to receive resilient flooring.
- J. Refer to ACI 302.2R “Guidelines for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials” for concrete design and construction.
- K. Concrete slab shall be fortified with continual steel reinforcement. Fiber reinforcement alone shall not be considered adequate fortification.

#### 1.7 WARRANTY

- A. Special Limited Warranty:
  - 1. Manufacturer's standard form in which manufacturer agrees to repair or replace sports flooring including labor that fails within specified warranty period.
- B. Material warranty must be direct from the product manufacturer.
  - 1. Material warranties from separate or third party insurance providers are not valid.
  - 2. Material warranties must come from original manufacturer or division thereof. Private label warranties from distributors or brokers are not valid. Supply original point of manufacturing upon request.
- C. Failures include, but are not limited to, the following:
  - 1. Material manufacturing defects.

2. Surface wear and deterioration to the point of wear-through of wear layer per ASTM F410/ASTM F1303.
  3. Failure due to substrate moisture exposure exceeding 98 percent relative humidity when tested according to ASTM F2170.
- D. Warranty Period:
1. For material defects and surface wear-through: 25 years from date of substantial completion.
  2. For moisture vapor tolerance: 25 years from date of substantial completion.
- E. Installer's Limited Warranty:
1. Installer's standard form in which installer agrees to repair or replace sports flooring that fails due to poor workmanship or faulty installation within the specified warranty period.
  2. Warranty Period: 2 years from date of substantial completion.

## 1.8 ADDITIONAL MATERIALS

- A. Furnish to the owner additional materials containing a total of at least 1% of each different color or design of the indoor resilient athletic surfacing used on the project.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. The basis of the design for the indoor resilient multipurpose surfacing is Omnisports ACTIVE+ as manufactured by Tarkett
- a. All other installation accessories and related components must be either made or approved by the indoor resilient athletic surfacing manufacturer.
- B. Other Manufacturers: or approved equal subject to compliance requirements of the basis of design

### 2.2 MATERIALS

- A. Prefabricated sport surface with wood flooring design and slightly textured embossed surface.
1. Embossing of wood design and solid colors must be the same; varying embossing or surface textures will not be allowed.
  2. Printing of wood design shall closely resemble standard wood strip flooring in size, color, board length, and grain appearance.
  3. Surface friction per ASTM F2772
  4. The wood design shall be protected by a clear layer of pure PVC (Polyvinyl Chloride) and a factory-applied UV cured urethane treatment.
  5. Fore reduction layer shall be high-density closed cell PVC foam with honeycomb embossing applied in one continuous manufacturer process. Laminated or adhered foam layers will not be allowed.
- B. Physical properties of the indoor resilient athletic surfacing shall conform to the following minimums:

Width		6' 6" (2 m)
Length		85' (25.9m) approx.

Wear Layer	Omnisports	2 mm
Total Thickness	Omnisports HPL	8.1 mm
Wear Layer	Type 1- grade 1	ASTM F1303/F410
Vertical Deformation	PASED	ASTM F2772
Rolling load	Passed	0.30 (EN 1569 {11/1999})
Surface finish effect	Passed	ASTM F2772 (80-110)
Chemical resistance	Excellent	ASTM F925
Impact resistance	Passed	EN 1717
Abrasion resistance	Passed	0.10 (EN ISO 5470- {06/1999})
Static load limit	Passed	ASTM F970 -Load 175lbs
Sound insulation	excellent	+/- 19 dB (ISO 717/12)
In round sound insulation	excellent	61 dB (NF S31-074)
Ball rebound	passed	ASTM > 90%
Fore Reduction	passed	ASTM F2772 Class 3
Fire Rating	Passed	ASTM E648 Class 1
Microbial Assay Test	No Growth	G21 ASTM – backing
Asthma and Allergy Friendly	ASP: 05-01/101	Certified Compliant
Phthalate-free technology	—	YES
REACH Compliant	—	YES
Heavy Metals	—	NO
ISO 9001	—	YES
ISO 14001	—	YES

1. Color: As noted on the finish plans and schedule consisting of a wood grained primary field, and color accents
  - a. As indicated on the drawings or selected from manufacturers full range
  - b. Texture: Texture to remain consistent between solid colors and wood design when blending colors.
- C. Welding Rod: As supplied by the indoor resilient athletic surfacing manufacturer or supplier.
  1. Color to blend with the indoor resilient athletic surfacing color or design.
  2. All seams shall be welded to create a monolithic and impermeable surface.
- D. Adhesive: As approved by the indoor resilient athletic surfacing manufacturer.
- E. Game Line Paint and Primer: As approved by the indoor resilient athletic surfacing manufacturer.
  1. Provide in custom colors as noted on the drawings for lettering, out-of-bounds areas, lines, custom logo, basketball key, volleyball lines and all other areas
- F. Second floor volleyball sleeves specified under section 116600 athletic equipment to be installed under this section and located per approved shop drawings for court layouts.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. It is the responsibility of the general contractor/construction manager to ensure that project/site conditions are acceptable for the installation of the indoor resilient athletic flooring.
- B. Verify that the area in which the indoor resilient athletic surfacing will be installed is dry and weather tight. Verify that permanent heat, light and ventilation are installed and operable.
- C. Verify that all other work that could cause damage, dirt and dust or interrupt the normal pace of the indoor resilient athletic flooring installation is completed or suspended.
- D. Verify that there is a stable room temperature of at least 65°F.
- E. Verify that there are no foreign materials or objects on the subfloor and that the subfloor is clean and ready for installation.
- F. Direct Full Spread Adhering to Concrete Subfloor Multi-poxy: moisture content less than 98% RH when tested per ASTM F2170.
- G. Follow manufacturers installation recommendations.
- H. Do not average the results of the tests. Report all field test results in writing to the General Contractor, Architect, and End User prior to installation.
- I. Verify that the concrete subfloor surface pH level is within the 7 - 11 range.
- J. Document the results confirming the slab is within manufacturer's tolerances for slab deviation.

### 3.2 PREPARATION OF SURFACES

- A. Sand the entire surface of the concrete slab.
- B. Sweep the concrete slab so as to remove all dirt and dust. If a sweeping compound is to be used it must be a sweeping compound that does not contain oil or other items that may inhibit the adhesive bond.
- C. Slab must be dust free. In the event that dust impairs adhesive bond, priming the slab prior to application of adhesive may be necessary. Follow installation guidelines.
- D. Follow OSHA guidelines.

### 3.3 INSTALLATION

- A. The installation area shall be closed to all traffic and activity for a period to be set by the indoor resilient athletic surfacing installer. The indoor resilient athletic surfacing installation shall not begin until the installer is familiar with the existing conditions.
- B. All necessary precautions should be taken to minimize noise, smell, dust, the use of hazardous materials and any other items that may inconvenience others.
- C. Install the indoor resilient athletic surfacing in strict accordance with the indoor resilient athletic surfacing manufacturer's written instructions.
- D. Install the indoor resilient athletic surfacing minimizing cross seams. Provide a seam diagram during the submittal process for approval prior to installation. Vinyl Sheet Flooring Seams: Comply with ASTM F 1516. Rout joints and heat weld to permanently and seamlessly fuse sections together.
- E. Paint game lines and all other areas, logos, and lettering using approved game line paint primer and game line paint in strict accordance with the game line paint manufacturer's instructions.
- F. Install appropriate threshold plates or transition strips where necessary

- G. Installation of athletic equipment sleeves to be coordinate and installed under this section in locations identified for proper striping.

3.5 CLEANING

- A. Remove all unused materials, tools, and equipment and dispose of any debris properly. Clean the indoor resilient athletic surfacing in accordance with the manufacturer's instructions.

3.6 PROTECTION

- A. If required, protect the indoor resilient athletic surfacing from damage using coverings approved by the manufacturer until acceptance of work by the customer or their authorized representative.

END OF SECTION



## **SECTION 096566 - RESILIENT ATHLETIC FLOORING**

### **PART 1 GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

#### **1.2 SECTION INCLUDES**

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the resilient athletic flooring, as shown on the drawings and/or specified herein.

#### **1.3 RELATED SECTIONS**

- A. Cast-in-Place Concrete - Section 033000.

#### **1.4 REFERENCES**

- A. American Society for Testing and Materials (ASTM)
  - 1. ASTM D 2047: Standard Test Method for Static Coefficient of Friction of Floor Surfaces.
  - 2. ASTM D 5116: Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products.
  - 3. ASTM F 710: Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
  - 4. ASTM F 1344: Standard Specification for Rubber Floor Tile (Sections 7.1-7.6, 8.4, 5 & 6).
  - 5. ASTM F 1859: Standard Specification for Rubber Sheet Floor Covering Without Backing (Sections 7.1-7.6, 8.4, 5 & 6).
  - 6. ASTM F 1869: Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Sub-floor Using Anhydrous Calcium Chloride.
  - 7. ASTM E 648: Standard Test Method for Critical Radial Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
  - 8. ASTM E 662: Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
  - 9. ASTM E 1745: Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

10. ASTM G 21: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

B. National Fire Protection Association

1. NFPA 101: Code for Safety to Life from Fire in Buildings and Structures.

## **1.5 SYSTEM DESCRIPTION**

A. Provide commercial rubber flooring composed of 100% synthetic rubber (styrene butadiene), the finest quality mineral aggregates, organic stabilizing agents, plus high quality fade resistant pigmentation.

## **1.6 QUALITY ASSURANCE**

A. Qualifications of Installers: Use only personnel who are thoroughly trained and experienced in the skills required and completely familiar with the requirements established for this work and are approved by flooring manufacturer.

## **1.7 SUBMITTALS**

A. Manufacturer's Data: Submit manufacturer's technical information and installation instructions for type of resilient sheet flooring required.

B. Samples: Submit samples of resilient sheet flooring in selected color. Provide 12" square samples to illustrate the range of color and pattern variation.

C. Maintenance Instructions: Submit 2 copies of manufacturer's written instructions for recommended maintenance practices for each type of resilient sheet flooring.

## **1.8 DELIVERY AND STORAGE**

A. Materials must be delivered in manufacturer's original, unopened and undamaged containers with identification labels intact.

B. Store material protected from exposure to harmful weather conditions, on a clean, dry, flat surface protected from all possible damage.

C. Recommended environmental conditions for storage is a minimum of 55 deg F.

D. Material should not suffer excessive damage during handling (i.e. edge chipping, excessive warping, etc)

## **1.9 JOB CONDITIONS**

A. Maintain a stable room and subfloor temperature of 65 to 80 deg F for a period of 48 hrs prior, during and 48 hrs after installation.

B. Moisture vapor emission content of the concrete slab must not exceed 3 lbs/1000 ft<sup>2</sup> per 24 hrs when using the calcium chloride test per ASTM F 1869.

## **PART 2 PRODUCTS**

### **2.1 SHEET RUBBER FLOORING MATERIALS**

- A. Product/Manufacturer: Subject to compliance with requirements, provide products manufactured by Thor Performance Products or approved equal.
  - 1. Basis for Project Design: "Thor rolled rubber" by Thor Performance Products
  - 2. Other Manufacturers:
    - Ecosurfaces
    - Roppe
    - Or approved equal.
- B. Product Description: Prefabricated commercial rubber flooring composed of 100% synthetic virgin rubber (styrene butadiene), mineral aggregates, organic stabilizing agents, plus high quality fade-resistant pigmentation.
  - 1. Total Thickness: 9mm in locations specified in drawings and 12mm in locations specified in drawings, see finish schedule
  - 2. Weight: 2.0 lb/ft<sup>2</sup> where 9mm and 2.6 lb/ft<sup>2</sup> where 12mm.
  - 3. Size: 48" wide rolls
- C. Colors: as indicated on the drawings.

### **2.2 ACCESSORIES**

- A. Adhesives: one or two component polyurethane, moisture cured capable of installation at a minimum of 85% RH and recommended by the flooring manufacturer.
- B. Leveling Compound: Latex/Portland cement flash patching and leveling compound equal to No. 226 with 3701 admixture made by Laticrete or equal made by Mapei, H.B. Fuller, or approved equal.
  - 1. Install with primer recommended in writing by leveling compound manufacturer.

## **PART 3 EXECUTION**

### **3.1 INSPECTION**

- A. Examine the areas and conditions where resilient athletic flooring is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

### **3.2 PREPARATION**

- A. Subfloors: Prior to start of laying the sheet flooring, broom clean or vacuum all surfaces to be covered.
  - 1. Lightly grind concrete subfloors with a terrazzo grinder to remove any trowel marks or other surface irregularities which will telegraph to the sheet flooring surface. If grinding is not required, acid etch floor with 10 percent muriatic acid as required to

remove any curing compound that would interfere with adhesive bond.

2. Use leveling compound as recommended by sheet flooring manufacturer for filling small cracks and depressions in subfloors.
  3. Subfloor shall be level to  $\pm 1/8"$  in 10'-0" distance and 1/4" total maximum variation from level shown.
  4. Perform moisture tests on concrete slabs to determine that concrete surfaces are sufficiently cured and are ready to receive flooring installation. Minimum three test locations for the first 1000gsf, and an additional test for every additional 1000gsf. Testing to be performed per ASTM F2170 for RH.
- B. Concrete Primer: Apply concrete slab primer if recommended by the sheet flooring manufacturer, prior to application of the adhesive. Apply in compliance with manufacturer's directions.

### **3.3 INSTALLATION OF SHEET FLOORING**

- A. Install sheet flooring only after all finishing operations, including painting, have been completed and permanent heating system is operating. Moisture content of concrete slabs, building air temperature and relative humidity must be within limits recommended by sheet flooring manufacturer.
- B. Flooring shall be installed to a tolerance of 1/8" in 10'-0" run; 1/32" offset at any location.
- C. Place sheet flooring with adhesive cement in strict compliance with the manufacturer's recommendations. Butt tightly to vertical surfaces, thresholds, nosings and edgings. Scribe around obstructions and to produce neat joints, laid tight, even and in straight, parallel lines. Extend sheet flooring into toe spaces, door reveals, and into closet and similar openings.
- D. Lay sheet flooring to substrate without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, or other surface imperfections.
- E. Lay sheet flooring to provide as few seams as possible. Match edges for color shading and pattern at seams in compliance with the manufacturer's recommendations, such as reversing adjoining sheets of the same roll, so that abutting edges are from the same edge of the roll.

### **3.4 CLEANING AND PROTECTION**

- A. Remove any excess adhesive or other surface blemishes from flooring, using neutral type cleaners as recommended by the flooring manufacturer. Protect installed flooring from damage by use of heavy Kraft paper or other covering.
- B. Finishing: After completion of the project and just prior to the final inspection of the work, thoroughly clean flooring.

**END OF SECTION**

## SECTION 096616 - PRECAST TERRAZZO TREADS AND RISERS

### PART 1 GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. Work of this Section, as shown or specified, shall be in accordance with the Contract Documents.

#### 1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the terrazzo as shown on the drawings and specified herein, including, but not limited to, the following:
  - 1. Precast terrazzo stair treads with risers and landing panels.
  - 2. Setting bed.
  - 3. Accessories.

#### 1.3 RELATED SECTIONS

- A. Cast-in-Place Concrete - Section 033000.

#### 1.4 REFERENCES

- A. *National Terrazzo and Mosaic Association, inc*
- B. *ASTM: C-150, C-33, C-140, C-293, C-12028*
- C. TCNA - Handbook for Ceramic, Glass and Stone Tile Installation; Tile Council of North America, latest 2013 Edition.
- D. ISO 13007 - International Standards Organization; classification for Grout and Adhesives.
- E. Stone Tile: Conform to requirements of MIA (Marble Institute of America) Dimension Stone Design Manual and ASTM C 1242.

#### 1.5 SYSTEM DESCRIPTION

- A. Performance Requirements
  - 1. Compressive Strength at the time of delivery to be not less than 10,000 psi, averaging 7,000psi when tested in accordance with ASTM C 140.
  - 2. Water Absorption shall not be greater than 5-1/2% to 6-1/2% when tested in accordance with ASTM C 293.
  - 3. Flexural Strength shall not be less than 3,000 psi, averaging,
  - 4. DCOF minimum 0.42.:

**1.6 QUALITY ASSURANCE**

- A. Setting and Grouting Materials: Provide material obtained from one source for each type and color of grout and setting materials.
- B. TCA Standards: Comply with specified provisions and recommendations of Tile Council of America (TCA).
- C. Manufacturer's Instructions: In addition to specified requirements, comply with precast terrazzo manufacturer's instructions and recommendations for substrate preparation, materials storage, mixing and application, finishing and curing.
- D. Qualifications: Precast Terrazzo Manufacturer and Trade Contractor must have a minimum of five (5) years of successful experience on projects of similar magnitude and complexity to that indicated for this project.
- E. Trade contractor to use only trained qualified tile setters for precast terrazzo installation.
- F. Manufacturer to supply a written Quality Assurance Program and Procedure Manual.

**1.7 SUBMITTALS**

- A. Samples: Submit 1'-0" square samples of each pattern, color and type of precast terrazzo required, including grout colors. Minimum 6" long samples of each type accessory item.
- B. Product Data: Manufacturer's specifications and technical data for system including:
  - 1. Installation Instructions: Precast Terrazzo Installation as recommended by TCA standards.
  - 2. Test Reports: Submit test reports from all testing required by Article 1.6 herein.
  - 3. Maintenance Instructions: Submit two copies of written instructions for recommended periodic maintenance of each type of precast terrazzo.

**1.8 TESTING**

- A. The manufacturer of the precast terrazzo tile shall perform independent testing for slip resistance per ASTM C 1028 and shall submit results of such test to the Architect.
- B. The Owner shall retain the services of an Independent Testing Laboratory to test the precast terrazzo tile for slip resistance in accordance with ASTM C 1028. The Contractor shall provide necessary material for testing and shall coordinate with the testing Laboratory as required. The Testing Laboratory shall submit results of the tests to the Owner, Architect and Contractor.

**1.9 DELIVERY, STORAGE AND HANDLING**

- A. Packaging and Shipping: Precast terrazzo to be stretch wrapped in rows and banded on pallets, delivered in original unopened packaging with legible manufacturer identification, including size, quantity, manufacture date and inspection initials.
- B. Storage and Protection: Precast terrazzo to be stored indoors, sheltered from moisture in original packaging. Protect from damage by other trades.

**1.10 PROJECT CONDITIONS**

- A. Inspect surfaces to receive precast but do not proceed with installation of precast terrazzo until

improper conditions have been corrected.

- B. Provide temperatures in precast terrazzo areas during installation and after completion as required by installation standard or manufacturer's instructions, but not less than 50 degrees F.
- C. If necessary to use temporary heaters, vent units to exterior to protect precast terrazzo work from carbon dioxide accumulation.

#### 1.11 MAINTENANCE

- A. Extra Materials: Deliver supply of maintenance materials to the Owner. Furnish maintenance materials from same lot as materials installed, and enclosed in protective packaging with appropriate identifying labels.
  - 1. Furnish not less than 1 percent of total product installed maintenance stock for each type, color, pattern and size of precast terrazzo product installed.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Aggregates: All aggregates to meet ASTM C 33 specifications, cleaned and properly graded to size. Aggregate shall be blended to meet individual project requirements.
- B. Coloring: Pigments used shall be inorganic, resistant to alkalinity and used per manufacturer's recommendations.
- C. Color Blending: Factory blend precast terrazzo that has a natural color range so products taken from one container will have the same range as products from a separate container. Pallets to be marked and shipped numerically. Install tile from pallets in a numerical sequence blending from two to three pallets.
- D. Stair Treads with Risers and landings: TCNA S-151.
- E. Setting Materials: Epoxy Adhesive non-staining on white and light-color marble with high bond strength conforming to ISO13007 with a R2 classification
  - 1. Basis of design Latapoxy 300 as manufactured by Laticrete or approved equal
- F. Grouting Materials
  - 1. High performance epoxy grout: 100% epoxy grout comply with ANSI A118.3, Iso 13007-3 RG
    - a. Basis of Design: Spectralock pro premium grout as manufactured by Laticrete or approved equal
  - 2. Grout Colors: To be determined by Architect, based upon final selection of colors for precast terrazzo. May require a custom color if satisfactory color is not available in manufacturer's standard range.
- G. Cleaner: Liquid neutral chemical cleaner with pH factory between 7 and 8, of formulation recommended by sealer manufacturer for type of precast terrazzo used, and complying with NTMA requirements.

- H. Impregnator: Colorless, slip and stain resistant penetrating impregnator that does not affect color or physical properties of precast terrazzo surface. Flash point (ASTM D 56): 80 degrees F., minimum. Provide terrazzo impregnator equal to "Stone Impregnator O.R." made by Vic International Corp.
- I. Abrasive Inserts: Shall consist of silica carbide and black epoxy. In number of lines indicated on drawings and extending the full width of the tread
- J. Caulks and Sealants: Urethane or polyurethane sealant as recommended by tread and riser manufacturer.
  - 1. Color to be selected by architect from full color range

## 2.2 MIXES

- A. Aggregate: Natural, sound, crushed marble chips without excessive flats or flakes complying with NTMA requirements.
- B. Matrix Pigments: Pure mineral or synthetic pigments, resistant to alkalis and non-fading. Mix pigments with matrix to provide required colors.
- C. Face layer shall include 70% coverage of the precast terrazzo face with marble aggregate.

## 2.3 PRECAST TERRAZZO STAIR TREADS WITH RISERS AND LANDINGS

- A. Provide precast terrazzo stair treads and risers as detailed on drawings with abrasive nosings consisting of aluminum oxide or silicone carbide; as manufactured by Wausau Tile, or approved equal from Concrete Collaborative or approved equal; color as selected by the Architect or as indicated on drawings.
  - 1. Basis of Design: Precast terrazzo E-31 epoxy tread and riser or approved equal
- B. Comply with NTMA specifications and recommendations for fabrication of precast terrazzo. Reinforce all precast terrazzo units.
- C. Match color and pattern of precast work with color and pattern of cast in place work, unless different color and pattern required.
- D. Materials shall conform to the requirements specified above in Para. 2.1.
- E. Furnish all inserts, anchors and accessories required for complete installation.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrate conditions over which terrazzo tile will be installed. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Before installing terrazzo tile, clean substrates to remove dust, debris, sealers, coatings, oil, curing compounds, and loose particles.
- B. Ascertain that substrates are free of previous surface-applied material. Prepare substrate



surfaces to accept new material.

1. Use trowelable leveling and patching compounds per tile-setting material manufacturer's written instructions to fill cracks, holes, and depressions.
  2. Remove protrusions, bumps, and ridges by sanding or grinding.
- C. Illuminate areas of installation using building's permanent lighting system; temporary lighting alone will not be acceptable.
- D. Verify that materials are those specified before installing.

### 3.3 INSTALLATION TOLERANCES

- A. Variations from Plumb: For surfaces of columns and walls, as well as for arrises, external corners, joints, and other conspicuous lines, do not exceed 1/8 inch in 8 feet.
- B. Variation in Level: For grades shown on counters, horizontal joints, and other conspicuous lines, do not exceed 1/8 inch in any room.
- C. Variation in Surface Plane of Flooring: Do not exceed 1/8" in 10'-0" from level or slope indicated when tested with a 10-foot straight edge.

### 3.4 INSTALLATION OF PRECAST TERRAZZO

- A. Install precast terrazzo as shown in accordance with NTMA specifications. Tamp units into setting bed to achieve a full bond without voids. Level units at joints. Finish grind at joints if required to remove any minor discrepancies in level of units. Replace warped, stained, damaged and non-matching units as directed. Grout joints with a mixture of Portland cement, pigment and water, matching the matrix of the joints.

### 3.5 ADJUSTING AND CLEANING

- A. Remove and replace material that is broken, chipped, stained, or otherwise damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in manner to eliminate evidence of replacement.
- B. Clean terrazzo tiles after setting with MiraSeal "MiraClean #1." Or approved equal. Use procedures recommended by tile manufacturer for types of application indicated.
- C. Apply one coat of sealer to cleaned terrazzo tile flooring. Use product compatible with cement terrazzo, and follow sealer manufacturer's guidelines.

### 3.6 PROTECTION

- A. Prohibit traffic from terrazzo tile after installation is completed for at least 7 days.
- B. Protect terrazzo tile flooring during construction period with Kraft paper or other heavy covering or type that will not stain or discolor tile.
- C. Before inspection for Substantial Completion, remove protective covering and clean surfaces using procedures and materials recommended by tile and accessory manufacturers.

END OF SECTION

## SECTION 09 6813 - TILE CARPETING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Modular carpet tile.
  - 2. Carpet accessories.
  - 3. Substrate preparation for carpet and accessories.

#### 1.2 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For carpet tile installation, plans showing the following:
  - 1. Carpet tile type, color, and dye lot.
  - 2. Type of installation.
  - 3. Pattern of installation.
  - 4. Pattern type, location, and direction.
  - 5. Pile direction.
  - 6. Type, color, and location of insets and borders.
  - 7. Type, color, and location of edge, transition, and other accessory strips.
  - 8. Transition details to other flooring materials.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
  - 1. Carpet Tile: Full-size Sample.
  - 2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch-long Samples
- D. Moisture Testing results, see moisture testing requirements below.
- E. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
  - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
  - 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Sample warranty.

**1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: Certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

**1.6 EXTRA MATERIALS:**

Provide minimum 5% area installed in full-size units for each carpet type from same dye-lot as installed product but not less than 10 square yards.

- 1. If multiple dye-lots are used in separate spaces, identify locations and provide extra material in amount indicated above for each dye-lot.

**1.7 DELIVERY, STORAGE AND HANDLING**

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

**1.8 PROJECT CONDITIONS:**

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:
  - 1. 48 hours before installation.
  - 2. During installation.
  - 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor tile installation, and for 48 hours after floor tile installation or as recommended by manufacturer.
- D. Install after other finishing operations, including painting, have been completed.

**1.9 WARRANTY**

Special Carpet Warranty: Written warranty, signed by carpet manufacturer agreeing to replace carpet that does not comply with requirements or that fails within specified warranty period. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, and delamination.

- 1. Warranty Period: Ten years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 CARPET TILE (WOT1 as defined in the finish schedule)

- A. Color, Pattern, Source: refer to the drawings and finish schedule for basis of design
- B. Fiber Content, type, pile characteristic, yarn twist, yarn count, and density: to match or exceed basis of design
- C. Size: as indicated on the drawings
- D. Dye Method: solution dyed
- E. GSA Stain release rating: Pass
- F. Applied Treatments:
  - 1. Soil-Resistance Treatment: Manufacturer's standard treatment.
  - 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
    - a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
- G. Performance Characteristics:
  - 1. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D7330.
  - 2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm according to NFPA 253.
  - 3. Dry Breaking Strength: Not less than 100 lbf according to ASTM D2646.
  - 4. Tuft Bind: Not less than 5 lbf for cut pile, 10 lbf for loop pile according to ASTM D1335.
  - 5. Delamination: Not less than 3.5 lbf/in. according to ASTM D3936.
  - 6. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
  - 7. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
  - 8. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
  - 9. Colorfastness to Light: Not less than 4 after 40 AFU (AATCC fading units) according to AATCC 16, Option E.
  - 10. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.

### 2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation
  - 1. VOC Limits: Provide adhesives with VOC content not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).
  - 2. Capable of moist

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

#### **A. Concrete Slabs:**

1. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
  - a. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement or as recommended by tile and adhesive product requirements.
  - b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

### **3.2 PREPARATION**

- A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

### **3.3 INSTALLATION**

- A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive unless indicated otherwise on drawings
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns recommended in writing by carpet tile manufacturer.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.
- I. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 6813

## SECTION 09 7200 - WALL COVERINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Wall Coverings (WC1)
  - 2. Digital printed vinyl wall coverings (DWC1 & DWC2)
  - 3. Wall liners for installation under wall coverings

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include data on physical characteristics, durability, fade resistance, and flame-resistance characteristics.
- B. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement, seams and termination points.
- C. Samples for Verification: Full width by 36-inch- long section of wall covering.
  - 1. Sample from same print run or dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of fabric.
  - 2. Provide full width x 36" long printed full scale mockup for each digitally printed wall covering.
- D. Qualification Data: For qualified testing agency.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for wall covering.
- F. Maintenance Data: For wall coverings to include in maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Surface-Burning Characteristics: As follows, per ASTM E 84:
    - a. Flame-Spread Index: 25 or less.
    - b. Smoke-Developed Index: 450 or less.
  - 2. Fire-Growth Contribution: Textile wall coverings tested according to NFPA 265, or NFPA 286 and complying with test protocol and criteria of UBC Standard 8-2, or in the 2003 IBC, as applicable.

- B. Mockup: Build mockup to verify selection made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
  - 1. Build mockup for each type of wall covering on each substrate. Comply with requirements in ASTM F 1141.
  - 2. Architect to approve seam matching of wall coverings.
  - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install wall coverings until wet work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Lighting: Do not install wall covering until a permanent level of lighting is provided on the surfaces to receive wall covering.
- C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

## PART 2 - PRODUCTS

### 2.1 WALL COVERINGS:

- A. Manufacturers: Subject to compliance with requirements, provided wall coverings as follows:
  - 1. See the finish schedule:
    - Carnegie Fabrics (basis of Design) Xorel type covering or approved equal from Wolf-Gordon, Astek, or approved equal

### 2.2 DIGITALLY PRINTED VINYL WALL COVERING

- A. Manufacturers: Subject to compliance with requirements, provide wall coverings as follows:
  - 1. Surface Materials (Basis of Design)
  - 2. Wolf-Gordon
  - 3. Astek
  - 4. Or approved equal
- B. Products: Refer to Finish Schedule on Drawings for products and visual appearance of graphics to be printed and installed

### 2.3 ACCESSORIES

- A. Adhesive: Mildew-resistant, non-staining, strippable adhesive, for use with specific wall covering and substrate application; as recommended in writing by wall-covering manufacturer and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 1. Adhesive: "Sure Grip Plus Mold and Mildew-Proof Commercial Wall Covering Adhesive" made by The Zinsser Co. Inc. or approved equal.
- B. Primer/Sealer: Mildew resistant, complying with requirements in Division 9 Section "Interior Painting" and recommended in writing by wall-covering manufacturer for intended substrate.



- C. Wall Liner: Nonwoven, synthetic underlayment and adhesive as recommended by wall-covering manufacturer.
- D. Seam Tape: As recommended in writing by wall-covering manufacturer.
- E. Metal Primer: Where required, provide interior ferrous metal primer complying with Division 9 Section "099000 Painting & Coatings."

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for levelness, wall plumbness, maximum moisture content, and other conditions affecting performance of the Work.

#### **3.2 Proceed with installation only after unsatisfactory conditions have been corrected**

#### **3.3 PREPARATION**

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.
- C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
  - 1. Moisture Content: Maximum of 5 percent when tested with an electronic moisture meter.
  - 2. Metals: If not factory primed, clean and apply metal as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
  - 3. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
  - 4. Painted Surfaces: Treat areas susceptible to pigment bleeding.
- D. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.
- E. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.
- F. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.
- G. Install wall liner, with no gaps or overlaps, where required by wall-covering manufacturer. Form smooth wrinkle-free surface for finished installation. Do not begin wall-covering installation until wall liner has dried.

#### **3.4 INSTALLATION**

- A. General: Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated except where more stringent requirements apply.
- B. Cut wall-covering strips in roll number sequence. Change roll numbers at partition breaks and corners.
- C. Install strips in same order as cut from roll.
- D. Install wall covering with no gaps or overlaps, no lifted or curling edges, and no visible shrinkage.
- E. Match pattern 72 inches above the finish floor.
- F. Install seams vertical and plumb at least 6 inches from outside corners and 6 inches from inside corners unless a change of pattern or color exists at corner. No horizontal seams are permitted.
- G. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.
- H. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without any overlay or spacing between strips.

### 3.5 CLEANING

- A. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.
- B. Use cleaning methods recommended in writing by wall-covering manufacturer.
- C. Replace strips that cannot be cleaned.
- D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

### 3.6 WALL COVERING SCHEDULE

- A. General: Provide wall coverings as indicated on the Drawings and Finish Schedules.

END OF SECTION 09 7200

## SECTION 09 9000 - PAINTS AND COATINGS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Interior and exterior paint and coating commercial systems including surface preparation.

#### 1.2 REFERENCES

- A. Steel Structures Painting Council (SSPC):
  - 1. SSPC-SP 1 - Solvent Cleaning.
  - 2. SSPC-SP 2 - Hand Tool Cleaning.
  - 3. SSPC-SP 3 - Power Tool Cleaning.
  - 4. SSPC-SP 13 / NACE No. 6 Surface Preparation for Concrete.
- B. Material Safety Data Sheets / Environmental Data Sheets: Per manufacturer's MSDS/EDS for specific VOCs (calculated per 40 CFR 59.406). VOCs may vary by base and sheen.

#### 1.3 SUBMITTALS

- A. Product Data: For each paint system indicated, including.
  - 1. Product characteristics.
  - 2. Surface preparation instructions and recommendations.
  - 3. Primer requirements and finish specification.
  - 4. Storage and handling requirements and recommendations.
  - 5. Application methods.
  - 6. Cautions for storage, handling and installation.
- B. Verification Samples: For each finish product specified, submit samples that represent actual product, color, and sheen.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Paint exposed surfaces. If a color of finish, or a surface is not specifically mentioned, Architect will select from standard products, colors and sheens available.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels unless indicated.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver manufacturer's unopened containers to the work site. Packaging shall bear the manufacturer's name, label, and the following list of information.
  - 1. Product name, and type (description).
  - 2. Application and use instructions.

3. Surface preparation.
  4. VOC content.
  5. Environmental handling.
  6. Batch date.
  7. Color number.
- B. Storage: Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.
- C. Store materials in an area that is within the acceptable temperature range, per manufacturer's instructions. Protect from freezing.
- D. Handling: Maintain a clean, dry storage area, to prevent contamination or damage to the coatings.

## 1.6 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

## 1.7 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
- B. Furnish Owner with an additional one percent of each material and color, but not less than 2 gallons of each product, color, and sheen, including primers and intermediate coat products. Provide as un-catalyzed product in separate containers, Part-A & Part-B where applicable

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Sherwin-Williams
- B. Other Manufacturers:
1. PPG
  2. Benjamin Moore
  3. Approved Equal

### 2.2 APPLICATIONS/SCOPE

- A. Interior Paint and Coating Commercial Systems:
1. Masonry: Concrete masonry units, including split-face, scored, and smooth block.
  2. Metal: Aluminum, galvanized steel.
  3. Metal: Structural steel, joists, trusses, beams, partitions and similar items.
  4. Drywall: Drywall board, Gypsum board.
- B. Interior Paint and Coating Healthcare Systems:
1. Concrete: Non-vehicular floors.

## 2.3 PAINT MATERIALS - GENERAL

- A. Paints and Coatings:
  - 1. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
  - 2. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color. Or follow manufacturer's product instructions for optimal color conformance.
- B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
- C. Coating Application Accessories: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required, per manufacturer's specifications.
- D. Color: Refer to Finish Schedule for paint colors, and as selected.

## 2.4 PAINT AND COATING COMMERCIAL SYSTEMS

- A. Masonry CMU:
    - 1. Vinyl Acrylic Latex over filler
      - a. Eg-Shel/Low Luster Finish:
        - 1) 1st Coat: S-W Pro Industrial Heavy-Duty Block Filler, B42W150 (75-125sq f/gal)
        - 2) 2nd Coat: S-W ProMar200 HP Zero VOC Interior Latex Eg-shel, B20-1950 series
        - 3) 3rd Coat: S-W ProMar200 HP Zero VOC Interior Latex Eg-shel, B20-1950 series (4.0 mils wet, 1.7 mils dry per coat).
        - 4) Or approved equal 3 coat system by approved equal manufacturer
- B. Masonry CMU walls within the Natatorium, Pool Mechanical Room, and Chem Storage rooms
  - 1. Eg-Shel/Low Luster Finish:
    - a. 1<sup>st</sup> coat: S-W Loxon Acrylic Block Surface LX01W020 (50-100sf/gal)
    - b. 2<sup>nd</sup> Coat: S-W Pro Industrial Waterbased Catalyzed Epoxy, B73 Series(5.0-12.0 mils wet, 2.0-4.9 mils dry)
    - c. 3<sup>rd</sup> Coat: S-W Pro Industrial Waterbased Catalyzed Epoxy, B73 Series(5.0-12.0 mils wet, 2.0-4.9 mils dry)
    - d. Or approved equal 3 coat system by approved equal manufacturer
- C. Interior and Exterior Hollow Metal Doors and Frames, loose lintels, bearing plates, other Miscellaneous Aluminum, Galvanized, and ferrous metals:
  - 1. Latex Systems:
    - a. Eg-Shel / Satin Finish High Performance:
      - 1) 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series (5.0 mils wet, 2.0 mils dry).
      - 2) 2nd Coat: S-W Pro Industrial Acrylic Eg-Shel, B66-660 Series. (2.0-4.0 mils dry per coat).
      - 3) 3rd Coat: S-W Pro Industrial Acrylic Eg-Shel, B66-660 Series (2.0-4.0 mils dry per coat).

- 4) Or approved equal 3 coat system by approved equal manufacturer
- D. Painted exposed ceilings & Structural Steel Columns where high-performance coating not specified: (exposed ceilings to include Joists, Trusses, Beams, Miscellaneous and Ornamental Iron, Structural Iron, Ferrous Metal, conduit, ductwork, fire sprinkler piping, compressed air piping and all other ceiling mounted components).
  1. Dryfall Waterborne Topcoat:
    - a. Flat Finish:
      - 1) 1st Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series (5.0 mils wet, 2.0 mils dry).
      - 2) 2nd Coat: S-W Pro Industrial Waterborne Acrylic Dryfall, B42-181 Series.
      - 3) 3rd Coat: S-W Pro Industrial Waterborne Acrylic Dryfall, B42-181 Series (6.0 mils wet, 1.7 mils dry per coat).
      - 4) Or approved equal 3 coat system by approved equal manufacturer
- E. Gypsum board: Walls, Ceilings, Gypsum Board and similar items.
  1. Latex Systems:
    - a. Eg-Shel / Satin Finish:
      - 1) 1st Coat: S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600 (4 mils wet, 1.5 mils dry).
      - 2) 2nd Coat: S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series.
      - 3) 3rd Coat: S-W ProMar 200 HP Zero VOC Latex Eg-Shel, B20-2600 Series (4 mils wet, 1.7 mils dry per coat).
      - 4) Or approved equal 3 coat system by approved equal manufacturer
- F. Concrete Floors:
  1. Water-Based Solid Color Stain System:
    - a. Matte Finish:
      - 1) 1st Coat: Acid etch surface using H&C ConcreteReady Etching Solution.
      - 2) 2nd Coat: H&C Colortop Water Based solid color stain
      - 3) 3<sup>rd</sup> Coat: H&C Colortop Water Based solid color stain
      - 4) Or approved equal 2 coat system by approved equal manufacturer

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared; notify Architect of unsatisfactory conditions before proceeding. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- B. Proceed with work only after conditions have been corrected and approved by all parties, otherwise application of coatings will be considered as an acceptance of surface conditions.
- C. Previously Painted Surfaces: Verify that existing painted surfaces do not contain lead based paints, notify Architect immediately if lead based paints are encountered.

### 3.2 SURFACE PREPARATION

- A. General: Surfaces shall be dry and in sound condition. Remove oil, dust, dirt, loose rust,

peeling paint or other contamination to ensure good adhesion. Prepare surfaces based on manufacturer recommendations and with compatible primers.

1. Prior to attempting to remove mildew, it is recommended to test any cleaner on a small, inconspicuous area prior to use. Bleach and bleaching type cleaners may damage or discolor existing paint films. Bleach alternative cleaning solutions are advised.
  2. Remove mildew before painting by washing with a solution of 1 part liquid household bleach and 3 parts of warm water. Apply solution and scrub the mildewed area. Allow solution to remain on the surface for 10 minutes. Rinse thoroughly with clean water and allow surface to dry before painting. Wear protective glasses or goggles, waterproof gloves, and protective clothing. Quickly wash off any of the mixture that comes in contact with your skin. Do not add detergents or ammonia to the bleach/water solution.
  3. Remove items including but not limited to thermostats, electrical outlets, switch covers and similar items prior to painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
  4. No exterior painting should be done immediately after a rain, during foggy weather, when rain is predicted, or when the temperature is below 50 degrees F (10 degrees C), unless products are designed specifically for these conditions. On large expanses of metal siding, the air, surface and material temperatures must be 50 degrees F (10 degrees F) or higher to use low temperature products.
- B. Aluminum: Remove all oil, grease, dirt, oxide and other foreign material by cleaning per SSPC-SP1, Solvent Cleaning.
- C. Block (Cinder and Concrete): Remove all loose mortar and foreign material. Surface must be free of laitance, concrete dust, dirt, form release agents, moisture curing membranes, loose cement, and hardeners. Concrete and mortar must be cured at least 30 days at 75 degrees F (24 degrees C). Test concrete to verify pH of the surface is between 6 and 9 unless the products are designed to be used in high pH environments. On poured-in-place concrete, provide commercial detergents and abrasive blasting as necessary to prepare the surface. Fill bug holes, air pockets, and other voids with a cement patching compound.
- D. Concrete, SSPC-SP13 or NACE 6: This standard gives requirements for surface preparation of concrete by mechanical, chemical, or thermal methods prior to the application of bonded protective coating or lining systems. The requirements of this standard are applicable to all types of cementitious surfaces including cast-in-place concrete floors and walls, precast slabs, masonry walls, and shotcrete surfaces. An acceptable prepared concrete surface should be free of contaminants, laitance, loosely adhering concrete, and dust, and should provide a sound, uniform substrate suitable for the application of protective coating or lining systems.
- E. Stainless Steel: Remove all oil, grease, dirt, oxide and other foreign material by cleaning per SSPC-SP 2, Hand Tool Cleaning.
- F. Drywall - Interior: Must be clean and dry. All nail heads must be set and spackled. Joints must be taped and covered with a joint compound. Spackled nail heads and tape joints must be sanded smooth and all dust removed prior to painting.
- G. Interior Galvanized Metal: Aged 6 months or greater from galvanization, clean per SSPC-SP1 using detergent and water or a degreasing cleaner to remove greases and oils. Apply a

test area, priming as required. Allow the coating to dry at least one week before testing.

- H. Steel: Structural, Plate, And Similar Items: Should be cleaned by one or more of the surface preparations described below. These methods are used throughout the world for describing methods for cleaning structural steel. Visual standards are available through the Society of Protective Coatings. A brief description of these standards together with numbers by which they can be specified follow.
  - 1. If no visible rust observed provide Solvent Cleaning, SSPC-SP1: Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants. Solvent cleaning does not remove rust or mill scale. Change rags and cleaning solution frequently so that deposits of oil and grease are not spread over additional areas in the cleaning process. Be sure to allow adequate ventilation.
  - 2. If rust observed: provide Power Tool Cleaning, SSPC-SP3: Power Tool Cleaning removes all loose mill scale, loose rust, and other detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Before power tool cleaning, remove visible oil, grease, soluble welding residues, and salts by the methods outlined in SSPC-SP1.
- I. Wood: Must be clean and dry. Prime and paint as soon as possible. Knots and pitch streaks must be scraped, sanded, and spot primed before a full priming coat is applied. Patch all nail holes and imperfections with a wood filler or putty and sand smooth.

### 3.3 INSTALLATION

- A. Apply all coatings and materials with the manufacturer's specifications in mind. Mix and thin coatings according to manufacturer's recommendations.
- B. Do not apply to wet or damp surfaces. Wait at least 30 days before applying to new concrete or masonry. Or follow manufacturer's procedures to apply appropriate coatings prior to 30 days. Test new concrete for moisture content and PH. Wait until wood is fully dry after rain or morning fog or dew.
- C. Apply coatings using methods recommended by manufacturer, including recommendations for surface preparation.
- D. Uniformly apply coatings without runs, drips, or sags, without brush marks, and with consistent sheen.
- E. Apply coatings at spreading rate required to achieve the manufacturers recommended dry film thickness.
- F. Regardless of number of coats specified, apply as many coats as necessary for complete hide, and uniform appearance.
- G. Inspection: The coated surface must be inspected and approved by the Architect just prior to the application of each coat.

### 3.4 PROTECTION

- A. Protect finished coatings from damage until completion of project.
- B. Touch-up damaged coatings after substantial completion, following manufacturer's



recommendation for touch up or repair of damaged coatings. Repair any defects that will hinder the performance of the coatings.

END OF SECTION

## **SECTION 09 9600 - HIGH PERFORMANCE COATINGS**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Exterior high-performance paint and coatings systems including surface preparation.

#### **1.2 RELATED SECTIONS**

- A. Section 05 1200 – Structural Steel Framing
- B. Section 05 50 00 - Metal Fabrications.

#### **1.3 REFERENCES**

- A. Steel Structures Painting Council (SSPC):
  - 1. SSPC-SP 1 - Solvent Cleaning.
  - 2. SSPC-SP 16 Brush-off blast cleaning of non-ferrous metals
  - 3. SSPC-SP 6 Commercial blast cleaning for non-galvanized structural steel.
- B. Material Safety Data Sheets / Environmental Data Sheets: Per manufacturer's MSDS/EDS for specific VOCs (calculated per 40 CFR 59.406). VOCs may vary by base and sheen.

#### **1.4 SUBMITTALS**

- A. Product Data: For each paint system indicated, including.
  - 1. Product characteristics.
  - 2. Surface preparation instructions and recommendations.
  - 3. Primer requirements and finish specification.
  - 4. Storage and handling requirements and recommendations.
  - 5. Application methods.
  - 6. Cautions for storage, handling and installation.
- B. Verification Samples: For each finish product specified, submit samples that represent actual product, color, and sheen.

#### **1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Paint exposed surfaces including fasteners. If a color of finish, or a surface is not specifically mentioned, Architect will select from standard products, colors and sheens available.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels unless indicated.
- D. Coordinate installation of conduit and lighting fixtures,
  - 1. Conduit, junction boxes, fasteners & bolts to be painted to match adjacent steel
  - 2. prefinished light fixtures to remain unpainted.

- E. In-Place Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship and to ensure proper adhesion. Mockup may remain if determined to be acceptable by architect.
  - 1. Finish surfaces for verification of products, colors and sheens.
  - 2. Finish area minimum one column and one beam.
  - 3. Provide samples that designate primer and finish coats.
  - 4. Do not proceed with remaining work until the Architect approves the mock-up.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver manufacturer's unopened containers to the work site. Packaging shall bear the manufacturer's name, label, and the following list of information.
  - 1. Product name, and type (description).
  - 2. Application and use instructions.
  - 3. Surface preparation.
  - 4. VOC content.
  - 5. Environmental handling.
  - 6. Batch date.
  - 7. Color number.
- B. Storage: Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.
- C. Store materials in an area that is within the acceptable temperature range, per manufacturer's instructions. Protect from freezing.
- D. Handling: Maintain a clean, dry storage area, to prevent contamination or damage to the coatings.

#### 1.7 PROJECT CONDITIONS

- A. Proceed with installation only when environmental conditions (temperature, humidity, and ventilation) are within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits for a period not less than the cure time of product being installed.

#### 1.8 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
- B. Furnish Owner with one gallon of each material and color including primers, intermediate coats and top coats. Provide in un-catalyzed form as separate components (part a and part b) where applicable.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Sherwin-Williams
- B. Other Manufacturers:

1. Tnemec
2. PPG
3. Approved equal

## 2.2 APPLICATIONS/SCOPE

- A. High Performance Exterior Paint and Coating Systems:
1. Metal: Aluminum, galvanized steel.
  2. Metal: Ferrous Steel

## 2.3 PAINT MATERIALS - GENERAL

- A. Paints and Coatings:
1. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
  2. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color. Or follow manufactures product instructions for optimal color conformance.
- B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer unless otherwise noted in coating system.
- C. Coating Application Accessories: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required, per manufacturer's specifications.
- D. Color: Refer to Exterior Finish Schedule for colors, and as selected.

## 2.4 HIGH PERFORMANCE COATING SYSTEMS

- A. Ferrous Metal: Non-Galvanized Steel (HPC-1)
1. Hi-Solids Aliphatic Polyurethane System over zinc primer
    - a. Semi-Gloss Finish:
      - 1) Primer: Coat Zinc Clad IV
      - 2) 1st Coat: S-W Macropoxy 646-100 Fast Cure Epoxy, B58 Series (7.0-13.5 mils wet, 5.0-10.0 mils dry per coat).
      - 3) 2nd Coat: S-W Hi-Solids Polyurethane 250, B65 Series, (4.5-8.0 mils wet, 3.0-5.0 mils dry per coat).
      - 4) 3<sup>rd</sup> Coat: S-W Hi-Solids Polyurethane 250, B65 Series, (4.5-8.0 mils wet, 3.0-5.0 mils dry per coat).
      - 5) Or approved equal 3 coat system by approved equal manufacturer
- B. Non-Ferrous Metal: Galvanized Metal (HPC-2 & HPC-3)
1. Fluoropolymer System (Pigmented Fluoropolymer over Epoxy Intermediate and Epoxy Zinc-Rich Primer system):
    - a. Semi-Gloss Finish:
      - 1) 1st Coat: S-W Macropoxy 646-100 Fast Cure Epoxy, B58 Series (7.0-13.5 mils wet, 5.0-10.0 mils dry per coat).
      - 2) 2nd Coat: S-W Fluorokem HS 100, B65 Series, (6.0-9.0 mils wet, 4.0-6.0 mils dry per coat).

- 3) Or approved equal 2 coat system by approved equal manufacturer

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared; notify Architect of unsatisfactory conditions before proceeding. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- B. Proceed with work only after conditions have been corrected and approved by all parties, otherwise application of coatings will be considered as an acceptance of surface conditions.

### 3.2 SURFACE PREPARATION

- A. General: Surfaces shall be dry and in sound condition. Remove oil, dust, dirt, loose rust, peeling paint or other contamination to ensure good adhesion.
  - 1. Prior to attempting to remove mildew, it is recommended to test any cleaner on a small, inconspicuous area prior to use. Bleach and bleaching type cleaners may damage or discolor existing paint films. Bleach alternative cleaning solutions are advised.
  - 2. Remove mildew before painting by washing with a solution of 1 part liquid household bleach and 3 parts of warm water. Apply solution and scrub the mildewed area. Allow solution to remain on the surface for 10 minutes. Rinse thoroughly with clean water and allow surface to dry before painting. Wear protective glasses or goggles, waterproof gloves, and protective clothing. Quickly wash off any of the mixture that comes in contact with your skin. Do not add detergents or ammonia to the bleach/water solution.
  - 3. Remove items including but not limited to thermostats, electrical outlets, switch covers and similar items prior to painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
  - 4. No exterior painting should be done immediately after a rain, during foggy weather, when rain is predicted, or when the temperature is below 50 degrees F (10 degrees C), unless products are designed specifically for these conditions. On large expanses of metal siding, the air, surface and material temperatures must be 50 degrees F (10 degrees F) or higher to use low temperature products
  - 5. Repair galvanized coating where bare steel is visible. Apply zinc-rich primer as recommended by high-performance coating manufacturer.
- B. Galvanized Steel: Allow galvanized steel to weather a minimum of 6 months in exposed environment then clean per SSPC-SP1 using detergent and water or a degreasing cleaner to remove greases and oils. Apply a test area, priming recommended by system manufacturer. Allow the coating to dry at least one week before testing. If galvanized steel not allowed to weather for full duration or if adhesion is poor during testing, Brush Blast per SSPC-SP16 to profile galvanized coating and remove oil and residue.
  - 1. Solvent Cleaning, SSPC-SP1: Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants. Solvent cleaning does not remove rust or mill scale. Change rags and cleaning solution frequently so that deposits of oil and grease are not spread

over additional areas in the cleaning process. Be sure to allow adequate ventilation.

2. If required due to insufficient adhesion after weathering: Brush Blast cleaning of non-ferrous metal surfaces, SSPC-SP16: A brush-off blast cleaned non-ferrous metal surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, metal oxides (corrosion products), and other foreign matter. Intact, tightly adherent coating is permitted to remain. A coating is considered tightly adherent if it cannot be removed by lifting with a dull putty knife. Bare metal substrates shall have a minimum profile of 19 micrometers (0.75 mil)
- C. Ferrous ungalvanized steel: Shop apply primer specified within coating system is recommended. If not shop applied, steel to prepared per SSPC-SP1 removing all oil and grease from surface by solvent cleaning and then Commercial Blast cleaned per SSPC-SP6 immediate prior to installation of primer on the same day. Prior to painting on-site, Clean per SSPC-SP1 using detergent and water or a degreasing cleaner to remove greases and oils.
1. Solvent Cleaning, SSPC-SP1: Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants. Solvent cleaning does not remove rust or mill scale. Change rags and cleaning solution frequently so that deposits of oil and grease are not spread over additional areas in the cleaning process. Be sure to allow adequate ventilation.
  2. SSPC-SP6: Commercial blast cleaning allows for stains or shadows up to 33 percent of each unit area of surface to remain. SSPC-SP 6/NACE No. 3 removes all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and any other foreign matter on the surface

### 3.3 INSTALLATION

- A. Apply all coatings and materials with the manufacturer's specifications in mind. Mix and thin coatings according to manufacturer's recommendations.
- B. Do not apply to wet or damp surfaces. Wait at least 30 days before applying to new concrete or masonry. Or follow manufacturer's procedures to apply appropriate coatings prior to 30 days. Test new concrete for moisture content. Wait until wood is fully dry after rain or morning fog or dew.
- C. Apply coatings using methods recommended by manufacturer.
- D. Uniformly apply coatings without runs, drips, or sags, without brush marks, and with consistent sheen.
- E. Apply coatings at spreading rate required to achieve the manufacturers recommended dry film thickness.

- F. Regardless of number of coats specified, apply as many coats as necessary for complete hide, and uniform appearance.
- G. Inspection: The coated surface must be inspected and approved by the Architect just prior to the application of each coat.

#### **3.4 PROTECTION**

- A. Protect finished coatings from damage until completion of project.
- B. Touch-up damaged coatings after substantial completion, following manufacturer's recommendation for touch up or repair of damaged coatings. Repair any defects that will hinder the performance of the coatings.

END OF SECTION

## **SECTION 10 1100 - VISUAL DISPLAY SURFACES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

A. Work Included: The Work of this Section includes:

1. Magnetic, glass dry erase whiteboards.

#### **1.2 ACTION SUBMITTALS**

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for visual display surfaces.

1. Include individual panel weights for visual display units.

B. Shop Drawings: For visual display surfaces.

1. Include plans identify locations, elevations, and attachments to other work.
2. Show locations of panel joints.

C. Samples for Verification: For each type of visual display surface indicated.

1. Visual Display Surface: Not less than 8-1/2 by 11 inches, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
2. Accessories: Full-size Sample of each type of accessory.

#### **1.3 INFORMATIONAL SUBMITTALS**

A. Product Schedule: For visual display surfaces.

B. Qualification Data: For qualified Installer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.

D. Maintenance Data: For visual display surfaces to include in maintenance manuals. Provide manufacturer's instructions for handling, installing, protecting and maintaining markerboards have been adhered to during the warranty period.

E. Warranties: Sample of special warranties.

#### **1.4 QUALITY ASSURANCE**

A. Source Limitations: Obtain visual display surfaces from single source from single manufacturer.

B. Surface- Burning Characteristics: As determined by testing identical products according to



ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame- Spread Index: 25 or less.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-built visual display surfaces, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefabricate components at the factory, disassemble for delivery, and make final joints at the site.
- B. Store visual display surfaces vertically with packing materials between each unit.

#### 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Verify actual dimensions of construction contiguous with visual display surfaces by field measurements before fabrication.
  1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

#### 1.7 WARRANTY

- A. Warranty on Markerboards:
  1. Provide written warranty, signed by manufacturer, agreeing to replace enamel markerboards which do not retain original writing and erasing qualities.
  2. Failures shall be defined:
    - a. To include surfaces which become slick and shiny, or exhibit crazing, cracking or flaking;
    - b. Replacement shall be limited to material replacement only and not include labor for removal and reinstallation.
  3. Warranty Period: Twenty-five (25) years from date of substantial completion.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS, GENERAL

- A. Hardboard: ANSI A135.4, tempered.
- B. Extruded Aluminum: ASTM B 221, Alloy 6063.

- C. Glass: Conforming to Division 08 Glazing section.

## 2.2 MARKERBOARD ASSEMBLIES

- A. Magnetic, Glass Markerboards: Manufacturer's standard markerboard assembly with low-gloss magnetic finish

- 1. Basis-of-Design, Products: Subject to compliance with requirements, provide the following:
  - a. Glasswrite Linxx with magnetic backing as supplied by Egan Glass or approved equal.
- 2. Other Manufacturers:
  - a. MooreCo
  - b. Bangor Cork Company, Inc.
  - c. Claridge Products and Equipment, Inc.
  - d. Greensteel.
  - e. PolyVision Corporation; a Steelcase company.
  - f. Or approved equal.

- B. Materials for Markerboards:

- 1. Writing Surface: Tempered, safety Glass on substrate with magnetic backing or paint.
- 2. Accessories:
  - a. 12" wide Marker System fastened or adhered to board, basis of design" egan aero marker tray" or approved equal,
  - b. 1 set of rare-earth magnets
  - c. 1 set of markers
  - d. 1 magnetic cleaning cloth

- C. Core: 7/ 16-inch medium density fiberboard (MDF), composed of approximately 90% post-industrial waste.

- D. Writing Surface Backing: Manufacturers standard moisture barrier.

- E. Panel Size: Refer to drawings.

- F. Color: as selected by the Architect, refer to finish schedule.

- G. Panelize markerboards to avoid seam in center or within projection areas as indicated on drawings.

## 2.3 MOUNTING DEVICES AND TRIM, GENERAL

- A. Concealed on back of panel, as recommended by manufacturer to support weight of panel, and as follows:

- 1. Splines: Manufacturer's standard concealed metal splines that engage the kerfed edges of

the panel, with other moldings and trim for interior corners, exterior corners, and exposed edges, with factory-applied finish on exposed items.

2. Adhesives: As recommended panel manufacturer and with a VOC content of 70 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).

## 2.4 FABRICATION

- A. Visual Display Boards: Factory assemble visual display boards unless otherwise indicated.

## 2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.6 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine walls and partitions for proper preparation and backing for visual display surfaces.
- C. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.

## 3.3 INSTALLATION, GENERAL

- A. General: Install visual display surfaces in locations and at mounting heights indicated on

Drawings, or if not indicated, at heights indicated below.

- B. Keep perimeter lines straight, level, and plumb.
- C. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

#### **3.4 INSTALLATION OF VISUAL DISPLAY SURFACES**

- A. Marker Boards: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches on center.
  - 1. Secure both top and bottom of boards to walls.
- B. Tack Boards and Panels: Install on wall surfaces in accordance with approved Shop Drawings and material manufacturers recommendations.

#### **3.5 CLEANING AND PROTECTION**

- A. Clean visual display surfaces per manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 10 1100

## SECTION 101400 - SIGNAGE

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Work Included: The Work of this Section includes:

1. Panel Signs
2. Pin mounted Aluminum dimensional lettering
3. Painted Acrylic Sign Panels
4. Applied Vinyl Graphics

#### 1.2 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's construction details relative to materials, dimensions of individual components, profiles, and finishes for each type of sign required.
- B. Shop Drawings: Provide Shop Drawings for fabrication and erection of signs. Include plans, elevations, and large-scale sections of typical members and other components. Show anchors, grounds, reinforcement, accessories, layout, and installation details.
1. Provide message list for each sign required, including full-size details of wording and layout of lettering.
  2. For signs supported by or anchored to permanent construction, provide setting drawings, templates, and directions for installation of anchor bolts and other anchors to be installed as a unit of Work in other Sections.
  3. Furnish full-size spacing templates for individually mounted dimensional numbers.
- C. Samples for Verification Panel Signs: For each type of panel sign showing each component and with the required finishes, in manufacturer's standard size unless otherwise indicated and as follows:
1. Panel Signs: Not less than 12 inches square, including corner; including one of each type insert indicated.
  2. Sign panels will not be returned for use in project.
- D. Samples for Verification Pin-mounted Dimensional Letters: For each type of sign assembly showing all components and with the required finish, in manufacturer's standard size unless otherwise indicated and as follows:
1. Dimensional Characters: Full-size Sample
  2. Exposed Accessories: Full-size Sample of each accessory type.
  3. Full-size Samples, will not be returned to Contractor for use in the Project.
- E. Samples for Verification Painted Acrylic: showing all components and with the required finish, in manufacturer's standard size unless otherwise indicated and as follows:
1. Panel Signs: Partial sign Not less than 12 inches square with all selected painted colors, including corner;
  2. Sign panels will not be returned for use in project

#### 1.4 CONTRACT CLOSEOUT

- A. Contract close out:
  - 1. Furnish appropriate checklist for aiding in reordering after Date of Substantial Completion. Maintain computer schedule program for five years for ordering new signage required by Owner.
  - 2. Maintenance data and cleaning requirements for sign surfaces.
  - 3. Furnish one complete software package compatible with Windows 10 for printing label inserts including all licensing fees for standalone installation

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by signage manufacturer.
- B. Source Limitations: Obtain each sign type through one source from a single manufacturer.
- C. Comply with the Americans with Disabilities Act (ADA) and with code provisions as adopted by authorities having jurisdiction.

#### 1.6 PROJECT CONDITIONS

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.

#### 1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Deterioration of finishes beyond normal weathering.
    - b. Separation or delamination of sheet materials and components.
    - c. Failure of all electrical and lighting components
  - 2. Warranty Period: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Basis- of- Design: ASI Signage Innovations or comparable product by one of the following:
  - 1. APCO Graphics, Inc.
  - 2. Appenx, Inc.
  - 3. ASI Sign Systems, Inc.
  - 4. Best Sign Systems, Inc.
  - 5. Clarke Systems.
  - 6. Or Approved Equal

B. Panel Signs Product:

1. Provide InForm thermoformed sign panels or approved equal

C. Pin mounted Aluminum Dimensional Lettering:

1. Provide Cut Metal dimensional letters or approved equal

D. Painted Acrylic Signs:

1. Provide cut Acrylic Dimension letters or approved equal solid acrylic with painted finish

## 2.2 FABRICATION, GENERAL

- A. Provide tamperproof, slightly recessed identifying devices for all locations indicated on the Drawings, if not indicated. Provide at all locations specified herein.
- B. Comply with Americans with Disabilities Act (ADA) requirements and elements required to be identified as accessible shall have international symbol of accessibility.

## 2.3 INTERIOR MODULAR PANEL SIGNS

- A. Panel Signs: High impact Acrylic/PVC thermoplastic allow, pressure molded as single unit.
  1. Sign Size: As indicated.
  2. Backer Panel: Shaped, decorative backing panel mounted behind signage system where installed on glass.
  3. Tactile Graphics and Text: Provide tactile copy and grade 2 Braille raised 1/32 inch minimum from surface using manufacturer's co-molding process.
    - a. Provide lettering and graphics precisely formed, uniformly opaque to comply with relevant ADA regulations and requirements indicated for size, style, spacing, content, position, and colors.
  4. Colors: high contract semi-matte integral colors for graphics. All integral resins are to be UV stabilized resins utilizing automotive grade pigments
    - a. As indicated on drawings or selected from manufacturers full range
  5. Fabrication options:
    - a. Panel depth: 0.25 inches
    - b. Attachable backplate panel depths: 0.25 inches
    - c. Panel appearance: selected from manufacturers standard, high contract, semi-matte product range
    - d. Surface texture: Smooth non-glare Matte, unless otherwise indicated.
    - e. Letter style, size, and layout: as indicated on drawings.
    - f. Signage size: as indicated on drawings.
    - g. Sign shape: as indicated on drawings
    - h. Edge profile: straight.
  6. Integral window option:
    - a. Subsurface, lateral slot, separate changeable graphic insert plaque construction in compliance with indicated materials, thickness, finish, colors, designs, shapes, sizes, and details. Subsurface graphics to comply with manufacturer's standard process for precisely formed, uniformly opaque graphics.
    - b. Graphic insert: die-cut paper with laser printed graphics and text
    - c. Panel size: as indicated on drawings
    - d. Visible window: size as indicated on drawings.
    - e. Lens: clear 0.80 inch thick matte first surface.

B. Mounting: Mount signs to wall surfaces using manufacturer's standard method with silicone adhesive or high-bond tape and with mechanical fasteners.

C. Accessories:

1. Provide user-changeable paper insert feature where indicated.
2. Adhesive: As recommended by sign manufacturer.
3. Adhesives shall have a VOC content of 70 g/L or less.

D. Fabrication:

1. General: comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction
2. Preassembly signs in the shop to the greatest extent possible to minimize field assembly. Disassemble signs only as necessary for shipping and handling limitations.
3. Form panels to required size and shape. Comply with requirements indicated for design, dimensions, finish, color, and details of construction.
4. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated

#### 2.4 PIN-MOUNTED ALUMINUM DIMENSIONAL LETTERING

- A. Scope: Lettering and hardware necessary for installation. Characters with uniform faces; square-cut, smooth, eased edges; precisely formed lines and profiles; and as follows:
- B. Materials: Aluminum, 1/2" thick unless otherwise indicated
- C. General Construction: Laser or Water-jet cut using computer controlled equipment
- D. Finishes: as indicated on the drawings, both of the following occur:
1. Integral Aluminum Finish: Anodized color as selected by Architect from full range of industry colors and color densities
    - a) typical finish unless otherwise noted.
- E. Font: as indicated on drawings or selected from Manufacturers full range
- F. Letter Size: as indicated on the drawings
- G. Mounting: Drilled and tapped with stainless steel spacer sleeved creating projection from face of wall. No fasteners to be visible. Minimum spacer depth 1/2" unless otherwise noted.

#### 2.5 PAINTED ACRYLIC SIGNS

- A. Panel Signs: High impact Acrylic/PVC thermoplastic.
1. Sign Size: As indicated, segment as required to achieve when exceeds single panel size.
  2. Colors: painted in scratch resistant finish. All paints and pigments to be UV stabilized resins
    - a. As indicated on drawings or selected from manufacturers full range
  3. Fabrication options:
    - a. Panel depth: 1 inches



- b. Panel appearance: selected from manufacturers standard, high contract, semi-matte product range
- c. Surface texture: Smooth non-glare Matte, unless otherwise indicated.
- d. Letter style, size, and layout: as indicated on drawings.
- e. Signage size: as indicated on drawings.
- f. Sign shape: as indicated on drawings
- g. Edge profile: eased with finished and painted edge.

B. Mounting: Mount signs to wall surfaces using manufacturer's standard method with silicone adhesive or high-bond tape and with mechanical fasteners.

C. Accessories:

1. Adhesive: As recommended by sign manufacturer.
2. Adhesives shall have a VOC content of 70 g/L or less.

D. Fabrication:

1. General: comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction
2. Preassembly signs in the shop to the greatest extent possible to minimize field assembly. Disassemble signs only as necessary for shipping and handling limitations.
3. Form panels to required size and shape. Comply with requirements indicated for design, dimensions, finish, color, and details of construction.
4. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated.

## 2.6 APPLIED VINYL GRAPHICS

A. Vinyl graphics: fully adhered UV stable vinyl applied to interior of glass.

1. Sign Size: As indicated, segment as required to achieve overall size.
2. Vinyl Film: UV stable printable film for permanent installation with minimum 7 year service life when installed on glass and exposed to sunlight. Removeable with heat.
  - a. Basis design: 3M™ Controltac™ Print Film 40C-114R or approved equal.
3. Colors:
  - a. As indicated on drawings or selected from manufacturers full range
4. Maximum service temperature 194 degrees f and minimum service temperature of -58 degrees F.

B. Mounting: Mount signs to inside face of glass surfaces with pressure-sensitive adhesive using manufacturer's standard method and procedures.

1. Adhesive type: solvent acrylic.

C. Fabrication:

1. Transparent film with printed areas as shown in the drawings. Print and cut film for installation on glass.
2. Provide templates as required.
3. Form panels to required size and shape. Comply with requirements indicated for design, dimensions, finish, color, and details of construction.
4. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated.

### PART 3 - EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Verify that items provided under other sections of Work are sized and located to accommodate signs.
- C. Examine supporting members to ensure that surfaces are at elevations indicated or required to comply with authorities having jurisdiction and are free from dirt and other deleterious matter.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Locate sign units and accessories where indicated, using mounting methods of the type described and in compliance with the manufacturer's instructions.
  - 1. Install signs level, plumb, and at the height indicated, with sign surfaces free from distortion or other defects in appearance.
- B. Painted Acrylic & Panel Signs: Attach panel signs to wall surfaces using the methods indicated below:
  - 1. Vinyl-Tape Mounting & Mechanical Fastenings:
    - a. Use double-sided foam tape and silicone adhesive, to mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
    - b. Mount signs using tamperproof, concealed fastening methods as recommended by the manufacturer. Provide heavy paper template to locate holes for fasteners.
- C. Mounting Locations: Mount signs as directed by the Architect to comply with the Americans with Disabilities Act (ADA) and with code provisions and as indicated on the drawings.

### 3.3 CLEANING AND PROTECTION

- A. At completion of the installation, clean soiled sign surfaces in accordance with the manufacturer's instructions. Protect units from damage until acceptance by the Owner.

END OF SECTION 1014000

## SECTION 101410 – RECORDS BOARD

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Work Included: The Work of this Section includes:

1. Records Board (within Pool)

#### 1.2 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's construction details relative to materials, dimensions of individual components, profiles, and finishes for each type of sign required.

B. Shop Drawings: Provide Shop Drawings for fabrication and erection of signs. Include plans, elevations, and large-scale sections of typical members and other components. Show anchors, grounds, reinforcement, accessories, layout, and installation details.

1. Provide message list for each sign required, including full-size details of wording and layout of lettering.
2. For signs supported by or anchored to permanent construction, provide setting drawings, templates, and directions for installation of anchor bolts and other anchors to be installed as a unit of Work in other Sections.
3. Furnish full-size spacing templates for individually mounted dimensional numbers.

C: Samples for Verification Records Board: showing all components and with the required finish, in manufacturer's standard size unless otherwise indicated and as follows:

1. Panel Signs: Partial sign Not less than 12 inches square with all selected painted colors, including corner;
2. Sample snap in letter in size and colors to be provided with board having rails to demonstrate function
3. Sign panels will not be returned for use in project

#### 1.4 CONTRACT CLOSEOUT

A. Contract close out:

1. Furnish appropriate checklist for aiding in reordering after Date of Substantial Completion. Maintain computer schedule program for ten years for ordering new signage required by Owner.
2. Maintenance data and cleaning requirements for sign surfaces.

#### 1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by signage manufacturer.

B. Source Limitations: Obtain each sign type through one source from a single manufacturer.

- C. Comply with the Americans with Disabilities Act (ADA) and with code provisions as adopted by authorities having jurisdiction.

#### 1.6 PROJECT CONDITIONS

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.

#### 1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

- a. Deterioration of finishes beyond normal weathering.
- b. Separation or delamination of sheet materials and components.
- c. Failure of all electrical and lighting components

2. Warranty Period: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS:

- 1. Basis- of- Design Products: Subject to compliance with requirements, provide the following:
  - a. School Pride Ltd.
  - b. Approved Equal

#### 2.3 RECORDS BOARD:

- A. General: Fabricated PVC board sign with painted graphics and removeable panels for athlete's names, times, event listings, and top ten record holders. Panels to plastic rails for snap-in lettering to allow ease of changing records
- B. Panel Signs: High impact Acrylic/PVC thermoplastic
  - 1. Board Back Panel substrate: Manufacturer's recommended thickness for size of sign indicated but not less than 1"
    - a. Painted in colors and with custom logos as indicated on drawings
  - 2. Overall records board size: 11'-0" x 8'-6"
  - 3. Applied Panels:
    - a. Provided in quantity indicated in drawings
    - b. All panels to be removeable with industrial hook hook and loop
    - c. Panels to have permanently printed graphics or plastic slots for snap-in lettering as indicated by design layout in drawings.
    - d. Size: see drawings.
  - 4. Snap-In Lettering: provide in size and color indicated in quantity recommended by manufacturer to allow all slots to be filled with names and record times.
  - 5. Colors: high contrast UV stable

C. Mounting: Mount signs to wall surfaces using manufacturer's standard method with corrosion resistant fasteners

D. Accessories:

1. Additional set of lettering in each color and size indicated

E. Fabrication:

1. General: comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction
2. Preassembly signs in the shop to the greatest extent possible to minimize field assembly. Disassemble signs only as necessary for shipping and handling limitations.
3. Form panels to required size and shape. Comply with requirements indicated for design, dimensions, finish, color, and details of construction.
4. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated

### **PART 3 - EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Verify that items provided under other sections of Work are sized and located to accommodate signs.
- C. Examine supporting members to ensure that surfaces are at elevations indicated or required to comply with authorities having jurisdiction and are free from dirt and other deleterious matter.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General: Locate sign units and accessories where indicated, using mounting methods of the type described and in compliance with the manufacturer's instructions.
  1. Install signs level, plumb, and at the height indicated, with sign surfaces free from distortion or other defects in appearance.
- B. Mounting Locations: Mount signs as directed by the Architect to comply with the Americans with Disabilities Act (ADA) and with code provisions and as indicated on the drawings.

### **3.3 CLEANING AND PROTECTION**

- A. At completion of the installation, clean soiled sign surfaces in accordance with the manufacturer's instructions. Protect units from damage until acceptance by the Owner.

END OF SECTION 1014000

## **SECTION 10 2113 – COLOR-THRU PHENOLIC TOILET COMPARTMENTS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Phenolic toilet compartments configured as toilet enclosure.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data:** For each type of product.
- B. Shop Drawings:** For toilet compartments. Include plans, elevations, sections, details, and attachment details.
- C. Samples** for each type of toilet compartment material indicated.

#### **1.3 INFORMATIONAL SUBMITTALS**

- A. Product certificates.**

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance data.**

#### **1.5 WARRANTY**

- A. Special Manufacturer's Warranty:** Provide manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials, workmanship, corrosion, delamination, or breakage during the following period after substantial completion:
1. Toilet Partitions: 25 years.
  2. Hardware: Lifetime.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. Surface-Burning Characteristics:** Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Class A

- a. Flame-Spread Index: 25 or less.
  - b. Smoke-Developed Index: 450 or less.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC ANSI A117.1-2009 for toilet compartments designated as accessible.

## 2.2 COLOR-THRU PHENOLIC TOILET COMPARTMENTS

- A. Manufacturer:
  - 1. ASI global partitions (basis of design manufacturer)
  - 2. Decolam
  - 3. Marlite
  - 4. Spec-rite Designs, LCC
  - 5. Or approved equal
- B. Toilet-Enclosure Style: Floor mounted, Overhead braced with integral no-sightline privacy system.
- C. Door, Panel, and Pilaster Construction and Materials: Solid phenolic with multiple resin-impregnated kraft sheets fused at high temperature and pressure. Phenolic core color shall be the same as the surface sheets. Provide manufacturer's optional privacy enhancements and integral zero-sightline routed edges.
  - 1. Doors & Pilasters: 3/4" thickness; 72" height and 9" above floor
  - 2. Panels: 1/2" thickness
  - 3. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units of size and material adequate for panel to withstand applied downward load on grab bar of at least 250 lbf when tested according to ASTM F446, without deformation of panel.
  - 4. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.
  - 5. Headrail shall be provided to bridge all compartments and brace the end freestanding pilasters to the wall; the headrail to comprise anodized aluminum with satin finish, contoured to provide anti-grip features.
  - 6. Finish: as selected from manufacturer's full range or as indicated on the drawings
- D. Pilaster Shoes and Sleeves (Caps): alloy 306 Stainless steel sheet with brushed #4 finish, not less than 0.031-inch nominal thickness and 3 inches high,
- E. Brackets (Fittings):
  - 1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel

## 2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: stainless steel operating hardware and accessories with brushes finish.

1. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
  2. Hinges: Self-closing continuous spring-loaded type adjustable to hold doors open at any angle up to 90 degrees, with emergency access by lifting door.
  3. Latch and Keeper: Concealed slide latch with wraparound rubber-faced combination door strike and keeper, with provision for emergency access, meeting requirements for accessibility at accessible compartments.
  4. Coat Hook: Combination hook and rubber-tipped stop, sized to prevent door from hitting compartment-mounted accessories. Provide wall bumper where door abuts wall.
  5. Provide formed L-shaped hook without stop at outswing doors.
  6. Door Pull: Standard unit on outside of inswing doors. Provide pulls on both sides of outswing doors.
  7. Occupancy indicator latch
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel anchors compatible with related materials.

## 2.4 FABRICATION

- A. Fabrication, General: Fabricate toilet compartment components to sizes indicated with overall height of 82" minimum. Coordinate requirements and provide cutouts for through-partition toilet accessories and solid blocking within panel where required for attachment of toilet accessories.
- B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- C. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide in-swinging doors for standard toilet compartments and 36-inch- wide out-swinging doors with a minimum 32-inch- (813-mm-) wide clear opening for compartments designated as accessible.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
1. Maximum Clearances:
    - a. Pilasters and Panels: 1/2 inch.



- b. Panels and Walls: 1 inch.
- 2. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.
  - a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
  - b. Align brackets at pilasters with brackets at walls.

### 3.2 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 10 2113

## **SECTION 10 2124 - CUBICLE TRACK SYSTEM AND CURTAIN**

### **PART 1 – GENERAL**

#### **1.01 SUMMARY**

- A. Section includes:
  - a. Ceiling mounted curtain track
  - b. Track accessories and attachments
  - c. Cubicle curtain

#### **1.02 SUBMITTALS**

- A. Product Data: Manufacturer's product data sheets for all specified curtain track.
- B. Detail Drawings: Mounting details with the appropriate fasteners for specified project substrates.
- C. Samples:
  - a. Verification samples of cubicle track, 4" in length. Complete with (1) carrier as specified and stop
  - b. Selection sample of curtain fabric, 12"x12"
  - c. Selection sample of curtain top mesh panel, 12"x12"
- D. Manufacturer's standard installation instructions

#### **1.03 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials in unopened factory packaging.
- B. Inspect material on delivery to verify products are as specified.

#### **1.04 WARRANTY**

- A. Manufacturer's standard warranty against manufacturer defects.

### **PART 2 - PRODUCTS**

#### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the requirements listed, provide cubicle track, carriers, and curtains from a single manufacturer as follows:

1. Construction Specialties Cubicle Curtains
2. Clickeze, InPro Corporation,
3. Cubicle Curtain Factory, Inc
4. Or approved Equal

## **2.02 CUBICLE TRACK SYSTEM**

- A. Basis of Design:

1. Track system: CS Cubicle Curtains #6062N with breakway carrier CS Cubicle Curtains 975P or approved equal

- B. Cubicle Tracks: surface-mounted tracks of heavy extruded aluminum alloy 6063-T4, 1 3/8" x 3/4", slotted to receive roller carriers, complete with accessories and components required for complete and secure installations including splices, end caps and corner bends.

1. Corner Bends: Corner bends up to 36" radius are to be fabricated in one continuous "L" shape. Radiuses above 36" to be continuous or spliced based on room condition.
2. Ends: shall be provided with manufacturer's standed end caps of aluminum or molded thermoplastic with finish to match track.
3. Finish:
  1. White powder coat finish

- C. Carriers:

1. Breakaway Carriers: Manufacturers standard all nylon breakaway carriers. Carrier to have virgin nylon hook, axle and nylon wheels. Carrier hook is to be designed to break away from axle at 22 pounds of applied pressure.
  - i. Provide one carrier for each 6" of cubicle curtain width

## **2.03 CUBICLE CURTAIN**

- A. Basis of Design:

- a. Curtain fabric: Construction Specialties Kaylor Cube fabric line or approved equal
  - i. , color selected by architect from manufacturers full produce line or as noted on the drawings

- B. Curtain Fabric: Cubicle manufacturer's standard, as follows:

- a. Fiber Content: 100 percent polyester, inherently and permanently flame resistant. Complies with NFPA 701 fire code standards.
- b. Products: Subject to compliance with requirements, provide the following:
  - i. Pattern: As selected by Architect from manufacturer's full range of available fabrics.
  - ii. Color: As selected by Architect from manufacturer's full range of available colors.
- C. Mesh: No snag, tightly woven selvedge, 1 1/4 inch fire retardant grommet band at top edge. White or beige nylon mesh with openings having a minimum of 70 percent open (1/2" diagonal).
- D. Curtain Grommets: #2 rolled-edge, rustproof, nickel-plated brass; spaced not more than 6 inches on center and machined into top header.
- E. Fabricate curtains to comply with the following requirements:
  - a. Width: Equal to track length from which curtain is hung plus 10-15 percent added fullness, unless otherwise specified.
  - b. Length: Equal to floor-to-ceiling height, with a minimum of 20 inches mesh top unless otherwise specified, and minus distance above finished floor at bottom as follows:
    - i. Cubicle Curtains: 10-12 inches.
  - c. Mesh: Mesh is serged to face fabric, turned and stitched with double needle lock stitch no less than 1/2 inch in width.
  - d. Bottom and Side Hems: Fabric is 3/4 inch and sewn with lock stitch drapery hems.
  - e. Vertical Seams: Vertical seams are serged together and sewn with double needle lock stitch not less than 1/2 inch wide.

### **PART 3 INSTALLATION**

- A. General: Install tracks level and plumb, according to manufacturer's written instructions. Provide track fabricated from one continuous length up to 18 feet.
- B. Curtain Track Mounting. Surface
- C. Surface Track Mounting: Fasten surface-mounted tracks at intervals of not more than 24 inches. Fasten support at each splice and tangent point of each corner. Center fasteners in track to ensure unencumbered carrier operation. Attach track to ceiling as follows:

- a. Mechanically fasten to suspended ceiling grid with screws.
- D. Track Accessories: Install end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.
- E. Curtain Carriers: Provide curtain carriers adequate for 6-inch spacing along the full length of the curtain.
- F. Curtains: Hang curtains on each curtain track.

END OF SECTION

## 102800 TOILET ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Work Included: Work of this Section includes:

1. Toilet room accessories.
2. Under lavatory guards.
3. Mirrors.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:

1. Construction details and dimensions.
2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Material and finish descriptions.
4. Features that will be included for Project.
5. Manufacturer's warranty.

B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements.

1. Approved full-size Samples will be returned and may be used in the Work.

#### 1.3 INFORMATIONAL SUBMITTALS

A. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify products using designations indicated.

B. Setting Drawings: Provide setting drawings, templates, instructions, and directions for installation of anchorage devices and for cut-outs in other work.

C. Warranty: Sample of special warranty.

D. ADA Compliance certification

E. Maintenance Data: For toilet accessories to include in maintenance manuals.

#### 1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Subject to compliance with requirements, provide toilet accessories of same manufacturer for each type of accessory unit with not less than 5 years successful experience manufacturing similar products.

- B. Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in concrete or built into masonry; coordinate delivery with other work to avoid delay.

- C. Accessory Locations: Coordinate accessory locations with other work to avoid interference and to assure proper operation and servicing.

#### 1.5 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

#### 1.6 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, visible silver spoilage defects.
  - 2. Warranty Period: 5 years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide toilet accessories as supplied by
  - 1. Bobrick (basis of design)
  - 2. American Specialties, Inc
  - 3. Gamco
  - 4. or approved equal.

#### 2.2 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
  - 1. Thickness: 22 gage (.034 inch) minimum, unless otherwise indicated.
- B. Galvanized Steel Mounting Devices: ASTM A 123, hot-dip galvanized after fabrication, 20 ga.
- C. Fasteners: Screws, bolts, and other devices of same material as accessory unit or of galvanized steel where concealed.
- D. Galvanized Steel Grab Bar Reinforcement: ASTM A 153/A 153M, 20 gauge, hot-dip galvanized after fabrication.
- E. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.
- F. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.



## **2.3 UNDERLAVATORY GUARDS**

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following. Refer to plumbing fixture schedule on drawings for basis of design models:
  - 1. Plumberex Specialty Products, Inc.
  - 2. Truebro by IPS Corporation.
  - 3. Or approved equal.

## **2.4 FABRICATION**

- A. If approved by the Architect, an unobtrusive logo of manufacturer is permitted on exposed surfaces. Provide manufacturer's name and product model number on concealed surfaces.
- B. Surface- Mounted Accessories, General: Fabricate units with tight seams and joints, exposed edges rolled. Hang doors or access panels with continuous stainless steel piano hinge. Provide concealed anchorage.
- C. Recessed Accessories, General: Fabricate units of all welded construction. Hang doors or access panels with full-length stainless steel piano hinge. Provide concealed anchorage.
- D. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION**

- A. Install accessories in accordance with manufacturers' instructions. Install units plumb and level, firmly anchored in locations indicated.
- B. Secure units to walls in concealed, tamperproof manner with special hangers, toggle bolts, or screws. Set units plumb, level, and square, at locations indicated, and in accordance with manufacturer's instructions.
- C. Secure mirrors to walls in concealed, tamper-resistant manner with special hangers, toggle bolts, or screws. Set units level, plumb, and square at locations indicated, according to manufacturer's written instructions for substrate indicated
- D. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested per ASTM F 446.

## **3.2 ADJUSTING AND CLEANING**

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.

- C. Clean and polish exposed surfaces per manufacturer's written recommendations.

**3.3 TOILET ACCESSORY SCHEDULE**

- A. Refer to drawings Restroom Fixture Schedules for accessories.

END OF SECTION 10 2800

## **SECTION 10 2813 - ELECTRIC HAND DRYERS**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. High Efficiency ADA Compliant Electric Hand Dryer

#### **1.2 RELATED SECTIONS**

- A. Section 061000 - Rough Carpentry: Blocking in stud partitions for mounting hand dryers.

#### **1.3 REFERENCES**

- A. ICC/ANSI A117.1 - American National Standard for Accessible and Useable Buildings and Facilities; 2017.
- B. UL, LLC / UL Environment - Product Category Rules (PCR) for Hand Dryers, 2016.

#### **1.4 SUBMITTALS**

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Operating instructions and performance.
  - 3. Storage and handling requirements and recommendations.
  - 4. Electrical wiring diagrams
  - 5. Installation methods.

#### **1.5 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing electric hand dryers with 10 years minimum experience.
- B. Source Limitations: Obtain all electric hand dryers from a single source and from single manufacturer.
- C. Equipment certified by Underwriters Laboratory, Inc., with UL and ULC labels.
- D. Comply with ICC/ANSI A117.1-2017

#### **1.6 WARRANTY**

- A. Special Manufacturer's Warranty: Provide manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or

workmanship within the following periods following the date of Substantial Completion:

1. Sensors: 1 year.
2. Motor Brushes: 3 years.
3. All Other Components: 10 years.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Excel Dryer Inc., ThinAir model TA-SB (basis of Design)
- B. Bradley corporation: Aerix+ model 2923-287401
- C. Palmer Fixture BluStorm Bolt
- D. Or approved equal

### **2.2 PERFORMANCE**

- A. UL Product Category Rule (PCR) Testing:
  1. Dry Time: Not greater than 15 seconds
  2. Energy Per Use: Not greater than 3.7 Wh (13.32 J)
  3. Sound level: 76db max
- B. Electrical Components: Listed and labeled per NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- C. Certification: Products certified by Underwriters Laboratory, Inc., with UL and ULC labels.
- D. Accessibility Requirements: Comply with requirements of ADA/ABA and accessibility requirements of authorities having jurisdiction.
  1. Comply with ICC/ANSI A117.1.
  2. Maximum protrusion from wall, 4"

### **2.3 ELECTRIC HAND DRYERS**

- A. High Efficiency Surface Mounted ADA Compliant Hand Dryer: high speed, energy efficient, rapid drying, automatic sensor, surface mounted, ADA Compliant, adjustable speed and sound control, adjustable heat control, electric hand dryer; entire dryer internally grounded. Made in the USA Certified.
  - a. Cover: Stainless steel.

- b. Finish: Brushed Number 4 finish.
- 2. Mounting: Surface Mounted (ADA Complaint) with maximum 4" protrusion from wall. Any approved substitution must meet protrusion requirements or be provided with recessed alcove.
- 3. Controls: Automatic, activated by infrared optical sensor located next to the air outlet. Dryer will operate as long as hands are under the air outlet and has a 35-second lockout feature if hands are not removed. Control includes adjustable sound and speed control mechanism, adjustable heat control with High, Medium, Low and Off settings. Sensor equipped with externally visible Red LED light that flashes error codes to assist in troubleshooting. Control assembly sealed for protection against moisture, lint, dust and vandalism.
- 4. Air Intake: Inlet openings on bottom of cover.
- 5. Air Outlet: Air baffle; designed to keep foreign objects out of dryer.
- 6. Nominal Size: 12-1/4 inches wide by 14-1/2 inches high by less than 4 inches deep.
- 7. Power Source:
  - a. Universal voltage 120V -277V. 950watts at 120, 208, 240; 1150w at 277V.
- 8. Motor: Thermally protected, series commutated, through-flow discharge vacuum motor/blower (1/2 hp / high-30,000 rpm, low-20,000 rpm) which provides air velocity of up to 13,200-19,800 LFM (linear feet per minute) at the air outlet
- 9. Heater: mounted inside blower housing to be vandal resistant. Heater Safeguard: Automatic resetting thermostat to open when airflow is restricted and close when airflow is resumed.
  - a. Exit Air Temperature: 130 degrees F.
- 10. Noise level at 79" = 69dB max
- 11. All metal parts coated according to Underwriters Laboratories, Inc. requirements.
- 12. Mount at the following heights above floor surface:
  - a. Toilets for Persons with Physical Disabilities: 37 inches (940 mm).

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### **3.2 PREPARATION**

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Coordinate requirements for blocking to ensure adequate means for support and installation of hand dryers.
- D. Coordinate requirements for power supply, conduit, disconnect switches and wiring.

### **3.3 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install dryers at specified heights.
- C. Install dryers securely to supporting substrate so that fixtures are level and aligned with each other. Use type and length of fastener as recommended by manufacturer for type of substrate.

### **3.4 PROTECTION**

- A. Inspect installation to verify secure and proper mounting. Test each dryer to verify operation, control functions, and performance. Correct deficiencies.
- B. Protect installed dryers until completion of project.
- C. Replace damaged products before Substantial Completion.

**END OF SECTION**

## SECTION 10 4400 - FIRE PROTECTION SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Work Included: The Work of this Section includes:
  - 1. Fire extinguishers.
  - 2. Semi-recessed mounted cabinets for portable fire extinguishers.
  - 3. Mounting brackets for fire extinguishers, where cabinets are not provided.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets, where provided.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.
- B. Warranty: Sample of special warranty.
- C. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

#### 1.4 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

#### 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure of hydrostatic test per NFPA 10.
    - b. Faulty operation of valves or release levers.
  - 2. Warranty Period: Six (6) years from date of Substantial Completion.



## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
- C. Fire-Rated Fire-Protection Cabinets, where required by project application: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

### 2.2 MANUFACTURERS

- A. Basis-of-Design, Products: Subject to compliance with requirements, provide the following:
  - 1. Potter-Roemer, Inc.; "Alta" cabinets or approved equal.
- B. Other Manufacturers:
  - 1. Larsen; Architectural Series
  - 2. J.L. Industries.
  - 3. Or approved equal.

### 2.3 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and surface mounted location indicated on drawings.
  - 1. Typical extinguisher: Multi-purpose Dry-chemical Type in enameled-steel container with monoammonium phosphate based dry chemical and having pressure indicating gauge
    - a. Size: UL rated 4-A:40-B:C; 30-lb nominal capacity
  - 2. In Pool Mechanical room where oxidizer stored and where noted in drawings: Pressurized Water Mist type in enameled-steel container with pressurized non-toxic de-ionized water and having pressure indicating gauge
    - a. Size: UL Rated 2A:C 2.5 gallons (9.4 liter) capacity.
  - 3. Valves: Manufacturer's standard.
  - 4. Handles and Levers: Manufacturer's standard.
  - 5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
  - 6. Mounting Bracket: where surface mounted, provide manufacturers standard bracket for size and type of extinguisher

## 2.4 FIRE EXTINGUISHER CABINETS

- A. General: Provide fire extinguisher cabinets where indicated, of suitable size for housing fire extinguishers of types and capacities indicated. Provide portable fire extinguisher in each cabinet in size indicated on drawings and within this specification.
  - 1. Fire-Rated Cabinets: UL listed with UL listing mark with fire-resistance rating of wall where installed.
- B. Cabinet Type: Semi-recessed with rolled edges in walls of sufficient depth to accommodate door construction.
  - 1. Cabinet Construction: Manufacturer's heavy gauge galvanized steel with an electrostatically applied, thermally-fused polyester coating with white finish. Cabinet door shall cover the flange of the tub, with concealed door hinge and pin. Weld joints and grind smooth.
  - 2. Provide rolled edges.
  - 3. Dimensions (Inside Box): to suit fire extinguisher type.
- C. Door and Frame Material and Construction:
  - 1. Door: Manufacturer's standard vertical window panel with 1/8" acrylic glazing and flush pull handle.
  - 2. Door finish: Alloy 306 Stainless steel with No. 4 brushed finish
  - 3. Door Hardware:
    - a. Provide flush pull handle and friction latch.
    - b. Provide manufacturer's aluminum or stainless steel concealed hinge with stainless steel pin to allow for 180 degrees opening of cabinet door.
  - 4. Identification: Provide cabinet door with die-cut letters applied vertically reading the words "FIRE EXTINGUISHER", in color as indicated below:
    - a. Die-Cut Letter and Color: vertical Red or Black, as selected by the Architect.

## 2.5 FACTORY FINISH

- A. General: Factory finish fire extinguishers, brackets and cabinets to comply with NAAMM "Metal Finishes Manual" after products are assembled. Protect finishes with plastic or paper covering, prior to shipment.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
  - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. Follow manufacturer's printed instructions for installation.
- C. Install units in locations and at heights indicated, or if not indicated, at heights to comply with applicable regulations of governing authorities. Fasten cabinets to structure, square and plumb.
  - 1. For units to be fully recessed, prepare recesses in walls for cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer's instructions.
  - 2. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- D. Identification: Apply letters at locations indicated.

### 3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Adjust cabinet doors that do not swing or operate freely. Refinish or replace cabinets and doors damaged during installation.
- B. Provide final protection and maintain conditions that ensure that cabinets and doors are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 10 4400

## **SECTION 10 5100 - Solid Phenolic Lockers**

### **Part 1 General**

#### **1.1 Summary**

- A.** Section includes:
  - 1. solid phenolic lockers
  - 2. solid phenolic benches

#### **1.2 Submittals**

- A.** Shop Drawings: Submit shop drawings indicating room sizes, layout, locker dimensions, material thickness, trim, hardware, finishes, locks, base, doors, accessories, and installation details.
- B.** Product Data: Submit manufacturer's technical data for materials, fabrication, finishing, fastenings, hardware, and installation details.
- C.** Samples: Submit samples of edge details, colors, patterns, finishes, and texture
- D.** Closeout Documents: Submit the following:
  - 1. Operation and Maintenance data
  - 2. Warranty

#### **1.3 Quality Assurance**

- A.** Qualifications:
  - 1. Fabricator shall have 10 years or more experience in fabrication of solid phenolic materials and shall be experienced in performing work of similar size and scope.
  - 2. Fabricator shall be capable of providing field service representation.
  - 3. Installer shall be approved by the manufacturer and be experienced in performing work of similar size and scope.
- B.** Pre Installation Meeting: Conduct pre-installation meeting prior to installation to verify project requirements and conditions.

#### **1.4 Delivery, Storage and Handling**

- A.** Ordering: Comply with supplier's ordering and lead-time guidelines to avoid delays.
- B.** Delivery: Deliver materials in the manufacturer's original protective packaging.
- C.** Storage and Handling: Store materials in an enclosed shelter providing protection from damage, temperature, humidity, and exposure to the elements.

#### **1.5 Coordination and Project Conditions**

- A.** Field Measurements: Before material fabrication, verify actual field measurements and show actual measurements on shop drawings.
- B.** Coordination: Coordinate field measurements with fabrication schedule construction progress to avoid construction delays.

## **1.6 QUALITY ASSURANCE**

- A.** Provide all lockers from a single manufacturer.

## **1.7 Warranty**

- A.** Submit executed copy of the Manufacturer 10-year warranty against defects in material and 2 years warranty for system.

## **Part 2 – Products**

### **A. Manufacturers**

### **B. Basis of Design Manufacture: Spectrum Lockers;**

- a.** Model: 1-Tier, 2-Tier and Athletic type as indicated on the drawings

### **C. Other Manufacturers:**

- a.** ASI storage solutions
  - b.** Hollman Inc
  - c.** Or approved equal

## **2.1 Materials**

### **A. Panel Material:**

- 1.** Decorative papers impregnated with the melamine resin on faces with a clear protective overcoat and integrally compression molded within a core consisting of solid phenolic impregnated kraft papers.
  - 2.** Core or panel material shall meet fire resistance per ASTM E84 Class A
  - 3.** High-pressure Laminate adhered to substrate is not acceptable

### **B. Doors:**

- 1.** Material: 1/2”thick solid phenolic composite material.
  - 2.** Corners: Rounded
  - 3.** Color: As selected from manufacturer’s full color range or as indicated on the drawings
  - 4.** Edges: Standard profile is straight edge no profile.
  - 5.** Door Fastening: Through Bolted.

### **C. Locker Bodies**

- 1.** Exposed edges: Straight profile; eased edges to remove sharpness; machine polished and free

from tooling imperfections.

**2.** Tops, bottoms, and intermediate shelves: 1/2" thick solid phenolic composite material with ventilation holes.

**3.** Locker backs: +/- 1/4" thick solid composite material.

**4.** Locker Sides: 3/8" thick solid phenolic composite material.

**D.** End Cover Panels: Finished end panels and closures shall be 1/2" thick solid phenolic composite material finish to match doors where sides are exposed

**E. Hardware**

**1. Hinges:**

**a.** Material: 304-grade stainless steel.

**b.** Quantity: Three (3) for full height doors and two (2) for multi-tier units or full height piano style.

**2. Interior hooks:**

**a.** Material: Stainless steel.

**b.** Top Hook: Two prong, one per opening for 1 and 2 tiers.

**c.** Side Hook: Single prong, two per opening for 1, 2 and 3 tiers.

**3. Interior Shelves:**

**a.** Material 1/2" thick solid phenolic

**b.** Quantity: provide (1) 12" below top of locker in 1-tier lockers and to separate tiered locker compartments

**4.** Fasteners: Exposed fasteners, where present, shall be 304 stainless steel

**5.** Fastener Application: Apply directly into or through the material.

**6.** Other Reinforcement: Aluminum or metal profiles for reinforcements shall not be permitted.

**7.** Door Identification (identification plates): engraved on integrated hasp handle

**F. Ventilation**

**1.** Door Vent: Provide minimum of 20 squares inches opening of front ventilation for full tier 12" wide x 72" high. For other styles, provide front ventilation 1.43 square inches per lineal foot of door perimeter.

**G. Base**

**1.** Base furnished with locker: Adjustable leg mounted: 3 3/4" adjustable to 5", ABS plastic mounting-leveling leg. Finish base plate of 1/2" phenolic panel.

**2.2 Size**

**1. 1-tier lockers:**

**a.** Overall height (without base): 71-3/4"

**b.** Overall width: 15" or 18" as indicated on the drawings

**c.** Overall Depth: 18"

**2. 2-tier lockers:**

- a. Overall height (without base): 71-3/4"
- b. Overall width: 18"
- c. Overall depth: 18"
- 3. Athletic lockers - custom:
  - a. Overall height (without base): 71-3/4"
  - b. Overall width: custom 18"
  - c. Overall depth: custom 18"
  - d. with continuous bench along adjacent units
  - e. Side panels contoured and cut-away sides having angled backrest, see drawings.

**2.3 Accessories and Options: 1-tier and 2-tier lockers:**

- A.** Locking System: Stainless Steel Hasp Plate and Bar with Integrated Handle
- B.** Locker Top: Sloped width 1/4" thick solid phenolic composite material to match door panels.
- C.** Door Identification:
  - 1.** engraved numbers visible on stainless steel hasp lock
  - 2.** Fonts to be a minimum 1/2" high and up to four alphanumeric characters
  - 3.** Numbering sequence to be provided by architect.
- D.** Fillers: 1/2" solid phenolic composite material.
  - 1.** Provide wall fillers where lockers full width of wall or built into alcove.
  - 2.** Provide corner fillers inside corners to allow doors to fully open.
- E.** Base Plate: 1/2" solid phenolic composite material to match door panel finish, miter corners
- F.** Extra Hang Rod: Aluminum, Matte Chrome Finish

**2.4 Accessories and Options: Athletic lockers:**

- A.** Custom lockable compartment with: Stainless Steel Hasp Plate and Bar with Integrated Handle
- B.** Continuous bench along adjacent lockers
- C.** Contoured side-panels, see drawings.
- D.** Locker Top: 1/2" flat finished top panel
- E.** Custom University Logo at rear panel
- F.** Identification:
  - 1.** engraved numbers visible on bench front
  - 2.** Fonts to be a minimum 1/2" high and up to four alphanumeric characters
  - 3.** Numbering sequence to be provided by architect.
- G.** Fillers: 1/2" solid phenolic composite material.
  - 1.** Provide wall fillers where lockers full width of wall or built into alcove.
  - 2.** Provide corner fillers inside corners to allow doors to fully open.
- H.** Adjustable shelf below seat

**2.5 Locker Benches**

- A.** Provide in size indicated on drawings
  - 1.** 2"x2" aluminum tube H-frame with nylon feet and stainless steel screw adjustment, capable of supporting 400lbs

2. ½" solid phenolic top, finish color to match lockers or as indicated on the drawings.

### **Part 3 – Execution**

- 3.1** Examination: Examine site conditions before locker installation. Notify architect of unacceptable areas. Do not install locker until unacceptable conditions have been corrected.

- 3.2** Installation

- A.** Install lockers in locations as shown on shop drawings per manufacturer's instructions.
- B.** Install lockers plumb, level, square, rigid, and flush.
- C.** Install all required trim, fillers, end panels, and closures per manufacturer's instructions.
- D.** Use hardware supplied or recommended by the manufacturer.
- E.** Attach number plates to doors as indicated on shop drawings.
- F.** Correct and/or replace damaged components as directed by architect.

- 3.3** Adjustment

- A.** Adjust doors and locks for smooth operation without binding.
- B.** Lubricate door hinges and locks per manufacturer's instructions.

- 3.4** Cleaning

- A.** Clean all surfaces in accordance with manufacturer's instructions.
- B.** Do not use abrasive cleaners.

End of Section



## SECTION 11 4500 – APPLIANCES AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Work Included: The Work of this Section includes:

1. Appliances and equipment as indicated on the drawings
  - a. Refrigerator/ Freezers.
  - b. Microwaves.
  - c. Multi-function printers
  - d. Vending Machines
  - e. Other equipment listed in equipment schedule on the drawings

#### 1.2 DELIVERY AND STORAGE

- A. Accept delivery of products in manufacturer's undamaged protective containers, after spaces to receive them have been fully enclosed.

### PART 2 – PRODUCTS

- A. refer to drawings for list of equipment and appliances
- B. Where noted as owner provided, provide dates required for delivery
- C. Where noted as contractor provided:
  - The specified product is basis of design, for any brand name manufacturer and/or product “or equal” shall be permitted, but substitutions will be evaluated in accordance with Div 1 specifications with architect to make determination of equivalency. All qualities of basis of design product shall be used as evaluation criteria, including warranty length offered by manufacturer, years in business, thickness of metal/wood/material properties, fabrication method and materials, and overall product size.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine and coordinate roughing-in for plumbing, mechanical, and electrical services, with Installer present, to verify actual locations of services before appliance and equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Coordinate delivery of appliances, equipment and accessories required for installation.

### 3.3 INSTALLATION

- A. General: Comply with manufacturer's instructions and recommendations.
- B. Built-In Equipment: Securely anchor units with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.
- C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate for proper operation of equipment.
- D. Utilities: Refer to Divisions 22, 23 and 26 - For Mechanical and Electrical requirements.

### 3.4 ADJUSTING AND CLEANING

- A. Testing: Test each item of residential equipment to verify proper operation. Make necessary adjustments.
- B. Accessories: Verify that accessory items required have been furnished.
- C. Remove protective coatings and other protection after construction procedures have been completed to assure equipment remains undamaged until the time of substantial completion.
- D. Cleaning: Remove packing material from residential equipment items and leave units in clean condition, ready for operation.

### 3.5 FIELD QUALITY CONTROL

- A. The contractor shall Perform the following tests and inspections
  - 1. Perform visual, mechanical, and electrical inspection and testing for each appliance/equipment according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
  - 2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After installation, start units to confirm proper operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.
  - 5. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
  - 6. An appliance will be considered defective if it does not pass tests and inspections.
  - 7. Prepare test and inspection reports.

END OF SECTION 11 4500

## **SECTION 116600 - ATHLETIC EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section includes:
  - 1. Gym Padding
  - 2. Basketball backstops and accessories.
  - 3. Volleyball Equipment.
  - 4. Second Floor Volleyball Sleeve Adapters
- B. Related sections:
  - 1. Section 051200 Structural steel framing to support basketball backstops
  - 2. Section 055000 Miscellaneous metals
  - 3. Section 096560 Synthetic Sports Flooring for installation of second floor volleyball sleeves.

#### **1.2 SUBMITTALS**

- A. Submit in accordance with Section 01330 - Submittal Procedures.
  - 1. List of proposed products and product data.
  - 2. Shop drawings showing layout, elevations, dimensions, fabrication details, method of attachment, loads to be transmitted to building structural members, requirements for supplementary bracing or structural support members and electrical wiring diagrams.
  - 3. Manufacturer must provide calculations and reports for tests performed by an independent testing laboratory accredited by the American Association of Laboratory Accreditation (A2LA) that clearly demonstrate compliance with minimum safety factors included in product specifications.
  - 4. Samples of fabric and all finish selections by Architect.
  - 5. Manufacturer's installation and maintenance instructions.

#### **1.3 QUALITY ASSURANCE**

- A. Source limitation: All components including suspension system, frame assembly, backboards, goals, electric winches, and controls for backstops shall be of a single manufacturer.
- B. All welding to be performed by personnel having passed Welder Qualification testing in accordance with American Welding Society (AWS) code D1.1 or higher. Manufacturer to provide certification and test results upon request.

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Provide volleyball floor sleeves, covers and floor inserts in accordance with requirements of related trades that are responsible for installation. Do not deliver balance of athletic equipment until building is enclosed and other construction within gymnasium is substantially complete.

### 1.5 PROJECT CONDITIONS

- a. Environmental Limitations: Do not install gymnasium dividers until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- b. Field Measurements: Verify position for gymnasium basketball hoops.

### 1.5 WARRANTY

- A. All Basketball Backstop support structures including clamps, fittings and tube to have a minimum warranty of 25 years from date of substantial installation.
- B. All volleyball equipment and wall padding to have minimum warranty of 5 years from date of substantial completion.
- C. Manufacturer's standard warranty for all other items and equipment.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the following:
  - a. Draper, Inc
  - b. Or approved equal

### 3.2 WALL PADDING

Wall padding shall be Model UI Greenguard Gold Certified, Class A Flame Retardant Wall Protection Pads EcoVision Fire-Rated Wall Pads or approved equal as supplied by Draper, Inc. or approved equal.

Wall pads to be standard sized 2' by 7' as indicated on drawings.

Wall pads shall be constructed using 7/16" thick urea-formaldehyde free oriented strand board (OSB) backer and 2" thick flexible urethane cushioning material bonded together, then fully wrapped with flexible PVC and scrim laminate that features a leather grain emboss pattern. Cover shall have average weight of 14 oz. per square yard, breaking strength of 350 PSI, tear resistance of 65 pounds and be rated as self-extinguishing in accordance with California State Fire Code F-230 and Class-A Rated in accordance with requirements of NFPA-101.

- 1. Cover to be resistant to rot, mildew, fungus and ultraviolet light.
- 2. Color as selected by the Architect.
- 3. Panel front and edges shall be fully wrapped and securely stapled to the OSB backer so that the backer is not exposed on front or four sides.
- 4. Pads shall be supplied with 1 inch fabric wrapped mounting flanges at panel

- top and bottom, with Z-clips at top.
5. Attachment: Provide pads without solid backing with Z mounting clips top and bottom.
  6. Provide with manufacturer's standard wall pad cutout trims for all devices, receptacles, switches, fire-extinguisher cabinets and other necessary cutouts occurring on walls with pads. Coordinate with MEPFP, AV/IT/Sec drawings for all occurrences which may or may not be shown on the interior elevations.

UL GREENGUARD Gold Certification: Entire wall pad assembly shall have been submitted to indoor air quality evaluation (IAQ) evaluation in accordance with UL 2811 test method to show compliance with emissions limits on UL 2818 Section 7.1 and 7.2. Materials are tested in accordance with ANSI/BIFMA M7.1-2011 and determined to comply with ANSI/BIFMA X7.1-2011 and ANSI/BIFMA e3-2014e credit 7.6.1, 7.6.2 and 7.6.3. Material of emissions of total volatile organic compounds of < 0.22 mg/m<sup>3</sup>, formaldehyde < 0.0135 ppm, total aldehydes < 0.043 ppm, individual volatile organic compounds < 1/1000 TLV and < 1/2 chronic REL and total phthalates < 0.01 mg/m<sup>3</sup>. Manufacturer must be able to provide independent lab and test reports to verify compliance.

Fire Rating: Entire pad assembly has been tested and meets the requirements of NFPA 101 Life Safety Code for class A rating (flame spread 0-25 and smoke development 0-450) when tested in accordance with ASTM E-84 (also published as NFPA-255, ANSI 2.5, UBC 8-1 (42-1) and UL 723). Entire pad assembly has been tested and meets the criteria when tested in accordance with NFPA 286.

Pads shall meet all requirements of ASTM F 2440-04. Manufacturer must be able to provide independent lab and test reports to verify compliance.

Manufacturer shall provide independent lab and test reports to verify compliance with above standards and certifications.

## **2.2 BASKETBALL BACKSTOPS**

### **A. Gym 1 (2 provided base bid, 4 additional as alternate see drawings)**

#### **1. Type:**

Basketball backstop shall be the DRAPER EZ FOLD Model TF-20 or approved equal, ceiling-suspended, forward folding by Draper, Inc or approved equal

Backstop shall be a welded together main frame constructed from steel mechanical tubing to form a rigid tetrahedral "T" design of back-to-back right triangles. The main stem shall be 6" OD 11-ga. steel tubing, the top of the "T" shall be 4" OD 11-ga. steel tubing and the side braces shall be 2-1/4" OD 14-ga. steel tubing. Side braces shall join stem no higher than 4'6" above goal (18" above top of backboard). The main stem shall be long enough to allow ±6" height adjustment of either fan or rectangular banks. The folding front brace shall be jackknife type, fully adjustable, self-locking in the down position and constructed of 2-1/2" OD 13-ga. (outer) steel tubing and 2-1/4" OD 14-ga. (inner) steel tubing.

Pivot or hinge joint for folding of backstop shall not exceed 15" from roof structure except when required by architectural conditions for coordination with other trades or equipment. Pivot or hinge point to be designed in a manner to provide a minimum

structural capacity of approximately 20,000 Lbs. and a safety factor of 50:1. The main backstop frame shall pivot on 1-1/4" minimum solid steel shaft secured in a milled bearing hole in 1/2" minimum steel plate hangers to ensure accurate positioning of bank.

Bank attached to the 6" OD main stem by heavy-duty bank hangers. Hangers constructed of 1" x 2" 11-ga. steel tubing and formed 1/4" steel plate with slotted holes for lateral adjustment. All banks shall have one upper bank hanger and include a goal brace, which attaches directly to the goal mounting plate and directly to the 6" main stem of the backstop to eliminate any strain on the bank and help prevent glass breakage. Backstop to have powder coat finish.

Backstop is raised or lowered by a 1/4" (6.35 mm) aircraft cable, certified minimum break strength of 7,000 pounds (3178 kg), operating on cast iron sheaves with bronze oilite bearings that do not require lubrication.

Backstop shall be supported from 4" OD 11-ga. steel mechanical tubing anchored to roof structure by means of heavy steel support hangers. Attachment to building structure to be with clamps capable of supporting a minimum of 20,000 Lbs. each. Superstructure shall be designed with a minimum of four attachment clamps to produce a combined minimum attachment point safety factor of 75 to 1 and manufacture must be able to present independent testing data to substantiate safety factor. Superstructure tubes shall be reinforced with bridging and/or bracing when truss centers exceed 12'0".

Backstop shall be provided with custom powder coat finish as selected from manufacturers standard offering of a minimum of 25 colors.

## **2. Operation:**

Winch is to be DRAPER model no. 503280 electric winch or approved equal

Winch has a powerful 3/4 HP, 115-volt, single phase, instant reverse motor with thermal overload protection that is governed to stall at 14 amps. Motor is rated at an intermittent 10-minute duty cycle. Winch motor operates at full load amperage rating of 11.5 full load amps. Winch has integral limit switches to stop travel in up and down positions.

Winch has an oil-bath gear case with precision ball bearings and premium seals for a lifetime of maintenance-free, leak free operation. Gear case features hardened steel gears that are securely captured to take on radial and thrust loads. Double worm gear reduction is in a ratio of 200:1 to provide exceptional holding power under load and eliminates the need for special or supplemental braking systems. Winch is specified to continuously run at the maximum rated load of 1250 lbs. (566 kilograms) for the motors rated duty cycle of 10 minutes without sustaining any gear damage.

Winch has a large 4 1/2" (114 mm) diameter cable drum that is helically grooved to accept 1/4" – 7 x 19 galvanized aircraft cable. Drum will accept up to 35' (10.7 meters) on a single layer and has a torsion spring tensioning roller to ensure cable tracks properly into grooves, even if cable is allowed to go slack. Large diameter, grooves and tensioning spring provide long cable life and performance.

Winch can be mounted in any orientation that allows for correct wrap direction and unobstructed cable travel which provides extreme flexibility during installation.

Winch Assembly is covered by a five-year limited warranty and weighs just 68 Lbs. (30.8 kilograms)

Motor shall be controlled by controls specified elsewhere in this section.

**3. Bank:**

Backboard to be DRAPER Model 503136 rectangular glass backboard or approved equal

Backboard to be 72" x 42" to meet all NCAA, NFHS and professional requirements. Backboard frame of a heavy, brushed aluminum extrusion for maximum durability. Extended frame section of high tensile aluminum (6063-T5). Ends of the frame extrusions mitered and fitted with steel brackets on all four corners, with the upper brackets incorporating keyhole slots for mounting the backboard to the support structure at standard mounting centers.

Goal mounting structure of a heavy, formed steel assembly, secured to the lower horizontal frame member to minimize stress on the glass section. Special steel sleeves at the goal mounting hole locations to secure rear structure to front mounting plate, forming a unitized assembly to minimize shock to the glass. Entire frame including goal-mounting structure fitted with a shock absorbing neoprene material to cushion and protect the glass section.

1/2" (12 mm) thick, fully tempered glass section with uniform load and impact strength. Glass is tempered to meet ANSI Standard Z91.1 Class A and CPSC Standard 16 CFR1201 Category II. Glass is tested to conform with requirement of FIBA Rule 2.8 – Rigidity Test for Backboard Tempered Safety Glass. Official white border and target area is permanently fired into front side of glass section so that it cannot wear away.

Goal mount structure provided with two holes (7/16") and two studs (3/8"-16) to secure backboard and goal to a direct mount "goal brace" feature which relieves all stress and shock on the backboard conforming to NCAA (Rule 1.15.1) and NFHS (Rule 1.11.1). Goal mounting holes (4) to be standard 5" (127mm) horizontal x 4" (102 mm) vertical mounting centers.

Backboard covered by a Lifetime Limited Warranty when installed on a Draper EZ Fold basketball backstop with Goal Brace or Direct Mount Height Adjuster.

**4. Backboard Safety Padding:**

Backboard Edge Padding to be DRAPER Model 5032XX bolt-on backboard safety padding or approved equal

Molding process produces a tough "skin" on the outside of the foam padding for long life. Pre-molded corners for improved player safety. Foam has about a 15 lbs. density and durometer of approximately 35 on the Shore A scale. Molded-in steel track and bolt-on attachment system eliminate frustrating re-gluing or taping. Meets or exceeds

all NCAA, NFHS and FIBA requirements. Available in Grey, Dark/Royal Blue, Red/Scarlet, Navy Blue, Marine/Columbia Blue, Kelly Green, Yellow, Forest Green, Orange, Purple, Black, and Maroon.) 10-year warranty when installed indoors.

**5. Goal:**

Goal to be DRAPER Model 503576 breakaway goal or approved equal

Goal is designed to withstand shock loads due to a player slam dunking and/or hanging on the rim. The rim shall deflect down when a static load in excess of 180 pounds is applied. The rim will return to the playing position once the load is removed. The function of the breakaway goal shall meet all NCAA and NFHS rules. Goal shall be set at factory for proper flex and rebound requirements but is field adjustable to ensure continued rule compliance.

Rim is fabricated from a 5/8" diameter steel rod formed into an 18" inside diameter ring. Inside of ring positioned 6" from the face of backboard by a heavy-duty mounting plate with mounting holes centered to match 5" x 5" or 5" x 4" backboard mounting holes. Goal will mount on standard glass, fiberglass, aluminum, steel, and wood backboards.

Rim rigidly braced by means of die cut steel braces formed and welded to underside of rim for maximum support. Goal is provided with twelve "no tie" net attachment clips, welded to rim for net attachment. Goal painted in an official durable orange powder coat and furnished with zinc plated mounting hardware and high-quality white nylon anti-whip net. Goal to have three-year limited warranty.

**6. Controls:**

Group Control System shall be DRAPER EZ Pad 3.0 Control System or approved equal

Group Controller is capable of controlling Basketball Backstops with Electric Winches, Electric Divider Curtains, Electric Height Adjusters, Overhead Volleyball Systems, Wrestling Mat Lifters and other Auxiliary Devices from a centralized location. Controller to consist of a combination of touch screens and relay/processor boxes and is fully programmable to operate gym equipment and auxiliary devices in groups of up to 8 devices. Controller to be capable of being networked with other controller devices (relay boxes or touch screens) in almost unlimited combinations.

Touch Screen(s) are Draper Model No 503337 EZ Pad 3.0 Color Touch Screens or approved equal. Touch Screen is 7 inches diagonally and include a trim ring for a neat clear appearance. Touch Screen communicates with relay/processor boxes via ethernet communications requiring CAT-5e or better cable.

Relay/Processor Box(es) are Draper Model No. 503358 EZ Pad 3.0 Relay Box or approved equal. Relay box is a 16" x 12" x 4" hinged steel enclosure that surfaces mounts. Each Relay Box includes two banks of relays that includes sufficient relays to operate four directional devices from input voltage and one on/off auxiliary device with an outside power source. Each Relay Box receives 2 (one for each bank of relays) dedicated 30-Amp Circuits. Relay enclosure is listed as a complete assembly as meeting requirements of UL Standard 66010-2-201-Standard for Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.



Control System includes multi-level password protection to ensure only authorized individuals can operate devices or alter system programming. User password only allows someone to operate devices individually or groups as defined in system programming. Administrator password allows same function as user password plus allows initial set up and other program modifications. Administrator password also allows user to name connected devices, name relay boxes, define and name groups, define timeout period and change passwords. System includes a hard coded backdoor password that is available from manufacturer to use should other passwords be lost or forgotten. Touch Screen automatically returns to inactive mode if inactive for more than the user defined timeout period.

Relay Boxes can be combined in unlimited quantities to operate as many devices as may be required. Each Relay box can operate up to two touch screens. All communications over ethernet connections using CAT-5e or better cable. Relay boxes must be within 300 feet of next relay box and touch screens must be within 300 feet of relay box to which it is connected

Control System if field programmed and all programming can be done from touch screen or from relay box interface. Programming is soft coded, there are any dip switches to address devices to be set during system set up. System allows for creation of up to 64 unique and namable groups. System will allow groups of up to 8 devices to run simultaneously and includes logic that prevents the creation of groups that might overload input circuits. To do this it will allow no more than two devices connected to any relay bank and a maximum of 4 devices in the same relay box. To have groups of 8 devices, two or more relay boxes are required.

Control system allows for devices or groups to be operated from relay panel if touch screen(s) were to become disabled. Devices are operated following instructions on LED screen and push buttons located on relay box control boards. User defined password(s) are required to operate devices from relay panels

**ELECTRICAL CONTRACTOR SHALL PROVIDE AND INSTALL:** All conduits complete with wire from power source to relay/processor box, from relay/processor box to devices being operated, CAT 5e or better ethernet wire between relay/processor boxes and touch screen, CAT 5e or better cable between each relay/processor box and next relay/processor on network and one standard 5-5/8" x 4-1/2" c 2-1/2" electrical box (RACO Box #942 or equivalent) for each touch screen.

**7. Safety Strap:**

Safety Strap to be DRAPER model no. 503229 Aut-O-Loc safety strap or approved equal

The safety Strap is designed to engage instantly whenever a cable or other lifting mechanism fails. Safety Strap is actuated by speed or inertia in order to stop a load from falling due to a sudden failure such as a cable breakage, cable clamp failure or any increase in speed due to failure or back drive of a winch. Safety strap is rated for a 1000 lbs. (454 Kg) load and incorporates a 2" wide polyester belt with a breaking strength rating of 6000 lbs. (2,721 Kg) to withstand a 1750 lbs. (794 Kg) free-falling load without any failure of components or the belt.

The housing and drum are manufactured from high tensile heat-treated aluminum alloy that naturally resists corrosion without paint. The drum which houses the mechanism is a singular machined piece to retain its structural integrity in the case of a load capture. The locking mechanism always remains in the ready position regardless of whether belt is retracting or extending. The unit operates at a sound level less than 20db to allow the operator to clearly hear the operational sounds of the winch and backstop, so they may stop winch operation if there are abnormal audible warnings to indicate possible mechanical issues.

Safety Strap has a universal mount that can accommodate 3 ½" (89 mm) or 4" tube (102 mm) and can mount to support tubes running parallel and/or perpendicular to the backboard. Unit is self-aligning with the use of two integral guide wheel to the force of a fall positions the unit in the ideal plane to prevent damage to unit and the supporting structure. The locking mechanism will fully engage within 3" (76 mm) of belt travel in the event of failure. The locking mechanism utilizes multiple high strength steel pawls that deploy and evenly load the drum and housing when engaged and do not rely on a singular locking mechanism.

Safety Strap's retractable nylon strap includes a brightly colored warning strip that indicates when maximum payout of the belt has been reached. The strap also features a brightly colored warning indicator that deploys automatically when engaged. Safety strap is permanently locked when a load of more than 1000 lbs. (454 Kg) of force is caught to prevent possible re-use and failure of critical components that are stressed when the unit engages.

## **2.3 VOLLEYBALL EQUIPMENT**

### **A. Competition Volleyball System (2 required):**

Volleyball System shall be Model 500041, EVS-01 Elite Volleyball System or approved equal

The Volleyball System shall consist of one standard with power winch and one standard with an adjustable anchor collar. Post shall meet all FIVB, USVBA, NCAA and NFSHSA requirements for competition. Post shall have infinite height adjustment between 6' and 8'-4" with preset volleyball settings for elementary school use to international competition for both men and women, for use with volleyball, tennis and badminton. The upright shall be 3-1/2" O.D. schedule 80 aluminum tube, with a wall thickness of .300". The upright is provided with a special rubber foot to protect finished floors and to provide precise net height adjustment.

The tensioning winch shall incorporate a heavy-duty, self-locking worm gear mechanism. Winch shall be furnished with a heavy 2" wide high tensile nylon strap with heavy-duty snap hook to eliminate the possibility of hook breaking and guarantee safe connection to net top cable. The power winch is furnished complete with a folding handle for player safety.

Systems shall come complete with Model 500004 Competition Volleyball Net by Draper, Inc or approved equal. Net shall be 32' long x 39-3/8" high. Netting shall be high quality 4" square #36 black nylon cord with vinyl coated polyester hem double stitched around entire perimeter of net. Top hem of net shall be furnished with a 40'6" long by 1/8" diameter 2000 lb. minimum breaking strength galvanized aircraft cable with a nylon coating (3/16" OD) to

protect against fraying. Ends of cable to have loops with heavy swaged type fittings for easy installation.

Hems in end of net shall be furnished with a pocket for use with a 1/2" diameter fiberglass dowel rod. Ends of net shall have six 1" wide polypropylene tension straps with buckles for providing additional tightening of net. Bottom of net shall be furnished with a 1/4" diameter braided white nylon rope equipped with a spring loaded, pressure type rope tensioner.

System also to include Model 500005 Rope Tensioner or approved equal and Model 500016 Combination Antenna and Boundary Marker or approved equal

**B. Floor Plate, Chrome-plated w/swivel cover (6 required)**

Volleyball Cover Plate shall be model 501035 Locking Brass Cover Plate Assembly by Draper, Inc or approved equal.

Cover plate assembly shall be provided for use in either synthetic or wood floors. Cover plate shall consist of cast aluminum recessed mounting flange, 5-3/16" in diameter, and a 5" diameter chrome plated cover. Cover shall be equipped with a swivel type retaining screw to prevent theft. A special key shall be provided for opening cover. Three #10 x 1-1/2" flat head wood screws shall be provided to securely mount cover plate assembly to floor.

**C. Floor Sleeve (One per cover plate and adapter)**

Floor Sleeves to be DRAPER Model 501006 3-1/2" I.D. Floor Sleeve or approved equal

Floor sleeve constructed of steel mechanical tubing with an inside diameter of 3-1/2", welded to an octagonal shaped bottom plate. Sleeve is 8-1/2" long and designed to be installed with the bottom at 9 1/2" below the playing surface and grouted into the floor sleeve adapter.

**D. Judge's Stand with protective pads (1 required)**

Judges stand shall be Model 5013xx (xx=color) by Draper, Inc or approved equal.

Judges stand shall be designed to attach to a collar by means of a removable, self- locking pin. Collar slides over 3-1/2" O.D. volleyball standard and is rigidly positioned to post with allen-head set screws.

Frame shall be constructed of 1-1/2" x 1-1/2", 14-gauge square steel tubing and 1" OD steel tubing, welded together. Legs, steps, platform, and handrails shall all be one solid unit. Judges platform shall consist of 1/2" thick, polyurethane finished Birch plywood, permanently bolted to stand. Handrail/ladder section shall be spaced vertically 16" on center with three (3) ladder steps spaced horizontally of 16" centers. Lower end of ladder tubes shall have 1/2" thick rubber bumper to protect finished floors. Ladder legs shall have 2" O.D. rubber wheels for easy transporting of stand. All metal components of stand shall be finished in black powder coat.

Judges stand shall be supplied complete with safety padding for player protection. Upper section of stand shall have a snapped into place 1/12" polyethylene foam padding. Lower ladder tubes shall have removable, hook and loop attached pads of 1" neoprene foam. All pads shall be wrapped with 14 oz., polyester reinforced,

- a. Color as selected by the Architect from manufacturers full range.

**E. Protective Pads (4 required)**

Volleyball Post Padding to be DRAPER Model 5011XX Official or approved equal  
Padding for 3-1/2" O.D. Volleyball Systems

Pads hinged at corners to fold neatly around posts and tensioning winch to provide maximum player protection. Pads are constructed of 1 1/2" thick polyethylene foam filler covered with polyester reinforced vinyl with three (3) hook and loop fastening straps for quick set-up and take-down, and constructed to accommodate winch, or judges stand when used.

- a. Color: selected from manufacturer's full range.

**F. Transporter (1 required).**

Heavy-Duty Volleyball Post Transporter/Storage Cart to be DRAPER model 501016 or approved equal

Heavy-duty transporter/storage cart capable of storing, and transport one referee stand and six volleyball posts. Transporter/Storage Cart is provided with vinyl covered bottom shelf and pouch to allow for storage of nets, pads antennas and boundary markers. Frame is rectangular steel tubing finished with attractive gloss black powder coat. Transporter/Storage Cart rolls 4" x 1 1/4" non-marking swivel casters.

- a. Color to be selected from manufacturer's full range.

**2.4 SECOND FLOOR SLEEVE ADAPTER**

Floor Sleeve Adapter (6 required) to be installed by GC and its subcontractors under specification 096560 Synthetic Sports Flooring

Floor Sleeve Adapters shall be for a second story raised slab on metal deck Model 501007" by Draper, Inc or approved equal

Second Story Floor sleeve shall be of all welded construction and shall consist of 6" OD – 11 Ga. Tubing, 2" x 3" x 3/16" steel angles and 1/4" HR Flat Steel. Second Story Sleeve Adaptor shall be finished with black powder coat paint. Unit to be bolted to underside of concrete slab so floor sleeves can be installed in a normal manner

**PART 3 – EXECUTION**

**3.1 PREPARATION**

- A. Coordinate support of basketball backstops and roof structure to ensure proper distribution of loads and adequacy of attachment points. Ensure that building structure has been designed for loads of specific gymnasium divider to be provided. Provide additional structural framing members as required in accordance with Section 055000 miscellaneous metals and 051200 Steel Framing.
- B. Coordinate configuration, size, and installation of basketball backstops and gymnasium divider curtains with height, slope, and type of building structure and lighting fixtures, mechanical equipment, ductwork, fire-suppression system, bleachers, athletic equipment, and other potential obstructions.
- C. Field-verify dimensions prior to fabrication.
- D. Coordinate electrical requirements for motorized operating mechanism to ensure proper power source, conduit, wiring, and boxes for keyed switches. Prior to installation, verify type and location of power supply. See "Electrical Contractor Shall Provide and Install"
- E. Coordinate delivery of Volleyball Floor Sleeves and Covers with sub-contractors responsible for installation.
- F. Coordinate delivery of Volleyball Floor Sleeve Adapters with General Contractor and its sub-contractors responsible for installation.
- G. For installations made after wood gymnasium is installed, provide protection and exercise care not to damage flooring.

### **3. 2 INSTALLATION**

- A. Install in accordance with manufacturer's written instructions and shop drawings.
- B. Install even, plumb and level.
- C. Install control switch such that operator has view of complete basketball backstop during lowering and raising.
- D. Adjust limit switches of electric winch to ensure accurate position in both stored and lowered positions.
- E. Erection of assemblies shall be done by the manufacturer or by an erector approved by the manufacturer. Use only thoroughly experienced mechanics for the work.
- F. Set backboards and goals and nets so they are the proper distance from the finished floor as per NCAA rules.
- G. Upon completion of installation, touch up scratched paint and remove blemishes.
- H. Anchoring to In-Place Construction: Use anchors and fasteners where necessary for securing gymnasium equipment to structural support and for properly transferring load to in-place construction.
- I. Connections: Connect automatic operators to building electrical system.

### **3. 3 TESTING AND DEMONSTRATION**

- A. Operate basketball backstops to ensure proper lifting and lowering. Adjust as required to ensure smooth operation and accurate positioning.
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain gymnasium equipment.
- C. Demonstrate to Owner's designated representative complete operation and required maintenance.
- D. Adjust movable components of gymnasium equipment to operate safely, smoothly, easily, and quietly, free from binding, warp, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Lubricate hardware and moving parts.

### **3.3 CLEANING**

- A. After completing gymnasium equipment installation, inspect components. Remove spots, dirt, and debris and touch up damaged shop-applied finishes per manufacturer's written instructions.
- B. Replace gymnasium equipment components and finishes that cannot be cleaned and repaired, in a manner approved by Architect, before time of Substantial Completion.

**END OF SECTION**

## SECTION 12 2400 –WINDOW SHADES

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Manually operated, dual roller blackout and solar shades interior window shades including mounting and operating hardware.

#### 1.2 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. NFPA 701-99 - Fire Tests for Flame-Resistant Textiles and Films.
- C. GREENGUARD Environmental Institute Gold.
- D. ANSI/WCMA A100.1-2018

#### 1.3 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product specified, including:
  - 1. Preparation instructions and recommendations.
  - 2. Installation and maintenance instructions.
  - 3. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.
  - 4. Storage and handling requirements and recommendations.
  - 5. Mounting details and installation methods.
  - 6. Typical wiring diagrams including integration of motor controllers with building management system, audiovisual and lighting control systems as applicable.
- B. Shop Drawings: Plans, elevations, sections, product details, installation details, operational clearances, wiring diagrams and relationship to adjacent work.
- C. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings, field verified window dimensions, quantities, type of shade, controls, fabric, and color, and include opening sizes and key to typical mounting details.
- D. Verification Samples: For each finish product specified, two complete sets of shade components, unassembled, demonstrating compliance with specified requirements. Shade fabric sample and aluminum finish sample as selected, representing actual product, color, and patterns. Mark face of material to indicate interior faces.
- E. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.
- F. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Obtain roller shades through one source from a single manufacturer with a minimum of twenty years experience in manufacturing products comparable to those specified in this section.
- B. NFPA Flame-Test: Passes NFPA 701. Materials tested shall be identical to products proposed for use.

- C. Mock-Up: Provide a mock-up of one manual roller shade assembly specified for evaluation of mounting, appearance and accessories.
  - 1. Locate mock-up in window(s) designated by Architect.
  - 2. Do not proceed with remaining work until mock-up is accepted by Architect.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver window shades until building is enclosed and construction within spaces where shades will be installed is substantially complete.
- B. Deliver products in manufacturer's original, unopened, undamaged containers with labels intact.
- C. Label containers and shades according to Window Shade Schedule.
- D. Store products in manufacturer's unopened packaging until ready for installation.

## 1.6 SEQUENCING

- A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.
- B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

## 1.7 PROJECT CONDITIONS

- A. Install roller shades after finish work and ambient temperature, humidity and ventilation conditions are maintained at levels recommended for project upon completion.

## 1.8 WARRANTY

- A. Hardware and Shade Fabric: Draper's standard twenty-five year limited warranty.
- B. Motors and Controls: Draper's standard five year limited warranty.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Draper Inc.
- B. Other manufacturers:
  - 1. Mechoshade
  - 2. Crestron
  - 3. Rollease Acmeda
  - 4. Or approved equal

### 2.2 MANUALLY OPERATED WINDOW SHADES (RS)

- A. Heavy-Duty Manually Operated Window Shades with Independent Control: Manually operated, vertical roll-up, fabric window shade with components necessary for complete installation; Clutch-Operated FlexShade NEXD as manufactured by Draper, Inc. or approved equal
  - 1. Operation: Bead chain and clutch operating mechanism allowing shade to stop when



chain is released. Designed never to need adjustment or lubrication. Provide limit stops to prevent shade from being raised or lowered too far.

- a. Clutch mechanism: Fabricated from POM thermoplastic with welded 0.354 inch (9 mm) primary steel post with rotational bearing, overrunning design, and positive mechanical engagement of drive mechanism to tube. White or Black color as selected by Architect. Center bead chain placement for right or left hand operation and accommodates side channel with no adjustment of chain location.
- b. Bead chain loop: Stainless steel bead chain.
- c. Bead Chain Hold Down: P-Clip.
2. Dual Roller Configuration:
  - a. Mounting:
    - 1) Inside 3-sided extruded aluminum recessed pocket
  - b. Enclosures: Aluminum Pocket – three-sided aluminum extrusion to conceal brackets, roller tube, fabric, and operating system. Provide with endcaps
    - 1) Recessed installation flush with finished ceiling.
    - 2) 4"x6" pocket size minimum
    - 3) Finish color as selected by architect from manufacturer's full range.
3. Shade slat:
  - 1) Closed pocket elliptical slat: 1 inch (25 mm) aluminum elliptical slat inside of a 1-5/8 inch (41 mm) pocket with heat sealed ends.
4. Rollers: Extruded aluminum roller tube of appropriate diameter to support shade fabric with minimal deflection.
  - a. Minimum Roller Tube Diameter: 1.25 inches (32 mm).
  - b. Fabric Connection to Roller Tube: Spline fabric/roller attachment system to allow shade fabric to be removed from roller without having to remove roller from brackets.
  - c. Fabric Length: 6 inches (152 mm) greater than window height minimum.
  - d. Hembar: Machine extruded aluminum, finished to match fascia..

## B. FABRIC

1. Light-Filtering Fabrics
  - a. T Screen with KOOLBLACK Technology 3 percent openness factor by Mermet: PVC coated fiberglass woven mesh. Dark on one side, light on the other. GREENGUARD Gold certified as a low emitting fabric. Manufacturer to supply GREENGUARD Gold certificate. Fire rating: NFPA 701-99 TM #1, California U.S. Title 19. 13.27 oz/sq yd, .029 inches thick. Average 3 percent open.
    - 1) Or approved equal
  - b. Color and pattern: as indicated on the finish schedule or selected from manufacturer's full range
2. Black-out Fabric
  - a. Sparta Twilight with 0 percent openness factor by Mermet or approved equal.
  - b. 100% polyester with acrylic foam coating.
  - c. Provides complete privacy
  - d. Solar reflectance: 73%
  - e. SHGC % improvement: 63%
  - f. GREENGUARD Gold certified as a low emitting fabric. Manufacturer to supply GREENGUARD Gold certificate.
  - g. Fire rating: NFPA 701-99 TM #1,
  - h. Color and pattern: as selected from manufacturers full range.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### **3.2 PREPARATION**

- A. Coordinate requirements for blocking and structural supports to ensure adequate means for installation of window shades.
- B. Coordinate requirements for power supply conduit, and wiring required for window shade motors and controls.

### **3.3 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install roller shades level, plumb, square, and true. Allow proper clearances for window operation hardware.
- C. Install the following items to conceal roller and operating mechanism. Do not use exposed fasteners.
  - 1. Fascias.

### **3.4 TESTING AND DEMONSTRATION**

- A. Test motorized window shades to verify that controls, limit switches, interface to other building systems, and other operating components are functional. Correct deficiencies.
- B. Demonstrate operation of shades to Owner's designated representatives.

### **3.5 PROTECTION**

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

**END OF SECTION**

## SECTION 127600 - TELESCOPING GYM SEATS

### PART 1 GENERAL

#### 1.01 SUMMARY

- A. Section Includes: Telescoping Gym Seating manually operated systems of multiple-tiered seating rows comprising of seat, deck components, understructure that permits closing without requiring dismantling, into a nested configuration for storing or for moving purposes.
  - 1. Typical applications include the following:
    - a. Wall Attached Telescoping Gym Seats.
- B. Related Sections:
  - 1. Division 9 finishes sections for adequate floor & wall construction for operation of Telescoping Gym Seats. Flooring shall be level and rear wall plumb within 1/8" in 8'-0" Maximum bleacher force on the floor, of a 25'-6" section, shall be a static point load of less than 300 psi.

#### 1.02 REFERENCES

- A. National Fire Protection Association (NFPA)
  - 1. NFPA 102 Standard for Assembly Seating, Tents and Membrane Structures.
- B. American Welding society (AWS):
  - 1. AWS D1.1 Structural Welding Code - Steel.
  - 2. AWS D1.3 Structural Welding Code - Sheet Steel.
- C. American Institute of Steel Construction (AISC):
  - 1. AISC - Design of Hot Rolled Steel Structural Members.
- D. American National Standards Institute (ANSI).
- E. American Iron & Steel Institute (AISI):
  - 1. AISI - Design Cold Formed Steel Structural Members.
- F. Aluminum Association (AA):
  - 1. AA - Aluminum Structures, Construction Manual Series.
- G. American Society for Testing Materials (ASTM):
  - 1. ASTM - Standard Specification for Properties of Materials.
- H. National Forest Products Association (NFoPA):
  - 1. NFoPA - National Design Specification for Wood Construction.
- I. Southern Pine Inspection Bureau (SPIB):
  - 1. SPIB - Standard Grading Rules for Southern Pine.

- J. National Bureau of Standards/Products Standard (NBS/PS):
  - 1. PS1 - Construction and Industrial Plywood.

- K. Americans with Disability Act (ADA)
  - 1. ADA - Standards for Accessible Design.

#### 1.03 MANUFACTURER'S SYSTEM ENGINEERING DESCRIPTION

- A. Structural Performance: Engineer, fabricate and install telescopic gym seating systems to the following structural loads without exceeding allowable design working stresses of materials involved, including anchors and connections. Apply each load to produce maximum stress in each respective component of each gym seat unit.
  - 1. Design Loads: Comply with NFPA 102, 1992 Edition, Chapter 5 for design loads.
- B. Manufacturer's System Design Criteria:
  - 1. Gymnasium seat assembly; Design to support and resist, in addition to it's own weight, the following forces:
    - a. Live load of 120 lbs per linear foot on seats and decking
    - b. Uniformly distributed live load of not less than 100 lbs per sq. ft. of gross horizontal projection.
    - c. Parallel sway load of 24 lbs. per linear foot of row combined with (b.) above
    - d. Perpendicular sway load of 10 lbs. per linear foot of row combined with (b.) above
  - 2. Hand Railings, Posts and Supports: Engineered to withstand the following forces applied separately:
    - a. Concentrated load of 200 lbs. applied at any point and in any direction.
    - b. Uniform load of 50 lbs. per foot applied in any direction.
  - 3. Guard Railings, Post and Supports: Engineered to withstand the following forces applied separately:
    - a. Concentrated load of 200 lbs. applied at any point and in any direction along top rail.
    - b. Uniform load of 50 lbs. per foot applied horizontally at top rail and a simultaneous uniform load of 100 lbs. per foot applied vertically downward.
  - 4. Member Sizes and Connections: Design criteria (current edition) of the following shall be the basis for calculation of member sizes and connections:
    - a. AISC: Manual of Steel Construction
    - b. AISI: Specification for Design of Cold Formed Steel Structural Members
    - c. AA: Specification for Aluminum Structures
    - d. NFOPA: National Design Guide For Wood Construction.

#### 1.04 SUBMITTALS

- A. Section Cross-Reference: Required submittals in accordance with "Conditions of the Contract" and Division 1 General Requirements sections of this "Project Manual."
- B. Project Data: Manufacturer's product data for each system. Include the following:
  - 1. Project list: Ten (10) seating projects of similar size, complexity and in service for at least five (5) years.
  - 2. Deviations: List of deviations from these project specifications, if any.
- C. Shop Drawings: Indicate Telescoping Gym Seat assembly layout. Show seat heights, row spacing and rise, aisle widths and locations, assembly dimensions, anchorage to supporting structure, material types and finishes.
  - 1. Graphics Layout Drawings: Indicate logo pattern of contrasting or matching seat colors
- D. Samples: Seat materials and color finish as selected by Architect from manufacturers offered color finishes.
- E. Manufacturer Qualifications: Certification of manufacturing experience, and copy of a telescopic load test to all loads described in 1.03 above, observed by a qualified independent testing laboratory, and certified by a registered professional structural engineer verifying the integrity of the manufacturer's geometry design and base structural assumptions.
- F. Installer Qualifications: Installer qualifications indicating capability, experience, and official Certification Card issued by manufacturer of telescopic seating.
- G. Engineer Qualifications: Certification by a professional engineer registered in the state of manufacturer that the equipment to be supplied meets or exceeds the design criteria of this specification.
- H. Operating/Maintenance Manuals: Provide to Owner maintenance manuals. Demonstrate operating procedures, recommended maintenance and inspection program.
- I. Warranty: Manufacturers standard warranty documents.

#### 1.05 QUALITY ASSURANCE

- A. Seating Layout: Comply with current NFPA 102 Standard for Assembly seating, Tents, and Membrane Structures, and specifically with Folding and Telescopic Seating, except where additional requirements are indicated or imposed by authorities having jurisdiction.
- B. Welding Standards & Qualification: Comply with AWS D1.1 Structural Welding Code - Steel and AWS D1.3 Structural Welding Code - Sheet Steel.
- D. Manufacturer Qualifications: Manufacturer who has a minimum of 40 years of experience manufacturing telescoping gym seats and can demonstrate continual design enhancement and 25-year minimum product life-cycle support of telescopic seating.

- E. Installer Qualifications: Engage experienced Installer who has specialized in installation of telescoping gym seat types similar to types required for this project and who carries an official Certification Card issued by telescoping gym seat manufacturer.
- F. Engineer Qualifications: Engage licensed professional engineer experienced in providing engineering services of the kind indicated that have resulted in the successful installation of telescoping bleachers similar in material, design, fabrication, and extent to those types indicated for this project.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver telescopic gym seats in manufacturers packaging clearly labeled with manufacturer name and content.
- B. Handle seating equipment in a manner to prevent damage.
- C. Deliver the seating at a scheduled time for installation that will not interfere with other trades operating in the building.

#### 1.07 PROJECT CONDITIONS

- A. Field Measurements: Coordinate actual dimensions of construction affecting telescoping bleachers installation by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid delay of Work.

#### 1.08 WARRANTY

- A. Manufacturer's Product Warranty: Submit manufacturer's Special warranty form for telescoping bleachers. This warranty is in addition to, and not a limitation of other rights Owner may have under Contract Documents.
  - 1. Warranty Period: ten years from Date of Acceptance.
  - 2. Beneficiary: Issue warranty in legal name of project Owner.
  - 3. Warranty Acceptance: Owner is sole authority who will determine acceptance of warranty documents.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Basis of Design Manufacturer: Hussey Seating Company, U.S.A.
- B. Other Acceptable Manufacturers: The products of the following manufacturer's may be accepted if in compliance with the performance characteristics of this specification.
  - a. Kodiak
  - b. Irwin
  - c. or approved equal

- C. Basis of Design Product: MAXAM Telescopic Gym Seat System by Hussey Seating Company or approved equal
- a. Model: MAXAM26 Series Telescopic Gym Seats, 24" Row Spacing or approved equal
  - b. Aisle Type: foot level aisles, front steps, intermediate aisle steps.
  - c. Seat Type: 10" Courtside (plastic seat module) Seat color finish: manufacturers 15 standard colors. Owner has choice of the following (up to (3) Colors as a standard):
  - d. Operation: manual
  - e. . Product Description/Criteria: (As Shown on Drawings)
    - a. Bank Length: 78'-6"
    - b. Aisle Widths: 4'-6", 3'-0"
    - c. Number of Tiers: 3
    - d. Row Spacing(s): 24"
    - e. Row Rise: 9 5/8"
  - f. Handicap Seating Provisions: Provide first tier modular recoverable Flex-rows per requirements of (ADA) Americans with Disability Act located as indicated. Flex row to be operated without the use of tools. It shall take no longer than fifteen seconds to operate flex-rows.

## 2.02 MATERIALS

- A. Lumber: ANSI/Voluntary Product 20, B & B Southern Pine
- B. Plywood: ANSI/Voluntary Product PS1, APA A-C Exterior Grade.
- C. Structural Steel Shapes, Plates and Bars: ASTM A 36.
- D. Uncoated Steel Strip (Non-Structural Components): ASTM A569, Commercial Quality, Hot-Rolled Strip.
- E. Uncoated Steel Strip (Structural Components): ASTM A570 Grade 33, 40, 45, or 50, Structural Quality, Hot-Rolled Strip.
- F. Uncoated Steel Strip (Structural Components): ASTM A607 Grade 45 or 50, High-Strength, Low Alloy, Hot-Rolled Strip.
- G. Galvanized Steel Strip: ASTM A653 Grade 40, zinc coated by the hot-dip process, structural quality.
- H. Structural Tubing: ASTM A500 Grade B, cold-formed.
- I. Polyethylene Plastic: ASTM D 1248, Type III, Class B; molded, color-pigmented, textured, impact-resistant, structural formulation; in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's standard colors.

- J. Fasteners: Vibration-proof, of size and material standard with manufacturer.

## 2.03 UNDERSTRUCTURE FABRICATION

### A. Frame System:

1. Wheels: Not less than 5" diameter by 1 1/4" with non-marring soft rubber face to protect wood and synthetic floor surfaces, with molded-in sintered iron oil-impregnated bushings to fit 3/8" [10] diameter axles secured with E-type snap rings.
2. Lower Track: Continuous Positive Interglide System interlocks each adjacent CPI unit using an integral, continuous, anti-drift feature and through-bolted guide at front to prevent separation and misalignment. Frames must have a minimum of 10" of engagement between each other. CPI units at end sections of powered banks and manual sections shall contain a Low Profile Posi-Lock LX to lock each row in open position and allow unlocking automatically. Provide adjustable stops to allow field adjustment of row spacing.
3. Slant Columns: High tensile steel, tubular shape.
5. Sway Bracing: High tensile steel members through-bolted to columns.
6. Deck Stabilizer: High tensile steel member through-bolted to nose and riser at three locations per section. Interlocks with adjacent stabilizer on upper tier using low-friction nylon roller to prevent separation and misalignment. Incorporates multiple stops to allow field adjustment of row spacing.
7. Deck Support: Securely captures front and rear edge of decking at rear edge of nose beam and lower edge of riser beam for entire length of section.

### B. Deck System:

1. Section Lengths: Each bank shall contain sections not to exceed 25'-6" [7772] in length with a minimum of two supporting frames per row, each section.
2. Nose beam and Rear Riser beam: Nose beam shall be continuously roll-formed closed tubular shape of ASTM A653 grade 40. Riser beam shall be continuously roll-formed of ASTM A653 grade 40. Nose and Riser beam shall be designed with no steel edges exposed to spectator after product assembly.
3. Attachment: Through-Bolted fore/aft to deck stabilizers, and frame cantilevers.
4. Decking: 5/8" [16], AC Southern Pine with plugged crossbands, produced in accordance with National Bureau of Standards PS-1-97. Plywood shall be cut and installed with top, center and bottom ply grain-oriented from front of deck to rear of deck (nose beam to riser beam). Adjacent pieces shall be locked together with tongue and groove joint from front to rear of deck. Longest unsupported span: MAXAM 26, 21 1/2" [546]. Deck systems with Polyethylene wear layer will not be accepted.
5. Deck End Overhang: Not to exceed frame support by more than 5'-7" [1702].

## 2.04 SEATING FABRICATION

### B. Plastic Seat System:

1. Seat Modules: 18" long assembled, injection-molded, high density polyethylene modules in mono or two-tone colors providing scuff resistant textured 10" wide seat surface with 1/2" minimum interlock on seat and face. Rear of seat module to be contained allowing a broom to pass down the deck smoothly thus prohibiting the



capture of trash and debris. Seat mounting bracket and support brace shall not be exposed. Seat modules with exposed ribbing will not be accepted. Unit structural tested to 360 lbs occupant load.

2. Comfort Profile: Designed with anatomically contoured seat surface using multiple internal reinforcement ribs that allow form-fit deflection for maximum spectator comfort. Cantilevered to the rear to provide not less than 3" [76] smooth toe space beneath the seat.
3. Seat Support: Each plastic seat module shall be supported by internal steel structural members secured against fore/aft movement by 3/8" grade 5 steel fasteners creating a steel-to-steel connection, tying the seat structure firmly to the steel nose beam.
4. End Caps: Each end of row shall be enclosed with matching end caps. End caps shall be designed flush with end-edge of seat top and provide indent for row letters. Color to match seat top.

#### 2.05 SHOP FINISHES

- A. Understructure: For rust resistance, steel understructure shall be finished on all surfaces with black "Dura-Coat" enamel. Understructure finish shall contain a silicone additive to improve scratch resistance of finish.
- B. Wear Surfaces: Surface subject to normal wear by spectators shall have a finish that does not wear to show different color underneath:
  1. Steel nosing and rear risers shall be pre-galvanized with a minimum spangle of G-60 zinc plating.
  2. Decking shall have use-surfaces to receive both a sealer coat and wear-resistant high gloss clear urethane finish. Decking with Polyethylene finish will not be accepted.
  3. Injection Molded seats to be selected from (15) fifteen standard colors. Colors shall be per manufacturer's standards

#### 2.06 FASTENINGS:

- A. Welds: Performed by welders certified by AWS standards for the process employed.
- B. Structural Connections: Secured by structural bolts with prevailing torque lock nuts, free-spinning nuts in combination with lock washers, or Riv-nuts in combination with lock washers.

#### 2.07 ACCESSORIES

- A. Flex-Row: Provide first row modular recoverable seating units to be utilized by persons in wheelchairs and able-bodied persons. Each Flex-Row unit shall have an unlock handle for easy deployment if wheelchair or team seating access is needed. Unlock handle shall lock the bleacher seats into position when fully opened.

1. Provide a black full-surround steel skirting with no more than ¾" floor clearance for safety and improved aesthetics.
  2. Provide a black injection molded end cap for the nose beam for safety and improved aesthetics.
  3. Provide a mechanical positive lock when the Flex-Row system is in the open and used position.
  4. Flex-Row modular units are designed to achieve multi-use front row seating to accommodate team seating, ADA requirements and facility specific requirements. Flex-Row units are available in modular units from 2 to 7 seats wide as well as full section widths.
  5. Flex-Row units to be operated without the use of tools.
  6. First row is capable of being utilized while the entire bleacher is in the closed position.
  7. Flex-Row is capable of being operated in less than fifteen seconds.
- B. Front Aisle Steps: Provide at each vertical aisle location front aisle step. Front steps shall engage with front row to prevent accidental separation or movement. Steps shall be fitted with four non-skid rubber feet each 1/2" [13] in diameter. Blow molded end caps shall have full radius on all four edges. Quantity and location as indicated.
- C. Non-Slip Tread: Provide at front edge of each aisle location an adhesive-backed abrasive non-slip tread surface.
- D. Foot Level Aisles: Provide deck level full width vertical aisles located as indicated.
- E. Intermediate Aisle Steps: Intermediate aisle steps shall be of boxed fully enclosed type construction. Blow molded end caps shall have full radius on all four edges. Step shall have adhesive-backed abrasive non-slip tread surface. Quantity and location as indicated.
- F. Aisle Handrails: Provide single pedestal mount handrails 34" [864] high with terminating mid rail.
- G. Self Storing End Rails: Provide steel self-storing 42" [1066] high above seat, end rail with tubular supports and intermediate members designed with 4" [102] sphere passage requirements.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Verification of Conditions: Verify area to receive telescoping gym seats are free of impediments interfering with installation and condition of installation substrates are acceptable to receive telescoping gym seats in accordance with telescoping gym seats manufacturer's recommendations. Do not commence installation until conditions are satisfactory.

3.02 INSTALLATION

- A. Manufacturer's Recommendations: Comply with telescoping gym seats manufacturer's recommendations for product installation requirements.
- B. General: Manufacturer's Certified Installers to install telescoping gym seats in accordance with manufacturer's installation instructions and final shop drawings. Provide accessories, anchors, fasteners, inserts and other items for installation of telescoping gym seats and for permanent attachment to adjoining construction.

3.03 ADJUSTMENT AND CLEANING

- A. Adjustment: After installation completion, test and adjust each telescoping gym seats assembly to operate in compliance with manufacturer's operations manual.
- B. Cleaning: Clean installed telescoping gym seats on both exposed and semi-exposed surfaces. Touch-up finishes to restore damage or soiled surfaces.

3.04 PROTECTION

- A. General: Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer to ensure telescoping gym seats are without damage or deterioration at time of substantial completion.

END OF SECTION

## SECTION 131100 - SWIMMING POOLS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT and applicable parts of DIVISION 1 - GENERAL REQUIREMENTS, as listed in the Table of Contents, be included in, and made a part of this Section.

#### 1.2 SUMMARY OF WORK *(for general guidance-not inclusive)*

##### A. Introduction

- 1. Provide labor, materials, equipment, and services necessary to construct the pool(s) and spa. This work must include the structure(s) and installation of pool finishes as well as products listed in Part 2 of Section 131100.

##### B. Work included in this section:

- 1. It is the intent of this section to place the entire responsibility for the construction of the pool(s) (including the construction of the pool shell(s)) under one vested Contractor. Under this section the Contractor will provide but is not necessarily limited to the following:
  - a. Provide equipment and services required for erection and delivery onto the premises the equipment or apparatus provided. Remove equipment from premises when no longer required.
  - b. Grade and replace load bearing or high plasticity index soil, pump and dewater as necessary to keep excavations free from water during construction and provide sub-surface drainage beneath the surge tank as needed or required in the project geotechnical report. Reference Division 31 - Earthwork.
  - c. Provide and maintain proper shoring and bracing for existing utilities, sewers and building foundations where required for related excavations. Reference Division 31 - Earthwork.
  - d. Provide electrical conduit, wiring, junction boxes etc. to low voltage pool equipment within pool filter/chemical rooms per Division 26 - Electrical. (Low voltage is considered less than 110 V.)
  - e. Coordinate for required bonding and grounding of the pool shell, fittings, and equipment.
  - f. Provide necessary piping and valving as shown on the drawings and specified herein.
  - g. Provide individually sized housekeeping pads for each pool pump. Provide housekeeping pads for pool equipment as required in the drawings.
  - h. Provide the main drain hydrostatic relief system and a sight sump as shown on the drawings. Reference Division 31 - Earthwork.
  - i. Construct the cast in place or pneumatically applied concrete pool shells and cast in place surge tanks as described in these specifications and detailed on the drawings, including reinforcement steel, inserts, fittings, fiberglass main drain sumps and embedded items (piping, anchors, spargers, etc.) for the pools and spa. Reference Division 3 - Concrete and Structural. Before commencing the placement of concrete,

verify electrical bonding of the pool and spa embedded items and reinforcing steel. Also, coordinate and arrange required electrical, plumbing and or building inspections. Provide structure drainage around the pool as shown on the drawings. Backfill and compact fill around the pool structure, piping trenches and excavations required by this work. Reference Division 31 - Earthwork.

- j. Provide a ceramic tile finish in the pool and spa. Reference Section 131103 - Swimming Pool Tile - including the tolerance requirements for the concrete substrate.
- k. Provide fully assembled cleaning and maintenance equipment for the pools as specified herein.
- l. Provide for the storage of pool related equipment, materials, and systems. Items are the responsibility of the Contractor until accepted by the owner.
- m. Obtain final acceptance by jurisdictional health department(s).
- n. Start, test, calibrate and adjust mechanical equipment, electrical equipment, recirculation, chemical, and other supplied systems including deck, loose, maintenance, and safety equipment. Instruct the Owner's representative in the systems operation and maintenance as described herein.
- o. Provide the heating system for the pool and spa. Include piping, heaters, heat exchangers, booster pumps, controls, gauges, thermostats, control valves and wiring required to draw water from the recirculation line, heat the water and return it back to the recirculation line and interlock with pool recirculation pumps.

**C. Related work specified in other sections:**

- 1. Section 131103 – Swimming Pool Tile
- 2. Section 131106 – Swimming Pool Timing System
- 3. The following work related to the swimming pools must be completed by other trades.
  - a. Provide, erect, and maintain necessary barricades, signs, lights, and flares for pool construction to protect workers and the public.
  - b. Provide and maintain proper shoring and bracing for existing utilities, sewers and building foundations where required for swimming pool related excavations. Reference Division 31 - Earthwork.
  - c. Provide the under-drain system beneath the pool(s) as needed.
  - d. Provide sub-surface drainage beneath the pump pit and backwash pit. Reference Division 31 - Earthwork.
  - e. Construct pump pit and backwash pit including reinforcement, inserts, wall sleeves, anchors, access hatches, and fittings. Reference Division 3 - Concrete.
  - f. Layout, excavate, remove from the construction site, replace, and grade materials as required beyond the limits of excavation of the pool shell(s) to complete the work described in this section. Reference Division 31 - Earthwork.
  - g. Prior to concrete pours, verify electrical bonding of the pool embedded items. Coordinate and arrange required electrical, plumbing and or building inspections that must be performed on embedded items. Reference Division 26 - Electrical.

- h. Provide sanitary sewer and storm drain connections. Reference Division 22 - Plumbing.
  - i. Provide deck mounted anchors, sockets, and inserts for the pool(s) and coordinate construction locations for each.
  - j. Provide deck finish beyond perimeter tile band. Reference Division 32 - Exterior Improvements.
  - k. Provide rules and regulations signage as required by code. Reference Division 1 - General Requirements.
  - l. Provide chlorine resistant caulking (sealant) and backer rod on pool decks. Reference Division 7 - Thermal and Moisture Protection.
- D. Related work specified in Plumbing section. Reference Division 22 - Plumbing. Work that must be completed by others.
  - 1. Provide trench drains and area drains on pool deck.
  - 2. Provide sanitary sewer piping from the filter room including floor drains, sumps, and sump pump.
  - 3. Provide water service to hose bibbs, flush hydrant boxes and auto-fill bypass to air gap above fill funnel(s). Provide the slow closing solenoid valve(s) in the bypass auto-fill piping.
  - 4. Provide water meter on the fresh water supply line upstream of the manual fill valve and the slow closing solenoid valve.
- E. Related work specified in Mechanical section. Reference Division 23 – HVAC. Work that must be completed by others.
  - 1. Provide air recirculation systems for pool related spaces.
- F. Related work specified in Electrical sections. Reference Division 26 – Electrical. Work that must be completed by others.
  - 1. Provide power to the exhaust fans for the chemical rooms.
  - 2. Provide motor starters, auxiliary contacts, magnetic relays, emergency stops and other electrical control devices necessary for the complete operation of the pool systems. Provide power to Variable Frequency Drive pool pump starters and power from VFD to the pool pump motor.
  - 3. Ground and bond pool structures, fittings, and equipment in accordance with Article 680 of the N.E.C. Test and verify that the system electrical ground is true and solid. Provide certification to this effort.
  - 4. Obtain permits, inspections, and approvals of wiring including grounding and bonding of metal components associated with the pool in accordance with Local, State and National Electrical Codes.
  - 5. Provide power, conduits, electrical boxes, and wiring for the Contractor provided electronic timing and scoreboard system with multi-sport capability for race swimming and diving.
  - 6. Provide power, conduits, electrical boxes, and wiring for the underwater lights and junction boxes.
  - 7. Confirm electrical conduits that penetrate the pool shell are watertight and installed per N.E.C. Article 680.

### 1.3 QUALITY ASSURANCE

- A. The specifications and drawings illustrate and detail three (3) swimming pool systems that are utilized for both competitive and recreational use. Certain technical aspects of the design are common only to pool systems planned for public use. Understanding these aspects, their functions and interaction through experience is vital to completing a successful operating system. It is a mandatory requirement that the Contractor have achieved such experience as a prerequisite for bidding on this project.
  - 1. If the Contractor has not received prior written approval for this project or has not been included in the pre-approved list of Contractors, they must submit a list of projects meeting the aforementioned qualifications, including contact information of the General Contractor must be submitted for review and approval at least 10 days prior to bidding of the project. The Contractor must have completed at least five (5) public-use pools with individual water surface areas in excess of 4500 square feet and a depth of 11'-6" or more within the past 10 years.
  - 2. The Contractor must submit prior to the start of construction the name of the on-site Project Superintendent including their relevant experience. The Contractor's on-site Project Superintendent must have completed at least five (5) public-use pools with individual water surface areas in excess of 4500 square feet and a depth of 11'-6" or more within the past 10 years. A list of projects meeting the aforementioned qualifications, including contact information of the General Contractor as well as Owner must be included with the experience submittal. Project Superintendent on the project cannot change unless written authorization has been provided by the Architect and Owner.
  - 3. The Owner reserves the right to reject a bid if the evidence submitted by, or investigation of, the Contractor fails to satisfy the Owner that the Contractor is properly qualified to carry out the obligation of the contract and to complete the work described or if the Contractor does not have the qualifications stated herein. Subject to compliance with item 2 above on this specification.

### 1.4 REGULATORY AGENCY REQUIREMENTS AND ENGINEERING SERVICES

- A. The system must comply with necessary pre-construction approvals.
- B. Give necessary notices, obtain permits, and pay government fees, and other costs in connection with his work, including the filing of necessary as-built drawings, prepare documents (including any amendments to the approved construction documents) and obtain necessary approvals of governmental departments having jurisdiction over their work. Obtain required certificates of inspection for his work and deliver copies to the Owner and Architect before requesting acceptance and final payment for the work.
- C. Include in the work, without extra cost to the Owner, labor, materials, services, apparatus, or drawings in order to comply with applicable laws, ordinances, rules, and regulations, whether or not shown on drawings and/or specified.

### 1.5 COORDINATION AND CLARIFICATION

- A. Coordinate with other trades' work relating to this section.
- B. Must establish with other trades, having related work in this section, that work necessary to complete the pool(s) as shown on the drawings and in the specifications is included in the base bid and alternates to the Owner.

- C. If in doubt regarding the responsibility for work covered in this section and/or discovery of errors or omissions in the bidding documents, notify the Architect through channels established by the specifications and request a clarification ten (10) days prior to the bid date.

#### 1.6 ALTERNATES

- A. Review the description of the alternates in Division 1 and on the drawings for possible effect upon work in this section. Alternates related to the work in this section are described in this division and on the bid proposal form.
- B. Pool Alternates
  - 1. Alternate #2: Base bid includes spa below deck piping stubbed at the mechanical room and pool deck floor. Add alternate includes construction of spa tank and spa mechanical room equipment.

#### 1.7 CONTRACTOR'S ALTERNATE PROPOSAL

- A. Submit bid to the owner based on materials, equipment and methods as specified in this Section. No substitution of material will be allowed.
- B. It is the intent of the contract documents to encourage competition. The base proposal must include the construction methods and equipment as specified and detailed. Proposed system substitutions must have prior written approval by the Architect.
- C. If there is a deviation from the basis of design equipment, confirm that engineering criteria are appropriate for the substituted equipment.
- D. Substitutions of specified construction methods and equipment must include a complete submittal as required by these specifications and drawings of appropriate scale incorporating required changes. Provide a list of at least ten (10) satisfactory installations comparable to this project that have been manufactured and installed under the manufacturer's current legal name. Submit a list of such projects with the name, address and current telephone number of the Owner's Operator and Architect of Record to the Architect on the bid date.
- E. Changes or modifications to the Contract Documents that are not authorized by the architect are the sole responsibility of the Contractor.

#### 1.8 SUBMITTALS

- A. Submittals must be made in accordance with the requirements of Division 1 - General Requirements and in strict compliance with the following procedures and guidelines.
- B. One (1) set of shop drawings and engineering data must be tabbed, indexed, and referenced to the specifications, compiled into an electronic submittal, and submitted in two stages. The first stage must include items for the pool shell(s), reference swimming pool structural specifications. The second stage must be for remaining items. Each section of items must be prefaced by a cover sheet listing the items submitted within the section. Electronic submittals must be organized, numbered, and submitted in the same format and order as the project specifications. Only complete sets will be reviewed.
  - 1. Engineering data covering systems, equipment, structures, and fabricated materials, which will become a permanent part of the work under this contract, must be submitted for review. This data must include drawings and descriptive information in sufficient detail and scale to show the kind, size, arrangement, and operation of component materials and devices; the external connections, anchorage and supports required; performance characteristics;



fabrication and dimensions needed for installation and correlation with other materials and equipment. A certification, in writing, must be provided indicating that equipment will fit in the space allotted and as shown on the drawings.

2. Submittals regardless of origin must be stamped with the approval of the Contractor and identified with the name and number of this contract, Contractor's name, and references to applicable specification paragraphs and contract drawings. Each submittal must indicate the intended use of the item in the work. When catalog pages are submitted, applicable items must be clearly identified. The current revision, issue number, and date must be indicated on drawings and other descriptive data.
3. The submittals will not be accepted from anyone but the Contractor. Submittals must be consecutively numbered in direct sequence of submittal and without division by subcontracts or trades.
4. The Contractor's stamp of approval is a representation that the Contractor accepts full responsibility for determining and verifying quantities, dimensions, field construction criteria, materials, catalog numbers and similar data, and that he has reviewed or coordinated each submittal with the requirements of the work and the contract documents.
5. Each submittal must include a statement prepared by the originator of the drawings and data, certifying compliance with the contract documents except for deviations, which are specifically identified.
6. Deviations from the contract documents must be identified on each submittal and must be tabulated in the Contractor's letter of transmittal. Such submittals must, as pertinent to the deviation, indicate essential details of changes by the Contractor (including modifications to other facilities that may be a result of the deviation) and required piping and wiring diagrams.
7. The Contractor must accept full responsibility for the completeness of each submission, and, in the case of a resubmission, must verify that exceptions previously noted have been considered.
8. The need for more than one resubmission, or a delay in obtaining review of submittals, will not entitle the Contractor to an extension of the contract time unless the delay of the work is directly caused by a change in the work authorized by a change order.
9. Review of drawings and data submitted by Contractor will cover only general conformity to the drawings and specifications, external connections and dimensions that affect the layout. Review does not indicate a thorough review of dimensions, quantities, and details of the material, equipment, device, or item shown. Review of submittals does not relieve Contractor from responsibility for errors, omissions, or deviations, or responsibility for compliance with the contract documents.
10. When the drawings and data are returned marked REJECTED, REVISE AND RESUBMIT or SUBMIT SPECIFIED ITEM, the corrections must be made as noted thereon and as instructed and six corrected copies (or one copy and one corrected reproducible copy) resubmitted.
11. Resubmittals must bear the number of the first submittal followed by a letter (A, B, etc.) to indicate the sequence of the resubmittal. Resubmittals must be indexed, tabbed, referenced to the specifications, and bound in a three-ring binder and submitted at one time.
12. When corrected copies are resubmitted, the Contractor must, in writing, direct specific attention to revisions and must list separately revisions made other than those called for on previous submissions.

13. When the drawings and data are returned marked NO EXCEPTIONS TAKEN or MAKE CORRECTIONS NOTED, no additional copies are to be provided unless specifically requested to do so for record.
- C. Permits, Receipts and Test Reports
1. Provide the Architect with copies of permits and receipts for fee payments.
  2. Submit a sample format for each test report intended for use. Submit test reports required herein only on approved forms.
- D. Include complete product data indexed, tabbed, and referenced to specifications with 8 ½" x 11" cover sheet covering:
1. Paragraph 2.1 - Overflow System
  2. Paragraph 2.2 - Pumping Equipment
  3. Paragraph 2.3 - Filtration Equipment
  4. Paragraph 2.4 - Recirculation Fittings
  5. Paragraph 2.5 - Piping Systems
  6. Paragraph 2.6 - Chemical Treatment Systems
  7. Paragraph 2.7 - Chemistry Monitoring and Control Systems
  8. Paragraph 2.8 - Flow Meters
  9. Paragraph 2.9 - Water Level Controllers
  10. Paragraph 2.10 - Deck Equipment
  11. Paragraph 2.11 - Loose Equipment
  12. Paragraph 2.12 - Maintenance Equipment
  13. Paragraph 2.13 - Safety Equipment
  14. Paragraph 2.14 - Thermometers
  15. Paragraph 2.15 - Swimming Pool Finishes
  16. Paragraph 2.16 - Waterproofing
  17. Paragraph 2.17 - Sealants
  18. Paragraph 2.18 - Underwater Lights
  19. Paragraph 2.19 - Dive Harness System
  20. Paragraph 2.20 - Pool Heaters
- E. Include engineering/construction drawings for the pool structure.
1. Reference Division 3 - Concrete.
- F. Include engineering construction drawings for pool piping.
- G. Include separate submittal for all color selections required to be made by the Owner/Architect. Physical samples and/or mock ups must be provided as requested and submitted for review. The following items must be included:
1. Gutter Grating

2. Pan Filled Skimmer Lids
3. Sight Sump Frame and Cover
4. Starting Platforms
5. Lifeguard Chairs
6. Pool Lift
7. Competition Floating Lane Ropes
8. Backstroke Flags
9. Lane Line Storage Reels
10. Movable Stanchions and Swag Lines
11. Swimming Pool Tile - Reference Section 131103
12. Sealants

H. Reference Section 131103 - Swimming Pool Tile

I. Reference Section 131106 - Swimming Pool Timing System

#### 1.9 TESTING REPORTS

A. Provide all testing reports as described in the specifications. Testing report(s) and any additional documentation of the test(s) must be submitted to the Architect within seven (7) days of the commencement of the test(s) unless otherwise noted. The following testing report(s) must be submitted for review/record:

1. The pool piping must be hydrostatically pressure tested prior to backfilling. Hydrostatic pressure tests must be performed by the Contractor and witnessed by the Owner, or a representative designated by the Owner.
2. The pool(s), gutter(s), surge/balance tanks(s) and spa(s) must be tested for water tightness prior to the application of any finishes. The water tightness test must be performed by the Contractor and witnessed by the Owner, or a representative designated by the Owner.
3. The pool tile finish must be visually inspected and sound tested prior to filling the pool. The visual inspection and sound testing of the tile finish must be performed by the Contractor and witnessed by the Owner, or a representative designated by the Owner. Refer to specification 131103.
4. Concrete test panels/cylinders must be tested for compressive strength. The Contractor to produce test panels/cylinders to be tested by a third-party testing agency provided by the Owner. Refer to Division 3 – Concrete

#### 1.10 OPERATION AND MAINTENANCE MANUALS AND CLOSE-OUT SUBMITTALS

A. Detailed operation and maintenance information must be supplied for equipment requiring maintenance or other attention. The equipment supplier and/or the Contractor must prepare an operation and maintenance manual for equipment. Parts lists and operating, and maintenance instructions must be provided.

B. Each operation and maintenance manual must include the following:

1. Equipment function and calibration, normal operating characteristics, and limiting conditions.

2. Assembly, installation, alignment, adjustment and checking instructions.
3. Operating instructions for startup, routine and normal operation, regulation, and control, shut down and emergency conditions.
4. One (1) copy of instructional videos.
5. Operating cycles must be specifically described in outline format and in referenced detail. A wall-mounted color-coded piping flow diagram must be provided in the pool equipment room. The diagram must be engraved on laminated plastic with color-coded piping to match the color of coding on piping, and including valves identified with number on tags. The minimum size is 11-inch x 17 inch.
6. Include manufacturer recommended maintenance schedule, parts lists, piping diagram (to agree with wall mounted diagram) and trouble-shooting information for pool mechanical equipment.
7. Using reference to keyed valves and wall diagram, include specific written instructions for procedures that must be followed for the following:
  - a. Emptying and refilling the pool(s) including de-watering during the period that the pool(s) will be empty.
  - b. Water level control adjustment and chemical control operation.
  - c. Normal surge tank operation and balancing.
  - d. Filter operation and backwashing; and
  - e. Super chlorination.
8. Lubrication and maintenance instructions.
9. Guide to "troubleshooting."
10. Parts list and predicted life of parts subject to wear.
11. Outline, cross section, and assembly drawings; engineering data and wiring diagrams.
12. Test data and performance curves, where applicable.
13. Specific written instructions for procedure for emptying and refilling the pool(s) including de-watering during the period that the pool will be empty. Provide a yellow warning sign 8-1/2 in. x 11 in., that must be mounted in the filter room, that reads:

**WARNING**  
Prior to emptying Pool  
Consult O & M Manuals for Procedures

Add another sign that reads:

Keep Caps, Plugs and Tops Tight Fitting to Prevent Escape of Fumes.

14. One set of applicable submittals must be included in each manual.
- C. The operation and maintenance manuals must be in addition to instructions or parts lists packed with or attached to the equipment when delivered, or which may be required by the Contractor.
- D. Manuals and other data must be printed on heavy, first quality paper, 8-1/2 x 11-inch size with standard 3-hole punching and inserted in plastic covers. Drawings and diagrams must be reduced to

8-1/2 x 11 inches or 11 x 17 inches. Where reduction is not practical, larger drawings must be folded separately and placed in envelopes that are bound into the manuals. Each envelope must bear suitable identification on the outside.

- E. Six (6) bound volumes of each manual must be submitted. Parts lists and information must be assembled in substantial manuals and permanent, three-ring or three-post binders. Material must be assembled and bound in the same order as specified, and each volume must have a table of contents and suitable index tabs.
- F. Material must be marked with project identification. Non-applicable information must be marked out or deleted.
- G. Shipment of equipment will not be considered complete until the required manuals and data have been received.
- H. The Contractor must provide, assemble, and inventory all deck, loose, safety, and maintenance equipment including any loose mechanical equipment prior to the Owner taking possession of the pool(s). The Contractor must provide a checklist that has been signed by the Owner verifying receipt of all items listed in Part 2 - Products.

#### **1.11 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver material in manufacturer's original, unopened containers and crates with labels intact and legible.
- B. Deliver materials in sufficient time and quantity to allow continuity of work and compliance with approved construction schedule.
- C. Handle materials in a manner to prevent damage.
- D. Store materials on clean raised platforms with weather protective coverings. Provide continuous protection of materials against damage or deterioration.
- E. Remove damaged materials from site.

#### **1.12 WARRANTIES**

- A. The Contractor warrants to the Owner and Architect that materials and equipment provided under the contract will be of good quality and new unless otherwise required or permitted by the contract documents, that the work will be free from defects not inherent in the quality required or permitted, and that the work will conform with the requirements of the contract documents. Work not conforming to these requirements, including substitutions not properly approved and authorized will be considered defective. The Contractor's warranty will exclude remedies for damage or defect caused by abuse, improper or insufficient maintenance, improper operations, modifications not executed by the Contractor or improper wear and tear under normal use. If required by the Architect, provide satisfactory evidence as to the kind and quality of materials and equipment.
- B. The Contractor must agree to repair or replace defective or non-complying work at no cost to the Owner upon written notification from the Owner within the warranty period. Pro-rated warranties are not acceptable.
- C. Warranties must be for a period of one year from the date of substantial completion or the owner begins using the pool unless otherwise specified. Submit warranties covering, but not limited to the following:
  - 1. Defects in material or workmanship of the pool and surge/balance tank structure(s) causing a loss of water for a period of three (3) years.

2. Defects in material, manufacture and installation of the filtration, backwash, chlorination, pH adjustments and cleaning systems, including controls for a period of one (1) year.
3. Defects in material, manufacture or installation of the recirculating overflow system and interior coating of the gutter/trench for a period of one (1) year.
4. Manufacturer's minimum ten (10) year warranty against defective materials, components, and workmanship in the pool gutter grating system.
5. Defects in material, workmanship, and installation of the pool pumps for a period of one (1) year.
6. Manufacturer's minimum eighteen (18) month warranty against defective materials, components, and workmanship in the variable frequency drive system.
7. Manufacturer's minimum fifteen (15) year warranty on the filter tank against defective materials or workmanship of the tank and components. (Additional warranty time may be purchased from the manufacturer.) Prorated warranties are not acceptable.
8. Defects in material, workmanship, and installation of the pool piping system and recirculation fittings for a period of three (3) years.
9. Manufacturer's minimum one (1) year warranty against defective materials, components, and workmanship in the sanitizing feed system.
10. Manufacturer's minimum one (1) year warranty against defective materials, components, and workmanship in the pH buffer feed system.
11. Manufacturer's minimum one (1) year warranty against defective materials, components, and workmanship in the ultraviolet sanitizing system (excluding the UV lamps, quartz, and seals). Medium pressure ultraviolet bulbs must be warranted for a period of 8,000 hours. Intermittently operated lamps ( $\geq 1$  on/off cycle per day) will be replaced free of charge should failure occur prior to 4,000 hours and replacement will be prorated between 4,000 and 8,000 hours.
12. Manufacturer's minimum three (3) year warranty against defective materials, components, and workmanship in the Clear-Flow Electronic Flocculation System (EFS).
13. Manufacturer's minimum five (5) year warranty against defective materials, components, and workmanship in the pool chemical controller. ORP, pH, flow and temperature sensors must be covered by a standard two (2) year warranty. Other sensors and flow cell components must be covered by a standard one (1) year warranty.
14. Manufacturer's minimum one (1) year warranty against defective materials, components, and workmanship in the pool water level control system.
15. Defects in material, workmanship, and installation of loose, deck, maintenance, and safety equipment including deck anchors for a minimum period of one (1) year.
16. Defects in material, workmanship, and installation of the tile finish against cracking and delamination for a period of five (5) years.
17. Manufacturer's minimum fifteen (15) year systems warranty against defective materials, components and workmanship in the pool tile setting materials.
18. Defects in material, workmanship and installation of the pool, surge/balance tank, gutter, and backwash pit waterproofing finish against delamination for a period of one (1) year.

19. Manufacturer's minimum two (2) year warranty against defective materials, components, and workmanship in the pool underwater lights.
20. Manufacturer's minimum ten (10) year warranty on the complete heat exchanger assembly. The titanium shell and tube heat exchanger must have a minimum five (5) year warranty. The cupronickel shell and tube heat exchanger must have a three (3) year warranty. Parts must be covered by a standard one (1) year warranty.

#### **1.13 SYSTEM TRAINING**

- A. A qualified representative of the Contractor performing work under this section must put the equipment into operation and instruct the Owner's representatives in the operation of this equipment to the Owner's satisfaction immediately after project's substantial completion.
- B. The Contractor's training representative must have completed the equipment/system's manufacturer's training requirements and be certified, by the manufacturer, to provide and teach system training.
- C. The representative from the Contractor must be either a CPO (Certified Pool Operator) or have an AFO (Aquatic Facility Operator) certification.
- D. Training periods to consist of 32 hours of on-site training and scheduled as follows:
  1. 16 hours of initial training on the complete swimming pool system. The 16 hours of initial training must be comprised of at least 4 hours of training on water chemistry analysis and adjustment. The water chemistry training will include in-depth review of the use of the Langlier index and its computation.
  2. The initial 16 hours of training must include information on the care, operation, adjustment, and maintenance of items provided by the Contractor under the "Part 2 – Products" section of this specification.
  3. 16 hours of training after the Owner's staff has had experience operating the system. This time may be requested after the pool has been placed in operation within a period of one (1) year from the time the pool was accepted by the Owner. The additional training must contain at least 2 hours of review of water chemistry.
  4. Provide a project specific video recording instruction manual in addition to the training sessions. The video instructions must be project specific and must include information on the care, operation, adjustment, and maintenance of items provided by the Contractor under the "Part 2 – Products" section of this specification. This video recording must be done separate from the Owner training.
  5. The Contractor must include one (1) copy of video recording instructions in each Operations and Maintenance Manual.

#### **1.14 POOL FILL WATER QUALITY**

- A. The Owner is to bear the cost of the water required for two (2) complete fillings of the pool (the initial water tightness test and the final filling). Removal of iron or copper (if in excess of .3 ppm) will be required for the final fill to avoid staining of the pool finish. Subsequent fillings or partial fillings (more than 25%) of the pool is by the Contractor, at its own expense.
- B. Provide the necessary plant equipment so that the temperature of fill water will be within plus or minus 10 degrees of the ambient air and/or the pool structure at the time of filling. Extreme caution is urged if the temperature variance is greater than 10-degree F.

- C. Provide the necessary chemicals and to adjust and balance the water chemistry in the pools to the following levels:

pH	7.4 - 7.6
Calcium Hardness	200 - 400 PPM
Total Alkalinity (Calcium Hypochlorite)	60 - 80 PPM
Langelier saturation index	-0.3 - +0.3
Total Dissolved Solids (TDS)	not to exceed 1,500 PPM

#### 1.15 START-UP CHEMICALS

- A. The Contractor must maintain the chemical balance of the pool water (including the cost of chemicals required) until the pool and mechanical system(s) are fully operational and accepted by the Architect and the Owner.
- B. Provide the Owner with sufficient quantities of the necessary chemicals to maintain the pool operation after the owner begins using the pool.
1. The Contractor is required to provide chemical quantities as shown on the drawings for the following chemicals:
    - a. Calcium Hypochlorite
    - b. CO<sub>2</sub>
    - c. Sodium Bisulfate
  2. The Contractor is required to provide chemical quantities as shown on the drawings for the following balancing chemicals:
    - a. Sodium Bicarbonate
    - b. Calcium Carbonate
    - c. Sodium Thiosulfate
- C. Chemicals must be provided to the Owner must include those required by the chemical feed systems provided.

#### 1.16 RECORD DRAWINGS

- A. Provide a complete set of record drawings of the entire pool system(s) including sub-systems. Record drawings must be prepared in accordance with the requirements and must be a complete, stand-alone set. The Contractor is permitted to obtain original documents and copy them for this purpose only. Provide a digital record set (latest version of AutoCAD or compatible software).

### PART 2 - PRODUCTS

#### 2.1 OVERFLOW SYSTEM

- A. It is the intent of the specifications that the perimeter overflow system and surface cleaning be maintained under conditions of normal operation and that no water be discharged to waste except when cleaning the filters or emptying the pool.
- B. Concrete Perimeter Overflow System



1. A perimeter overflow system consisting of a continuous concrete and tile overflow channel must be provided as detailed and shown on the drawings for the pool. The bottom of the trough must be level throughout.
2. The complete gutter trough interior must be coated with epoxy paint. Refer to section 2.16. Areas not meeting the manufacturer's recommended thickness will be recoated without additional cost to the Owner.
3. Grating corner installations must be prefabricated thermo-welded corner sections provided by the grating manufacturer and installed with adequate support per manufacturer recommendations. Butting grating sections together at corners is not permitted.
4. The grating must be formed of molded PVC sections. Modular, interlocking pieces of UV stabilized PVC grating. The top surface must have a raised, diamond ridge design to create good friction, wet or dry and be 11/16" wide with an outside depth of 1.0" and a middle depth of 1-3/8" for extra strength. The space between pieces must not exceed 3/8". Each piece of grate must have a slotted hole at the ends for insertion of a stainless-steel fastener clip and anchor screws every 5 feet and must be easily removable. Grating surface bars must run parallel to the pool wall and with the gap, provide at least 35% open space per foot for unrestricted water flow. The color of the grate must be selected by the Owner/Architect. The width of the grating must allow the insertion of the touchpad holding brackets between the grating and the gutter lip.
  - a. Basis of Design: Grating must be manufactured by Lawson Aquatics supplied by Neptune-Benson, Daldorado, or approved equal.
5. Materials, anchors, and fasteners must be 316L stainless-steel.

**C. Skimmer Overflow System**

1. Provide skimming system consisting of units as shown on the drawings. Skimmers must be located to ensure maximum skimming action.
  - a. Basis of Design: Spa skimmers must be Admiral SC-20 by Pentair Products or approved equal.
2. Skimmers must receive pan-filled, removable access lids that receive deck finish to match the surrounding deck. Lids must be manufactured by Pour-A-Lid, or equal. Refer to the Owner/Architect for color selection.
3. The piping and other pertinent components of skimming equipment must be designed for a total capacity of the required filter flow of the recirculation system, and no skimmer can be designed for a flow-through rate of less than 30 gallons per minute or 5 gallons per minute per lineal inch of weir.
4. The skimmer weirs must be automatically adjustable and must operate freely with continuous action to variations in water level over a range of at least 4 inches. The weirs must operate at flow variations. The weir must be of such buoyancy and design so as to develop an effective velocity.
5. An easily removable and cleanable basket or screen through which overflow water passes must be provided to trap large solids.
6. The skimmer equalizer fitting at the base must be capped.
7. The skimmer must be of sturdy, corrosion-resistant materials.

8. Each skimmer must be equipped with a variable orifice trimming device to allow balancing of flow.
9. Skimmers must be NSF approved.
10. Provide a solid aluminum or fiberglass lintel plate spanning the top of each skimmer throat opening in the pool wall to support the pool coping. Lintel to have dimensions of 7'-3/4" by 2'-0" and be 3/8" thick. Aluminum lintel plates require bonding in accordance with NEC Article 680. Fiberglass lintel plates must be of rigid design with factory finished or field sealed edges to prevent exposed jagged surfaces and moisture intrusion into the fiberglass material.

## 2.2 PUMPING EQUIPMENT

- A. Proposed substitutions must include a mechanical drawing incorporating required changes in layout, piping, and valves. The cost of such changes must be included in the price of the substitute. Confirm correct pump motor voltage prior to ordering pump. Motors must be capable of continuously running without overloading at points on the characteristic curve of the pump without overload or damage. Confirm by 1/4-inch scale shop drawing that the pumps provided will fit within the available space and can be reasonably removed for servicing.
  1. Pumps must be certified by the National Sanitation Foundation (NSF) and bear the certification mark.
  2. If the pump is powered with a VFD, the impeller must be trimmed to a maximum diameter based on the most limiting condition of either the diameter of the maximum non-overloading rated motor horsepower at the design point or a diameter resulting in 10% greater head than the specified head.
  3. The pump motor must be totally enclosed, fan cooled (TEFC) and premium efficiency of the horsepower and speed specified. A pump requiring larger horsepower is not acceptable unless submitted as a substitute and approved by the engineer, in which case necessary electrical revisions must be coordinated and provided.
  4. Provide an emergency shutoff switch for the pool(s) and spa pump(s). One (1) switch must be provided for each complete pool and spa system, including all recirculation and feature pump(s). The system must include a clearly labeled emergency shutoff switch for pool and spa pump(s) per Article 680-38 of the NEC. Emergency switch must include tamper-resistant/weather-resistant cover and audible alarm. Architect to approve the location of the switch(es) no less than 5'-0" from the pool or spa wall and within sight of pool or spa users. The wiring must be done per Division 16/26 and coordinated with the pool wiring.
    - a. Basis of Design: Pentair ComPool LX820, STI SS2202PO-EN with cover, or approved equal.
  5. Provide a 15-minute spa timer for each hydrotherapy pump. Architect to approve the location of the timer(s). The wiring must be done per Division 16/26 and coordinated with the pool wiring. Basis of design: Intermatic DPST #FD415M or equal.
  6. The entire pumping unit must be mounted on a base using cap screws to preserve the back-pull-out feature of the pump. Pumps must not be secured with floor studs or "all-thread." The pump base must be coated with the same epoxy coating as the pump. An OSHA approved guard must protect coupling and exposed rotating components of the pump and motor where required.
  7. Recirculation and Feature Pumps – Metallic Components

- a. Provide horizontally mounted centrifugal pumps as shown on the drawings and described in these specifications. Each pump must be of a straight centrifugal, end suction, bronze fitted, close coupled type.
  - b. Pumps manufactured by Paco, Griswold, Aurora or Herborner are considered equal, provided they meet the requirements.
  - c. Pump casing must be cast iron fitted with a replaceable bronze case wear ring. Mechanical seals must be provided specific for a chlorinated water application. Pump impeller must be enclosed type of cast bronze or 316L stainless-steel, statically, and dynamically balanced, and trimmed for the specified design conditions. If a VFD is used in conjunction with a pump, the impeller must be trimmed to the maximum diameter based on the rated motor horsepower. Bronze materials must be suitable for use in a chlorinated environment. Suction and discharge flanges must be provided and tapped for gauge connections. Provide steel or cast-iron bases with equivalent epoxy coating for corrosion protection.
  - d. Provide a fusion-bonded epoxy coating on wetted parts to protect pump internals from corrosion, including pump volute interior and complete pump impeller (bronze impellers only). Sandblast to bare, white metal. The thickness must be 8 to 12 mils (heavy film). Verify thickness by non-destructive testing. Coat parts as recommended by the manufacturer, including preheating parts to 400 degrees and electrostatic deposition or fluidized bed technique. Provide primers if required to resist chlorinated water <10 ppm. The coating must be Scotchkote 134 manufactured by Fusecote or approved equal.
  - e. Provide a hair and lint strainer, for each pump, of fiberglass or epoxy coated stainless-steel construction with a clear observation top in the sizes (or pipe sizes) indicated on the drawings. Verify and coordinate pipe and pump suction sizes in the field. Provide a stainless-steel basket with at least 4 times the free open area as the inlet pipe, and one spare basket with each strainer.
    - 1) Basis of Design: As manufactured by MerMade Filter Inc., or Neptune/Benson Inc., or Fluidtrol Process Technologies, Inc.
  - f. Recirculation pumps must be provided by the same manufacturer. Confirm voltages prior to ordering pumps.
8. Recirculation and Feature Pumps – Composite Components
- a. Provide horizontally mounted, self-priming, centrifugal pumps as shown on the drawings and described in these specifications. The pumps must be of a straight centrifugal, end suction, non-corrosive PPO Resin material construction, closed coupled type, with integral hair and lint strainer.
  - b. The pump body, seal plate, and attached hair and lint strainer must be constructed of non-corrosive PPO Resin materials, and close-coupled to an electric motor by means of an adaptor of the same material.
  - c. The pump must have a PPO Resin diffuser to aid in priming and it must contain a replaceable bronze wear ring for the impeller. The impeller must be of the closed type and PPO Resin, non-overloading at points on the performance curve. The mechanical shaft seal must be constructed of ceramic and carbon seal faces, with stainless-steel, brass, and Buna N materials in the spring bellows portion. The impeller must be secured to the motor shaft by means of a stainless-steel key and locking screw into the end of

the motor shaft. The pump must be capable of operating at up to 50 psi, 104° F continuous water temperature.

- d. The electric motor coupled to the pump must be of the NEMA Rated series JM construction with stainless-steel shaft inside a removable shaft sleeve of 300 series stainless-steel. Motors must be continuous duty rated at 40° C (or realign better) ambient and be suitable for outdoor installation.
  - e. Pumps must meet Department of Energy (DOE) minimum efficiency standards for dedicated-purpose pool pump (DPPP) motors.
  - f. The pump strainer must consist of a PPO Resin body, Polycarbonate Resin Thermoplastic cover with O-ring seal, and Cam and Ramp Lid, and a strainer basket of mineral reinforced polypropylene material.
  - g. The strainer basket must be securely positioned below the suction inlet of the trap, with access for inspection and cleaning through a removable trap body lid. The trap body lid must be secured by means of a locking ring. Provide one spare basket for each strainer.
9. Other System Pumps and Motors
- a. Provide one (1) portable utility pump(s). The pump(s) must be a 1 HP, 3600 RPM, 115/230-volt, 1 phase, 60 cycle unit capable of 60 GPM at 25 ft. TDH.
    - 1) Basis of Design: Pump must be a Godwin GSP10 or approved equal.

B. Variable Frequency Drive Starters

- 1. Provide variable frequency drive starters (VFD) for the pool pumps. VFDs must be Eco-Flow-C by H2Flow Controls, AcuDrive by Pentair, GreenDrive by Neptune Benson, or approved equal.
  - a. Basis of Design: AcuDrive by Pentair
- 2. Ensure that equipment is provided with the correct operating voltage and that interconnected electrical and electronic equipment must adequately communicate and operate the specified pumping equipment. Equipment installations must meet or exceed the requirements of the National Electric Code and other local and state regulations.
- 3. Variable Frequency Drive Capabilities
  - a. Provide complete VFD as specified herein or in the equipment schedule for loads designated that must be variable speed or variable flow.
  - b. The VFD must convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC induction motors. The VFD must be a six-pulse input design, and the input voltage rectifier must employ a full wave diode bridge. The output waveform must closely approximate a sine wave. The VFD must be of a PWM output design utilizing current IGBT inverter technology and voltage vector control of the output PWM waveform.
  - c. Indoor Applications: VFD must be fully enclosed in a corrosion resistant NEMA 12/IP54 UL listed enclosure.
  - d. VFD and required options will be incorporated by the VFD manufacturer into an integrated package, with a single input feed and main disconnect.

- e. VFD must have a fused disconnect and battery back-up, for the purpose of maintaining programming in the event of a power outage.
  - f. The VFD must produce an output waveform capable of handling maximum motor cable distances of up to 1,000 ft. (unshielded) without tripping or derating.
  - g. The VFD must provide rated RMS fundamental output voltage. The VFD must utilize VVC<sup>PLUS</sup>, an output voltage-vector switching algorithm, or equivalent, in both variable and constant torque modes. This allows the motor to operate at a lower temperature rise, extending its thermal life.
  - h. The VFD selected must be able to source the motor's full load nameplate amperage (fundamental RMS) on a continuous basis and be capable of running the motor at its nameplate RPM, voltage, current, and slip without having to utilize the service factor of the motor.
  - i. The VFD must offer a programmable motor parameter that allows the total number of poles of a motor that must be programmed to optimize motor performance.
  - j. VFD must automatically boost the power factor at lower speeds.
  - k. The VFD will be capable of running either variable or constant torque loads. In either CT or VT mode, the VFD must be able to provide its full rated output current continuously and 110% of rated current for 60 seconds.
  - l. An Automatic Energy Optimization (AEO) selection feature must be provided in the VFD to minimize energy consumption in variable torque applications.
  - m. VFD must offer a motor spinning test that will run the motor at 5 Hz until the OK button is pressed. This feature will allow the user to determine if the motor is running in the correct direction.
  - n. Switching of the input power to the VFD must be possible without interlocks or damage to the VFD at a minimum interval of 2 minutes.
  - o. Switching of power on the output side between the VFD and the motor must be possible with no limitation or damage to the VFD and must require no additional interlocks.
  - p. An Automatic Motor Adaptation (AMA) function must measure motor stator resistance and reactance to optimize performance and efficiency.
  - q. Cooling must be via an aluminum heat sink and must prevent the introduction of ambient air to the electronics for cooling. With the exception of the water-resistant heat sink fan, electronics must be fully sealed within the enclosure.
  - r. The VFD must have temperature-controlled cooling fans for quiet operation, minimized internal losses, and greatly increased fan life.
  - s. VFD must provide full torque to the motor, given input voltage fluctuations of up to +10% to -10% of the rated input voltage.
  - t. The VFD must include additional contacts for interface with a remote start/stop panel and the emergency stop function. When the VFD is supplied for a spa hydrotherapy pump, the drive must also interface with a remote timer switch to control pump operation via a preset timed duration (15-minute timer switch).
4. Harmonics:

- a. The VFD must provide internal DC link reactors to minimize power line harmonics and to provide near unity power factor.
  - b. The VFD must be provided with line-side harmonic reduction, as required, to ensure that the current distortion limits, as defined in table 10.3 of IEEE 519-1992, are met.
  - c. Harmonic solutions must be designed to withstand up to 2%-line imbalances with the maximum Current Distortion not to exceed 11% at 100% load.
  - d. Harmonic solutions must be capable of withstanding up to 2% ambient voltage distortion with the maximum Current Distortion not to exceed 12% at 100% load.
5. Protective Features:
- a. VFD must have input surge protection utilizing MOV's, spark gaps, and Zener diodes to withstand surges of 2.3 times line voltage for 1.3 msec.
  - b. VFD must include circuitry to detect phase imbalance and phase loss on the input side of the VFD.
  - c. Printed Circuit boards must be conformal coated to reduce the corrosion effect from environmental gases and other conditions. The conformal coating must meet IEC 61721-3-3, Class 3C2 as standard.
  - d. Automatic "No-Flow Detection" must be available to detect a no-flow situation in pump systems where valves can be closed. This must be functional in closed loop control or when controlled by an external signal.
  - e. Dry-pump detection must be available to detect if the pump has run dry. If this condition occurs, the drive will be safely stopped. A timer must be included to prevent nuisance tripping.
  - f. End-of-Pump curve detection must stop the motor when the pump is operating outside of its programmed pump curve.
  - g. VFD must provide a flow compensation program to reduce energy by adjusting the Setpoint to match changes in flow (friction loss).
  - h. VFD must include current sensors on three-output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.
6. Interface Features:
- a. VFD must provide an alphanumeric backlit display keypad (LCP) which may be remotely mounted using a standard 9-pin cable. VFD may be operated with keypad disconnected or removed entirely. Keypad may be disconnected during normal operation without the need to stop the motor or disconnect power to the VFD.
  - b. VFD Keypad must feature an INFO key that, when pressed, must display the contents of the programming manual for the parameter that is currently viewed on the display.
  - c. VFD Display must have the ability to display 5 different parameters pertaining to the VFD or the load including: current, speed, DC bus voltage, output voltage, input signal in mA, or other values from a list of 92 different user-selectable parameters.
  - d. A red FAULT light, a yellow WARNING light and a green POWER-ON light must be provided. These indications must be visible both on the keypad and on the VFD when the keypad is removed.

- e. Two-level password protection must be provided to prevent unauthorized changes to the programming of the VFD.
  - f. A quick setup menu with factory preset typical parameters must be provided on the VFD to facilitate commissioning.
  - g. A digital elapsed time meter and kilowatt hour meter must be provided in the display.
  - h. VFD must offer as standard an internal clock. The internal clock can be used for: Timed Actions, Energy Meter, Trend Analysis, date/time stamps on alarms, Logged data, Preventive maintenance, or other uses.
  - i. A battery back-up must be provided to maintain internal clock operation during power interruptions.
  - j. Inputs and outputs must be optically isolated.
  - k. The VFD must have two analog signal inputs. Inputs must be programmable for either 0 -10V or 0/4-20 mA.
  - l. One programmable analog output must be provided for indication of the drive status. This output must be programmable for output speed, voltage, frequency, motor current and output power. The analog output signal must be 0/4-20 mA.
  - m. The run permissive circuit must be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
  - n. The VFD must be equipped with a standard RS-485 serial communications port and front-of-drive accessible USB port.
7. Adjustments:
- a. The VFD must have an adjustable output switching frequency.
  - b. Four complete programming parameter setups must be provided, which can be locally selected through the keypad or remotely selected via digital input(s), allowing the VFD to program for up to four alternate control scenarios without requiring parameter changes.
  - c. In each programming setup, independent acceleration and deceleration ramps must be provided. Acceleration and deceleration time must be adjustable over the range from 0 to 3,600 seconds to base speed.
  - d. The VFD must have four programmable "Bypass frequencies" with adjustable bandwidths to prevent the driven equipment from running at a mechanically resonant frequency. The feature must offer a Semi-Automatic program to simplify the set-up.
  - e. VFD must include an automatic acceleration and deceleration ramp-time function to prevent nuisance tripping and simplify start-up.
  - f. The VFD will include a user-selectable Reset function, which enables the selection of between zero and twenty restart attempts after a self-clearing fault condition (under-voltage, over-voltage, current limit, inverter overload, and motor overload), or the selection of an infinite number of restart attempts. The time between restart attempts must be adjustable from 0 through 600 seconds.
  - g. An automatic "on-delay" function may be selected from 0 to 120 seconds.

- h. The VFD will include a user-selectable Auto-Restart function that enables the VFD to power up in a running condition after a power loss, to prevent the need to manually reset and restart the VFD.
- 8. Bypass
  - a. Provide a manual bypass in conjunction with the VFD for the recirculation pump(s) consisting of a door interlocked main fused-disconnect pad lockable in the off position, a built-in motor starter and a four position DRIVE/OFF/BYPASS/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at a programmable speed or flow rate from the VFD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at full speed from the AC power line and power is disconnected from the drive so that service can be performed. In BYPASS Position, a soft starter will be in the circuit to allow the motor to avoid an across the line start. In the TEST position, the motor is operated at full speed from the AC line power. This allows the drive to give an operational test while continuing to run the motor at full speed in bypass.
- 9. Individual VFD options such as bypass, motor selection contactors, etc. must be incorporated by the manufacturer onto a single panel with a single input feed and main disconnect function. Enclosures must be UL listed and fully assembled by the VFD manufacturer.
- 10. Service Conditions:
  - a. The ambient operating temperature of the VFD must be -10°C to 50°C (14 to 122°F).
  - b. 0 to 95% relative humidity, non-condensing.
  - c. Elevation to 3,300 feet (1000 meters) without derating.
  - d. VFD's must be rated for line voltage of 525 to 690VAC, 380 to 480VAC, or 200 to 240VAC; with +10% to -10% variations. Line frequency variation of  $\pm 2\%$  is acceptable.

C. Pump Gauges

- 1. Pressure gauges must be provided on the discharge of the pumps.
- 2. Compound gauges must be provided at the intake port of the pumps, after the hair and lint strainer.
- 3. Gauges must be liquid filled, 316L stainless-steel bourdon tube type with a minimum 2-1/2-inch diameter dial, high impact polypropylene or stainless-steel case, corrosion resistant white scale with black divisions and numerals, 300 Series stainless-steel heavy duty rotary bushed movement, black enameled balanced Micrometer pointer.
  - a. Basis of Design: Gauges must be manufactured by Weksler Instrument Corporation or approved equal.
- 4. Scale ranges must be selected to indicate the normal system operating pressure of each system or location within the system. Pressure ranges must be calibrated in psig (0-60 psi) and compound gauge must be calibrated in inches of mercury (0-30 in Hg / 0-60 psi).
- 5. A stainless-steel filter type pressure snubber must be provided for each pressure gauge consisting of a 3/8-inch diameter by 1/8-inch-thick micro metallic stainless-steel filter and placed in the line just before the pressure gauge. Provide isolation brass valves or brass gauge cocks at each gauge for easy replacement and maintenance.



## 2.3 FILTRATION EQUIPMENT

- A. The filter system must consist of high-rate pressure sand filter tanks as shown on the drawings. Every aspect and component of the filter system must be certified by the National Sanitation Foundation (NSF) and bear the certification mark. The filter must have an engraved metal data plate permanently affixed on the face of the system that describes operational data and instructions and indicates startup date.
- B. It is the intent of these specifications to describe a filtration system complete in every respect with accessory items and supplied and warranted by one manufacturer.
- C. Horizontally Oriented Fiberglass Tanks
  - 1. The filter tanks must be horizontally oriented single cell fiberglass tanks, minimum 42 inches in diameter. The filter system must be listed as approved by the National Sanitation Foundation prior to bid date.
    - a. Basis of Design: Fiberglass filters must be the product of Stark/Pentair, Waterco, or Neptune Benson provided they meet the specifications and layout. System design is based upon Neptune-Benson. Valves must be provided to backwash one filter at a time.
  - 2. Filter tanks must incorporate components and features as described in this section.
  - 3. Two (2) saddle style bases must be provided for tank support. Systems that incorporate stacked tanks must include similar bases and mounting saddles for the upper vessel. Tank supports and connections must be seismic rated to support the filter tank(s) for the appropriate seismic zone where the project is located. Access to the tank must be provided by a 14" x 18" manhole with two (2) curved yokes. Manhole seal must be complete with a one-piece 1/4" neoprene gasket and positioned so that internal pressure from the filter will augment the seal. No additional hardware or through bolts will be allowed.
  - 4. Each filter tank must be equipped with the necessary flanges and connections for the internal and external piping. Connections must be comprised of fiberglass flanges and schedule 80 PVC flanges.
  - 5. Tank connections 2 inches and smaller must be 150 lb. Type 316L stainless-steel threaded full couplings. Tank connections 3 inches and larger must be heavy steel bosses drilled and tapped on both sides to receive standard flanged fittings or Sch. 40 Type 316L stainless-steel nipples.
  - 6. The discharge from the automatic air release valve must be hard piped to waste. Each filter tank must have a means of releasing air. Each coupling or orifice must be provided with a slotted PVC sand retainer or stainless-steel strainer. An automatic air release system must be provided for each tank.
  - 7. The drain system must consist of a 3/4-inch 316L stainless-steel coupling mounted at the lowest point in the bottom head. This drain must be valved and piped to the nearest floor drain or backwash pit.
  - 8. Filter Piping - Internal
    - a. The lower internal distribution system must be a horizontal header/lateral arrangement. The header must be Schedule 80 PVC construction, capped on one end and flanged or threaded at the other end for field connection. Lateral connections must be spaced no more than 6 inches on centers and must be 1-1/2-inch FPT

- connections. Attachments to header must be solvent welded and thermo-welded to ensure integrity of connection.
- b. Under drain system must be factory installed and constructed of extra heavy Schedule 80 high impact PVC. Multiple PVC main headers must be tapped and threaded to receive laterals.
  - c. Laterals must consist of 1-1/2-inch Schedule 80 PVC pipe with openings as required. Each lateral must be fabricated complete with socket cap on one end and male adapter on the other end. Both fittings must be solvent welded to the slotted pipe. Laterals must be designed and sized at the factory, so they are installed in the field and over the entire cross sections area of the filter.
  - d. The upper distributor must consist of PVC piping Schedule 80 and/or deflector plate per manufacturer standard design.
  - e. Each filter must be supplied with a pressure equalizing upper internal distribution system consisting of a horizontal header/lateral arrangement. The header piping must be constructed of Schedule 80 PVC. The header/lateral piping and connections must be designed and sized to provide uniform distribution and unrestricted flow during the filtration and backwash cycles.
  - f. Upper laterals must be constructed of Schedule 80 PVC pipe with machine slotted openings or orifices. Machined slots or orifices must be clean, de-burred and free of obstructions that would not permit the free flow of water through the opening. Details of the lateral attachment to the header must be submitted for review and approval.
  - g. The lower and upper distribution systems must be properly supported and anchored. Hardware in wetted areas must be Type 316L stainless-steel or non-metallic. Tank interiors must be inspected prior to the media being placed in the filters.
9. Filter Piping - External (Face)
- a. External face piping must be Schedule 80 PVC pipe and fittings. Flanges must be located so as to allow for easy dismantling of face piping. Fittings must be solvent cemented.
  - b. Piping must be drilled and tapped where necessary to accommodate gauge tubing connectors.
  - c. Valves 3" and larger must be constructed with cast aluminum S12A alloy (as defined by ASTM B275) housing and fully coated with Rilsan on interior and exterior surfaces. Internal components include EPDM resilient lining, Rilsan coated ductile iron disc and 316L stainless-steel shaft. Valves must be rated for 150 psi bubble tight shutoff. Unless otherwise specified, nuts and bolts must be stainless-steel with stainless-steel washers and used when secured to PVC flanges. Systems incorporating solenoid, pneumatic, pressure amplified, hydraulic or multi-directional valves are not acceptable.
  - d. Standard accessory items must include sight glass rated for 50 psi with polycarbonate glass, remote mounted gauge panel with two 4½" diameter pressure gauges, ¼" petcocks, ¼" poly vent tubing with PVC compression adapters.
10. Backwash Control

- a. The filter manifold face piping must be designed to allow for one (1) filter tank to backwash at a time while the recirculation system is operating. A manual backwashing system must be provided with the filter system.
- b. Manual Backwash System
  - 1) The manual backwash system must be equipped with a face piping configuration such that the operator must manually control and operate both the time and sequencing of the backwash cycle. Valving on the filter face piping must be a mechanical linkage device allowing the operator to simultaneously move two (2) valves at once. Mechanical linkage components must be PVC or Type 316L Stainless-steel.
- 11. Automatic Air Relief Valve
  - a. A 1" valve must be provided to automatically and continuously release air in the filter. The valve must be fabricated of plastic with Buna-N seals. A plumbing kit must be provided with two (2) PVC ball valves to allow manual air relief and isolation of the automatic valve. Valves fabricated of cast iron, bronze or stainless-steel valves will not be accepted.
- 12. Filter Media
  - a. Filter media must be a carefully selected grade of hard uniformly graded silica material. Media must be milled angular shaped particles of silica quartz. The filter sand must have a particle size between 0.45 mm and 0.55 mm and have a uniformity coefficient not to exceed 1.53. Specific gravity must not be less than 2.5 with a pH of 7.0.
  - b. Media (sand) must be cleaned and free from clay or limestone deposits. The bottom layer of support media must be placed by hand to avoid damage to the under-drain system and leveled before the addition of the upper layer of filter media.
  - c. Media must be delivered after approval by the manufacturer of the filter and stored in 100-pound bags for ease of handling and elimination of possible contamination.
  - d. Media must be supplied by the filter manufacturer and approved by the filter manufacturer prior to shipping.
- 13. Support Media
  - a. A Gravel support media of a hard-coarse aggregate with a sub-angular grain shape with a particle size of 1/8" x 1/4" must be used on the inside of the bottom head to the elevation where the filter media commences. The specific gravity must not be less than 2.5. Support media must be placed by hand to avoid damage to the underdrain system and leveled before the addition of the upper layer of filter media. Concrete under fill is not recommended. Support gravel must be delivered and stored in 100-pound bags (approximately one cubic foot) for ease of handling and elimination of possible contamination. Media must be free from minerals which can precipitate onto pool surfaces.
  - b. Sand must be a carefully selected grade of hard, uniformly graded silica material. Media must be naturally rounded particles of silica or milled angularly shaped particles of silica quartz. Sand must have a particle size between 0.45mm and 0.55 mm (#20). No more than 1.5% is allowed to pass through a #40 sieve (.0164"). Uniformity coefficient must not exceed 1.53. Specific gravity must be not less than

2.5. The filter must contain a minimum bed depth as recommended by the manufacturer. Systems which do not provide a minimum bed depth will not be accepted. Sand must be delivered and stored in 100-pound bags (approximately one cubic foot) for ease of handling and elimination of possible contamination. Media must be free from minerals which can precipitate onto pool surfaces.

## 2.4 RECIRCULATION FITTINGS

- A. Main drains must be PVC/Fiberglass box with PVC grating as sized on the drawings. Grate openings must not exceed 11/32 inch in width, providing an open flow area to allow water velocity not to exceed 1.5 fps. The grate must be PVC and fit closely and flush with top surface of frame and secured to frame with vandal proof fasteners. Provide additional stainless-steel flanged pipe connections where required by the drawings for approved equalizer lines. Provide a no-leak seal flange at the midpoint of the boxes. The exposed edges of main outlets must be rounded and smooth, free of burrs and sharp edges. Main drain covers must comply with the Virginia Graeme Baker Act and ANSI/APSP-16 2017.
- B. Provide a water bonding fitting PB-SK-20 manufactured by Perma-cast Swimming Pool Products or approved equal. Bonding fitting must be installed at the lowest point of the main drains.
- C. Concrete dropout boxes (converters) must be concrete sumps with 12-gauge 316L stainless-steel frame and PVC grating and sized as shown on the plans. Grate openings must not exceed 11/32 inch in width, providing an open flow area to allow water velocity not to exceed 1.0 fps. The grate must be PVC and fit closely and flush with top surface of frame and secured to frame with vandal proof fasteners. Provide a no-leak seal flange at the midpoint of the boxes.
- D. Wall inlet fittings must be cycloc directional inlet Hayward model #SP-1421-E mounted in model #SP-1022S, Aquastar model #3301 or approved equal from Sta-Rite.
- E. Adjustable floor inlet fittings must be provided each consisting of an ABS plastic body and adjusting top plate with a positive locking device. A spanner wrench must be provided to facilitate flow adjustment. The inlet body must be provided with a 2-inch cycloc solvent weld connection and internal NPT threads to facilitate line pressure testing. Floor inlet fittings must be Sta-Rite model #8417-0200-black, Aquastar model #4DIV102 or approved equal.
- F. The sight sump frame and cover must provide access to the vertical sight sump standpipe as indicated in the plans. Frame and cover must be provided as a pan-filled, removable access lid that can receive the surrounding deck finish. Lids must be model #SQ201 PAL (Tan), #SQ201 PAL (Gray) or #SQ201 PAL (Frosted) manufactured by Pour-A-Lid or approved equal. Refer to the Owner/Architect for color selection.
- G. Water surface agitator valve box cover(s) and frame(s) must be Zurn model #ZANB-1461-12-VP, nickel bronze with polished scored top, vandal proof screws or approved equal.
- H. Water Surface Agitator
  - 1. Water surface agitators must be detailed on the plans and connected to the filtered water supply. Construction must be machined of cast bronze/brass and stainless-steel. Face plates must be removable for nozzle alignment or nozzle cleaning by using a security key model WMF083. Water inlet connection must be 1" diameter. The unit must be the Combination Water Surface Agitator WMD108 by Crystal Fountains.
  - 2. Provide a 1" solenoid valve, normally closed, stainless-steel fitted, bronze body, 120 VAC slow closing type. The solenoid must be located on the main water surface agitator supply line as shown on the drawings. The solenoid must be activated through a receptacle located near

the diving boards in the natatorium. Refer to Division 26 for location of receptacle. Slow-closing solenoid must be manufactured by ASCO or approved equal.

- I. Anti-vortex plates must be provided at the suction points of the main recirculation pump(s) in the surge tank(s). Each plate must be connected to the suction pipe via a PVC flange and must be ½ in. thick with minimum dimension of at least 2.5 times the connecting pipe diameter. The plate must be located 4 inches above the finished floor of the surge tank. Four (4) ¾ in. stainless-steel threaded rods, nuts, anchor bolts and washers must be used to fix the offset distance and provide a secure base for the suction pipe. Manufactured fiberglass or PVC anti-vortex plates by Daldorado, Neptune-Benson or approved equal.
- J. Hydrotherapy inlet fittings must be provided consisting of a cast bronze or cyclac venturi body with 1-1/2-inch water inlet pipe connections and 1/2-inch air intake connection. A 1/8-inch IPS thread must be provided in the inlet throat to permit hydrostatic pressure testing of the piping system. The inlet must be designed to operate at 20 GPM at a working pressure of 15 PSI and installed as shown on the drawings. Jet Body must be Waterway model #210-5950 with Waterway Adjustable Fitting model #210-8750 or approved equal. Provide fitting adjustment tool from Waterway, model #210-1770A, or approved equal.

## 2.5 PIPING SYSTEMS

### A. General

- 1. Provide recirculating piping between the pool(s) and the filter room, fill receptor and interconnecting piping to and from the chemical feed systems and chemical controller.
- 2. Provide necessary pipe supports and support systems required to support associated piping and valves.
- 3. Provide other tubing, conduit, or piping associated with equipment specified herein. Coordinate with other trades.

### B. Pipes

- 1. Pipe routing as shown and detailed on the contract drawings is diagrammatic only and is not intended to show minor details or exact locations of piping systems. Installation is required and must be adjusted to accommodate interference and adjustments anticipated and encountered. Pipe sizes on plans refer to the nominal inside diameter of the pipe.
- 2. PVC swimming pool piping must be NSF approved and conform to the requirements of ASTM D-1785.
- 3. PVC pipes must be the product of one manufacturer. Approved manufacturers of PVC piping are Eslon, Harvel, and Chemtrol or approved equal.
- 4. Swimming pool piping above the floor or deck in the filter room must be Schedule 80 PVC.
- 5. Swimming pool piping below the filter room floor or deck must be NSF approved, Schedule 80 PVC.
- 6. Swimming pool piping under the pool floor must be NSF approved, Schedule 80 PVC that is backfilled within a ¾" minus fine crushed aggregate conforming to ASTM C136, and per recommendations indicated in the project geotechnical report. Fill material must be submitted to the Architect for review and approval prior to placement of below grade pool pipe.
- 7. Below grade swimming pool piping not located beneath the pool floor can be backfilled with native granular material free of ice, clay, debris, organic matter, and rocks larger than 4"

across their greatest dimension, and per recommendations indicated in the project geotechnical report.

8. The influent and effluent lines to the heat exchanger unit must be CPVC. Connections between metallic piping and/or equipment and PVC must be flanged.
9. PVC and CPVC fittings must be the product of one manufacturer. Molded fittings must be manufactured by Asahi, Eslon, Chemtrol, Harvel, Spear, Lasco or acceptable substitutes. Fabricated fittings must be manufactured by Harrison Machine, Plastinetics, or acceptable substitute.
10. Vertical sight sump piping must be NSF approved, Schedule 40 PVC. Horizontal sight sump piping must be NSF approved, Schedule 40 PVC that is perforated and wrapped with fabric and have 3/8" diameter holes located top and bottom on 4 ft centers. Horizontal sight sump piping must extend 1 ft minimum beyond the main drain.
11. Chemical feed lines from chemical feeders to recirculation piping must be Schedule 80 PVC piping. Piping must be hard piped into the recirculation piping via tee or saddle per the drawings. Required valves must be of PVC construction.
12. Splash collar(s) for the fill funnel(s) must be clear Schedule 80 PVC and manufactured from a Type I, Grade I PVC compound with a Cell Classification of 12454 per ASTM D1784. The pipe must be manufactured in compliance with ASTM D1785.
13. Flanged plumbing connection hardware must be stainless-steel.
14. Materials must be installed by workmen thoroughly skilled in their trades and work must present a neat and mechanical appearance when complete. At no additional expense to the Owner, replace or correct work not judged acceptable by the Architect, Engineer, or Owner's representation.
15. Support hardware, brackets, fasteners, hangers, etc. furnished and installed in the surge tank must be 316L stainless-steel.
16. No installation allowed that will provide a cross-connection or interconnection between a distributing supply for drinking purposes and the swimming pool, or between the pool and a sanitary or storm water sewer system that will permit a backflow of water into the pool water system.
17. Piping must be hydrostatically (water) pressure tested for leaks before and after backfilling to guarantee water tightness. Pneumatic (air) pressure test not allowed.
18. Provide water seals for watertight penetrations of concrete walls and floor slabs.
  - a. Pool Concrete: Water seals must be coupling or sleeve type with a thermo welded or molded flange and the O.D. must be sized to 150% of the O.D. of the pipe. The thermo-welded type must be welded from both sides. Water seals must be located at the centerline of the wall or slab being penetrated prior to placing the concrete to assure a watertight seal. Manufactured fiberglass and PVC water seal fittings by Daldorado, A.S.A. Manufacturing, Aqaulogic or approved equal.
  - b. Pump Pit: Link seals must be provided in the sizes and quantities shown on the drawings and installed to provide flexible watertight penetration. Metal parts must be made of 316L stainless-steel. Links must form a continuous rubber seal that is tightened with a series of stainless-steel bolts to form a watertight seal. Link seals must be manufactured by GPT, Calpico Inc. or an approved equal. Xypex Patch'n Plug or

approved equal must be used to seal pipe penetration. Link seals must be installed with either a cored hole or a Century Line pipe sleeve.

- c. Surge Tank: Water seals must be coupling type with a thermo welded or molded flange and the O.D. must be sized to 150% of the O.D. of the pipe. The thermo-welded type must be welded from both sides. Water seals must be located at the centerline of the wall or slab being penetrated prior to placing the concrete to assure a watertight seal. Manufactured fiberglass and PVC water seal fittings by Daldorado, A.S.A. Manufacturing, Aqualogic or approved equal. Link seals are also acceptable with a cored hole or a Century Line pipe sleeve.
- 19. Adhere to the applicable provisions in Division 22 - Plumbing, "General Provisions" and "Basic Materials and Methods" for installation of piping system.
- 20. Mechanical equipment must be connected into the recirculation piping system must be connected utilizing flanged or union connections.
- 21. Provisions must be made to purge pipes in the system.
- 22. Concentric reducers must be fiberglass by MerMade Filter, Inc., or equivalent reducers of schedule 80 PVC construction.

C. Pipe Hangers and Supports

- 1. Manufacturer
  - a. Subject to compliance with these specifications, pipe hanger and support systems must be manufactured by Cooper B-line (basis of design), Inc, TOLCO, and Anvil International or approved equal.
- 2. Hangers
  - a. Pipes 2 inches and smaller
    - 1) Adjustable steel clevis hanger, B-Line models B3100 or B3104.
    - 2) Adjustable steel swivel ring (band type) hanger, B-Line model B3170.
  - b. Pipes 2-1/2 inches and larger
    - 1) Adjustable steel clevis hanger, B-Line model B3100.
    - 2) Adjustable steel yoke pipe roll, B-Line model B3114.
- 3. Multiple or Trapeze Hangers
  - a. Trapeze hangers must be constructed from 12-gauge roll formed ASTM A1011 SS, Grade 33 structural steel channel, 1-5/8 by 1-5/8-inch minimum, B-Line B22 strut or stronger as required.
  - b. Mount pipes to trapeze with 2-piece pipe straps sized for outside diameter of pipe, B-Line B-2000 series.
- 4. Wall Supports
  - a. Pipes 2-1/2 inches and smaller
    - 1) Steel offset "J" hook hanger, B-Line model B3600.
  - b. Pipes 3 inches and larger
    - 1) Welded strut bracket and pipe straps, B-Line models B3064 and B2000 series.

- 2) Welded steel bracket B-Line model B3066 or B3067 with roller chair or adjustable steel yoke pipe roll. B-Line model B3120 or B3110.
  5. Floor Supports
    - a. Electroplated carbon steel adjustable pipe saddle and nipple attached to steel base stand sized for pipe elevation. B-Line model B3092 and B3088T or B3090 and B8088. Pipe saddle must be screwed or welded to an appropriate base stand.
  6. Vertical Supports
    - a. Steel riser clamp sized to outside diameter of pipe, B-Line model B3373.
  7. Plastic Pipe Supports
    - a. V-Bottom clevis hangers with galvanized 18-gauge continuous support channel, B-Line models B3106 and B3106V, to form a continuous support system for plastic pipes smaller than 1 inch or flexible tubing.
    - b. A vented and sloped continuous PVC Schedule 40 pipe no smaller than 1-1/2 inch outside diameter will be used to route flexible tubing with the appropriate pipe supports.
  8. Supplementary Structural Supports - Design and fabricate supports using structural quality steel bolted framing materials. Channels must be roll formed, 12-gauge ASTM A1011 SS Grade 33 steel, 1-5/8 inch or greater as required by loading conditions. Submit design for pipe tunnels, pipe galleries etc. for approval. Use clamps and fittings designed for use with the strut system.
- D. Hanger Attachments
1. Upper Attachments
    - a. Beam Clamps
      - 1) Beam clamps must be used where piping must be suspended from building steel. Clamp type must be selected on the basis of load supported and load configuration.
      - 2) C-Clamps must be locknuts and cup point set screws similar to B-Line model B351L or B3036L. Top flange c-clamps must be used when attaching a hanger rod to the flange of structural steel, B-Line model B3034 or B3033 or approved equal. Refer to manufacturer's recommendations for set screw torque. Retaining straps must be used to maintain the clamp position on the beam where required.
      - 3) Center load beam clamps must be used where specified. The steel clamps must be B-Line models B3050 or B3055. Forged steel beam clamps with cross bolt must be B-Line B3291-B3297 series or approved equal as required to fit beams.
    - b. Concrete Inserts
      - 1) Cast in place spot concrete inserts must be used applicable, either steel or malleable iron body, B-line B2500 or B3014 or approved equal. Spot inserts must allow for lateral adjustment and have means for attachment to forms. Select inserts to suit threaded hanger rods sizes, B-line models N2500 or B3014N series.



- 2) Continuous concrete inserts must be used where applicable. Channels must be 12 gauge, ASTM A1011 Grade 33 structural quality carbon steel, complete with Styrofoam inserts and end caps with nail holes for attachment to forms. The continuous concrete insert must have a load rating of 2,000 lbs/ft. in concrete, B-Line models B22I, 32I, or 52I or approved equal. Select channel nuts suitable for strut and rod sizes.

E. Hanger Accessories

1. Hanger rods must be threaded on both ends or continuously threaded rods of circular cross section. Use adjustable lock nuts at upper attachments and hangers. No wire, chain, or perforated straps are allowed.

F. Hanger Finish

1. Indoor Finishes
  - a. Hangers must be zinc plated in accordance with ASTM B633 or must have an electro-deposited green epoxy finish.
  - b. Strut channels must be pre-galvanized in accordance with ASTM A653 SS Grade 33 G90 or must have an electro-deposited green epoxy finish.
  - c. Zinc Plated hardware is not acceptable for use in chemical rooms.

G. Valves

1. Valves 3 inches and larger must be butterfly type valves, with PVC body, 150# SWP with stainless-steel shaft, PVC or polypropylene disc and replaceable resilient seat bonded to a rigid shaft and guaranteed for bubble tight shutoff from 27-inch vacuum to 150 PSI. Extended neck 2 inches beyond flanges for insulated piping must be provided with handle for manual operation. Valve components must be suitable for swimming pool chlorinated water service. Butterfly valves must be Georg Fischer Type 563, Asahi/America Type SP Pool-Pro, Chemtrol Model-B, Simtech VP series, Colonial Valve 411 Series, or approved equal.
2. Valves smaller than 3 inches must be PVC true union ball valves, full port, three-piece construction, blowout-proof stem, Viton seal with socket end connectors.
3. Check valves must be a quick closing non-slam type, either self-aligning wafer or flanged type, of corrosion resistant materials suitable for use in a swimming pool environment. Provide check valves in accordance with the manufacturer's recommendations. Locate check valves at least 5 pipe diameters from pumps and fittings. Check valves must be Technocheck Corp., model 5050, with epoxy coated cast iron body and bronze swing plates on a stainless-steel spring, Colonial Valve model 601N or 601NP PVC valve with EPDM O-ring and stainless-steel spring or approved equal, for installation between 150 lb. flanges.
4. Modulating float valve in the surge tank(s) must have PVC body and stainless-steel wafer disc. Hardware must be non-corrodible. The float-operated valves must be provided horizontally on the main drain lines in the surge tank(s). A valve must consist of non-corrosion components including shaft, float arm, pins, and floats. Valve must be suitable for mounting on a 125E class standard PVC flange. The float arm leverage weight and pivot lengths must be adjustable to obtain desired ratio of surge tank level change to pool gutter overflow level change. Two floats and a stabilizer required. Valve must be model FV-D XWB (Extra Weight Ball) as manufactured by MerMade Filter, Inc. or approved equal manufactured by Neptune-Benson, EPD, or Fluidtrol Process Technologies, Inc.

5. Submerged valves up to 3 inches must be PVC true union ball valves. Submerged valves over 3 inches must be PVC bodied, wafer type, butterfly valves with stainless-steel handle extensions as required. Valves must be by approved manufacturers listed above. Submerged valves must be provided with stainless-steel connectors. The stem housing extensions must be properly supported and braced.
6. Butterfly type valves 8 inches and larger must be fitted with a watertight gear operator.
7. Valves located 7 feet or greater off the floor must be fitted with a chain operator.
8. Submerged valves, valves buried below grade, or valves not readily accessible, must be provided with a stainless-steel reach rod and handle.
9. Valve hardware must be 316L stainless-steel and meet ANSI hardware installation guidelines.

H. Pipe and Valve Identification

1. Exposed pool piping must be equipped with color coded flow directional arrows at thirty (30) inch intervals per local and state swimming pool health code. In addition to the flow direction arrows, exposed pool piping must be fully painted per NY City and State swimming pool health code. Verify that pool piping identification is in accordance with local and state health regulations.
2. Valves must be identified with minimum 1-1/2-inch diameter plastic laminate engraved tags with minimum 1/2-inch-high numbers. Tags must be fastened to valves with a nylon attachment (zip tie). Valves must be described as to their function and referenced in the operating instruction manual and wall mounted piping diagram that must be prepared.

2.6 CHEMICAL TREATMENT SYSTEMS

A. Calcium Hypochlorite (Chlorine Tablets)

1. Shop drawings complete with a piping diagram depicting the location in which the dry chlorination feeder is connected to the system must be provided and approved prior to installation. Installation of the system must be as specified in the manufacturer's directions with no exceptions taken.
2. A factory-authorized representative must provide training to the owner and the training must be video recorded.
3. Accu-Tab PowerBase
  - a. General Description
    - 1) The system must be designed to feed low concentrations of calcium hypochlorite in solution intermittently or continuously as required for pool applications. The system must be a single pre-assembled, package unit with a welded aluminum frame consisting of chlorinator, electrical box, centrifugal pump, and solution tank for ease of installation and operation. The system must be the Accu-Tab PowerBase. Only Accu-Tab Blue SI calcium hypochlorite tablets must be used, the patented blue colorant added for safety (to help prevent accidental mixing with other chemicals).
    - 2) The system must use an NSF Standard 50 listed erosion feeder and tablet combination and must be capable of meeting the requirements of the Health Department having jurisdiction over the installation.

b. System Features

- 1) A maximum chlorine solution level of 0.05% (500 ppm) must be maintained to prevent calcification in system components. Systems producing chlorine concentrations higher than 0.05% are not acceptable.
- 2) Delivery must be by erosion feed technology to control accurate and consistent concentration limits in the chlorine treatment solution. Soaking type, spray and/or vortex technology systems are not acceptable.
- 3) The chlorinator must automatically and continuously feed a limited quantity of chlorine in solution as needed; when the system is not running, no more chlorine than that amount which can be fed in one minute or less must be left in the tank to prevent dilution. Batch systems preparing excess quantities of solution for delivery over an extended period are not acceptable.
- 4) A centrifugal pump wired to the system electrical box must feed freshly mixed chlorine treatment solution only as required for maximum efficiency. Batch systems requiring the use of a metering pump or pumps to feed pre-prepared standing solution are not acceptable.
- 5) Piping in the chlorinator unit must be Schedule 40 PVC. Systems with flexible tubing are not acceptable.

c. System Components

- 1) Accu-Tab PowerBase chlorinators are designed exclusively for Accu-Tab Blue SI calcium hypochlorite tablets. Tablets are placed on a sieve plate inside the chlorinator; as water flows across the sieve plate, the tablets erode at a rate proportional to the flow rate.
- 2) Inlet Water Supply Connection.
  - a) Model 1030: 1.5" (water supply of 10 GPM required)
- 3) Inlet Water Filter: A filter to protect chlorinator components from start-up debris and sand from broken filter laterals.
- 4) Flow Meter:
  - a) A rotameter flow meter, measuring the flow of the water-eroding stream to the chlorinator. (For models 1030, 3070AT, 3140AT)
  - b) Clamp-on flow meter, measuring the flow of the water-dissolving stream to the chlorinator. (For model 3500)
- 5) Solution Tank: PowerBase 3500 made of HDPE; others made of PVC.
- 6) Capacities:
  - a) Model 1030: 7 gallons
- 7) Primary Solution Tank Level Control: Made from Schedule 80 PVC and 316L stainless-steel. The float valve opens to maintain the pump rate as it is manually throttled.
- 8) Overflow Protection: Two (2) level switches in the upper portion of the solution tank will run the pump from high to lower level to prevent system overflow.

- 9) Solution Delivery Pump: Delivers chlorinated solution to the return line. A single-stage centrifugal pump is provided for systems with pressures up to 20 PSIG.
- 10) Primary Backflow Prevention: A PVC swing check valve prevents reverse flow of water into the system.
- 11) Discharge Control Valve (manual): PVC gate valve allows operator to adjust flow of solution to the system.
- 12) Outlet Connection:
  - a) Model 1030: 1"
- 13) Aluminum Frame: Type 6061-T.
- 14) NEMA 4X Electrical Enclosure

B. pH Buffering System (CO<sub>2</sub>)

1. Shop drawings complete with a piping diagram depicting the location in which the CO<sub>2</sub> feeder is connected to the system must be provided and approved prior to installation. Installation of the system must be as specified in the manufacturer's directions with no exceptions taken.
2. Multi-Cylinder Storage
  - a. Provide a system for storing, regulating, and feeding carbon dioxide for pH control. The system must consist of CO<sub>2</sub> storage tanks, a pressure reducing/regulating system, a feed and rate of flow adjustment control system, injection system/mass transfer system, and valves, tubing, fittings, and appurtenances required for a complete and operable system. The system is to include the following components.
    - 1) CO<sub>2</sub> Storage Tanks
      - a) Pressure storage tanks supplied and exchanged by the Owner's chemical supply company. Capacity of each tank must be 50 lbs of CO<sub>2</sub>. Provide CO<sub>2</sub> as necessary for startup and operation prior to Owner acceptance. Provide two (2) full CO<sub>2</sub> tanks at the time of acceptance.
    - 2) Pressure Regulator
      - a) Provide one (1) per CO<sub>2</sub> storage tank; a single tank pressure regulator, with gauges for up to 850 psi nominal cylinder pressure and 40 psi adjustable output to feed unit.
3. Adjustable Rate of Flow Feed Unit(s)
  - a. Provide an adjustable rate of flow feed unit to control the flow of CO<sub>2</sub> from the storage tank(s) to each pool. The feed unit(s) must be connected to the storage system with thick wall 3/8-inch OD reinforced braided polyethylene tubing enclosed in schedule 40 PVC. The feed system must include 120-volt AC solenoid operated valve for remote on/off control of CO<sub>2</sub>. Feed system must be provided by Prominent, BECS, EKO3, or approved equal and as shown on the drawings.
  - b. Injection System: Provide one (1) system for each body of water; a wet stone diffuser designed for use with CO<sub>2</sub>, sized to the pipe in which it must be inserted and for the maximum anticipated rate of CO<sub>2</sub> flow. Provide with pipe saddle connector and fittings

and connectors required for a complete and operable installation. The system must be certified per NSF/ANSI Standard 50.

4. Remote Fill Box

- a. Provide a remote fill station for each storage tank capable of filling at the rate of approximately 30 to 50 pounds per minute in a manner that does not require entry to the storage room containing the CO<sub>2</sub> tank(s). The length of tubing between remote fill box and bulk storage tank must not be more than 20', unless otherwise noted. Each fill station must consist of a flush mounted (recessed) lockable fill box located at the exterior of the building, as indicated, connected to the CO<sub>2</sub> system. It must include a quick disconnect and automatic closure coupling. Box must be 6" x 6" x 4" deep and constructed of painted 16 gauge galvanized or stainless-steel or sized to module with exterior masonry.
- b. Each tank must be connected to an outside fill station, as indicated, with two lengths of 1/2 inch outside diameter copper tubing for the purpose: one to transfer liquid to the tanks from a bulk delivery vehicle, and the other from the relief valves to the outside of the building. Copper tubing from remote fill box to storage tank must be fitted with either double ferrule swage fittings, or silver soldered fittings.
- c. Following the remote fill installation, pressurize the system to 150 PSI with gaseous CO<sub>2</sub> through the fill connection to test for leaks. Pressure test must be Snoop Liquid Leak Detector from Nupro Co. or approved equal.

C. Ultraviolet Dechloramination and Disinfection System

1. Medium Pressure UV

- a. Ultraviolet Disinfection Equipment: Must operate within the UVC electromagnetic spectrum emitting wavelengths in the range of 200nm to 400nm. This required wavelength will provide constant disinfection/inactivation of bacteria, algae, molds, viruses, and destruction of Monochloramines, Trichloramines, and Dichloramines. Ultraviolet Lamp/Chamber and Spectra Touch Control Panel by Evoqua Technologies Ltd. or approved equal. Deviations/exceptions must be provided in writing to and approved by the designer prior to the bid date.
  - 1) Ultraviolet disinfection equipment by Aquionics and Prominent are approved equals.
- b. The UV System must have a MET or equivalent (ETL, CSA, or UL) listing, be NSF-50 2016 certified including Section 14.18 (crypto inactivation) and 3rd party validated to the USEPA UVDGM 2006 Guidelines.
  - 1) Equipment General Description: The Ultraviolet System must be provided in a complete package to include a stainless-steel chamber, Spectra Control System located in NEMA 12 (IP52) rated panel, Medium Pressure Bulb(s) designed to emit wavelengths within the UVC electromagnetic spectrum, automatic wiper system, and Project Commissioning by a Certified Ultraviolet Technician.
- c. Wafer (WF) Units: Ultraviolet manufacturer to offer unit capability of a horizontal OR vertical installation application using state of art design and direct flow through characteristics. Unit must be a medium pressure system with 94% UVT at the indicated design flow rate. Systems validated or designed for flows based on 98%

UVT are not acceptable. Chamber and Control Cabinet must be as indicated on the drawings.

d. Ultraviolet Lamp

- 1) Ultraviolet lamp must be medium pressure high intensity. Lamp must be designed to emit continuous Ultraviolet wavelengths in the range of 200nm to 400nm. This will provide optimal disinfection benefits and destruction of the Monochloramine, Dichloramine, and Trichloramine compounds. The lamp(s) must remain unaffected by temperature variance of 0 degrees F (-17 C) to 200 degrees Fahrenheit (93 degrees Celsius).
- 2) The lamp system must provide a constant dose of not less than 60 mJ/cm<sup>2</sup> until the end of the lamp life for indoor applications and not less than 40 mJ/cm<sup>2</sup> for outdoor disinfection and this must be based on constantly monitoring the full recirculating flow rate, not on a side stream treatment. The system must be equipped with infinitely variable power control of the lamp intensity & dose. Power stepping not acceptable. The lamps must be capable of turndown to 30% of the nominal rated power.
- 3) The lamp must be connected via means of a plug connector and must have a mechanical interlock to prevent lamp removal when lit for safety reasons.

e. Ultraviolet Reactor

- 1) The unit must be constructed of 316L stainless-steel electropolished and passivated to prevent corrosion within the harsh pool environment.
- 2) The Ultraviolet chamber must come complete with the following equipment: Ultraviolet intensity monitor factory calibrated to provide intensity in mWcm<sup>2</sup>, monitors providing percentage of lamp output not acceptable. It must include a built-in alarm system to notify the operator when the output level drops below the required level of 60 mJ/cm<sup>2</sup> for indoor pools or 40mJ/cm<sup>2</sup> for outdoor pools (or operator set dosing levels).
- 3) UV Reactor will be a validated system with third party testing to a recognized international standard such as the USEPA DGM.
- 4) Ultraviolet temperature monitoring system must be provided to maintain system integrity in the event of flow interruptions to the chamber.
- 5) Ultraviolet chamber must come complete with annealed quartz sleeve with "O" ring seals for water tightness. The system must be complete with advanced seal arrangement to reduce the risk of quartz over-compression on the seal face.

f. Automatic Wiper System

- 1) An automatic cleaning system must be provided for cleaning of quartz sleeve and Ultraviolet monitor probe. The system must travel the entire length of the quartz sleeve twice per desired cleaning cycle. Precision molded wiper rings must be provided to ensure thorough quartz tube cleaning and quartz tube protection. The wiper cycle must be user selectable and adjustable within a range of 5 minutes to 24 hours depending on anticipated application and deposit build-up.
- 2) The wiper system must have the following characteristics:

- a) The system must utilize direct drive with square faced coupling and acme threaded shaft to prevent slippage and pin shearing. Systems utilizing shear pins or complicated gear boxes will be unacceptable.
  - b) The wiper power supply must be 24-volt DC for improved safety. Higher voltage not acceptable.
  - c) System must incorporate Direct Shaft Encoding for positional location. Systems relying on external limit switches or internally located magnets will be unacceptable.
  - d) The wiper interval must be operator selectable with optional override switch.
  - e) Wiper faults must be indicated on the control system display.
  - f) Wiper System to utilize “Intelligent Operation” for automatic start-up commissioning.
- 3) Records wiper position at chamber ends. Position must be fixed and not dependent on a timed interval or component striking end of chamber.
- 4) Establish a travel run without using limit switches to ensure system integrity and longevity.
- g. UV Strainer
  - 1) The UV system must be provided with a downstream strainer to protect against the possibility of lamp/quartz breakage traveling downstream.
- h. Ultraviolet Control System
  - 1) The control cabinet must be a SPECTRA control unit and or pre-approved equal.
  - 2) The power must be controllable to provide full power, half power and infinite variable power based on real time interface with changes in UVT, Flow Rate or Combined Chloramines. The power panel must house the electronic ballasts required to ignite and power the lamps.
  - 3) Three levels of operation must be provided to meet the needs of the operator and pool environment: Simple Control (start, stop and reset), Full Parameter Display, and Customized Operator Configuration.
  - 4) Modes of operation must be password protected to secure system critical setup functions. Touch Control system must have clearly identifiable start, stop, and reset icons (suitable for gloved operation) with Running and Fault LCD indicators.
  - 5) The display must include the following:
    - a) Ultraviolet calculated dose
    - b) Ultraviolet intensity (as a percentage and  $\text{mW}/\text{cm}^2$ )
    - c) Lamp Current
    - d) Flow rate (as gallons per minute or  $\text{m}^3/\text{hour}$ )
    - e) Chamber Temperature

- f) Operation hour meter
  - g) Fault indicators to include Lamp fault, low UV & temperature alarm, ground fault trip, wiper fault.
  - h) Alarm functions must have a simple text message display to assist in fault finding.
- i. Ultraviolet Control System Interface
  - 1) The Control system must have a minimum of the following system interface control:
    - a) Remote operation
    - b) Process interrupt features (from valves & flow meters)
    - c) Low UV dose
    - d) Flow meter input.
    - e) Auto-Restrike.
    - f) Half to full power UV setting with 24 hour/7-day settable timer.
    - g) Variable power/Dose pacing interface
  - 2) Control system must have built in data-logging capabilities to record the following information:
    - a) UV intensity required.
    - b) UV intensity measured.
    - c) Lamp current
    - d) Chamber Temperature
    - e) Flow Rate
    - f) Time and date stamp, every alarm generated.
- j. Manufacturers must maintain spare or replacement parts in the USA for the same day or not longer than next day delivery in North America.

D. Electronic Flocculation System

1. The Clear-Flow Electronic Flocculation system must be provided and installed on the recirculation piping for the swimming pools and spas. The Clear-Flow system must be a non-chemical water treatment system designed to operate as an electronic flocculant in recreational water systems. When implemented into the system, the Clear-Flow system must work to agglomerate both organic and mineral particulate resulting in filtration enhancement on all types of filtration systems. This filtration enhancement must allow for a reduction in backwashing frequency - saving water, chemicals, and energy.
2. The Clear-Flow system must be UL listed and certified to NSF/ANSI Standard 50 and documentation of such certification must be provided by the manufacturer with each system.
3. When used in a recreational water application, the Clear-Flow system must work as an electronic flocculant. By generating and propagating a low-frequency treatment signal throughout the entire plumbing system, the technology must produce an ongoing flocculation effect which will aid in a reduction in turbidity and improved clarity.



4. The Clear-Flow system's ongoing flocculation effect must enhance filtration efficiency. The flocculation effect must create larger particles allowing for a reduction in both frequency and duration of backwashing.
5. Equipment
  - a. The following components are contained in a standard Clear-Flow kit and must be provided for each system:
    - 1) ABS or SS enclosure with 3 glands (2 for signal leads and 1 for power supply)
    - 2) Signal cables complete with mounting tags (Temp. rating -40°F to +140°F) (Qty. 2)
    - 3) Stainless steel hose clamps (Qty. 4)
    - 4) Gland plug (Qty. 1)
    - 5) 2A / 250 VAC UL-listed slow blow fuse (Qty. 1)
    - 6) 4mm Allen wrench (for grub screw) (Qty. 1)
6. Clear-Flow electronic flocculation system models must be the following:
  - a. For pipes up to 3": Model # CF-300C
  - b. For 4" pipes: Model # CF-400
  - c. For 6" pipes: Model # CF-600
  - d. For 8" pipes: Model # CF-800
7. Power Requirements:
  - a. Input Voltage: 100–240 VAC
  - b. Input Frequency: 50 - 60 Hz
  - c. Power Rating: 4W for CF-300C, 5.4W for all other models
  - d. Internal Fuse Rating: 2A / 250VAC UL-Listed slow-blow
  - e. Temperature Range: -40°F to +140°F
  - f. The electrical supply must be properly grounded, or the system will not work. Hard wiring is preferred to avoid accidentally unplugging the unit.
  - g. All safety-critical components must conform to relevant CE/IEC/UL 60950, E235235. Terminals, wires, fuse, on/off switch, AC/DC PSU. PSU must be Class II protected.
  - h. Armored 2 Core Cable:
    - 1) Spec. BC 6883; 1999
    - 2) IEC 600332 –3—22 Category A
    - 3) Temperature rating - 22°F to +140°F
    - 4) ISO 9001 – 2008 Approved
8. Installation
  - a. To ensure proper start-up of equipment the Contractor must consult a Clear-Flow representative.

- b. Optimal results are achieved if the Clear-Flow system is connected to a grounded power outlet (100-240 VAC, 50-60 Hz, 4-amp) that shares the same ground as the recirculation system the unit is being installed on.
  - c. The Clear-Flow system must come with two identical signal cables. One is intended as the “T” (transmit) signal connection, the other is intended as the “A” (antenna) signal connection. The “T” signal tag must be installed downstream from the pump and before the filter. It is preferred that the “T” signal tag is mounted on a metal reducer or stainless-steel spool piece downstream of the pump. The “A” tag must be mounted on a metal structure that is electrically connected to the system loop, which may include but is not limited to a grounded filter, nearby structure, or ground rod.
  - d. The maximum cable run length from the control cabinet (typically wall mounted) to the “T” signal tag installed on the pool recirculation pipe must be 33 feet. Installation locations must be coordinated to meet this parameter.
9. The Clear-Flow system unit must be rated for -40° F + 140° F ambient operation. The unit must have no ventilation requirements and be able to be used indoors and outdoors.
10. After identifying the proper installation location for the “T” tag, the Contractor must prepare the point for strong electrical contact with the tag. The Contractor must remove any epoxy or enamel coating which may inhibit a strong connection. The Contractor to make output connections per wiring schematic. Connect “T” and “A” connections into the labeled terminals inside the enclosure.
11. The Contractor must confirm Clear-Flow system is functioning properly and operating under the following conditions. After powering on the unit, consult the LCD screen to determine the frequency and amperage output.
- a. The optimal frequency range is between 100-350 kHz.
  - b. Optimal amperage is between 1 and 5 amps.
  - c. If frequency and amperage are outside of these ranges, the Contractor must adjust capacitor switches on the upper right side inside the enclosure.
  - d. If current amperage is not achievable under 5 amps after making capacitor adjustments, the Contractor must disconnect “A” tag from inside the terminal block and repeat adjustment of capacitors.
  - e. If these steps do not result in an optimal sine wave within the recommended frequency and amperage, the Contractor must consult a Clear-Flow Representative.
  - f. As an additional means of signal verification, an oscilloscope can be used. By touching the oscilloscope probe onto the pipe near where the “T” tag is connected, signal strength and frequency can be measured. A clean, declining sine wave with minimal harmonics should be observed.
12. The Contractor must cut excess signal cable, but not to less than 10 feet (3 meters) in length. The Contractor must not coil power cord or signal cables; doing so will interfere with signal operation.
13. The Clear-Flow system must be powered on/off via a switch on the enclosure.
14. Replacement fuses must be UL-listed.
15. The complete installation must be by the manufacturer’s installation instructions and certified on-site for proper operation by the manufacturer’s representative for each system installation.

16. The Clear-Flow system requires that the electrical supply be properly grounded. The Contractor must follow Institute of Electrical and Electronics Engineers (IEEE) standards ensuring a ground resistance of 5 ohms or less.

## 2.7 WATER CHEMISTRY MONITORING AND CONTROL SYSTEMS

- A. A programmable pool chemical automation system must be provided for continuous monitoring and control of the pool(s) water chemistry and related disinfection equipment. The installation of the system must be per the manufacturer's specification. A factory trained/authorized representative must provide training to the Owner and the training must be video recorded. Water chemistry controllers must be provided by ProMinent Fluid Controls, BECS Technology, SB Control Systems, or a technically equal system capable of providing equal performance for operating functions.
  1. The water chemistry control systems for the pool and spa must feature and be capable of the following. Water chemistry controllers without these capabilities and features are not considered equal. Water chemistry control system requirements are based upon the following products: ProMinent DCM511/512, BECSys7, Chemtrol 3000.
    - a. Continuous, real-time monitoring and control of pH and ORP.
    - b. Free chlorine, total chlorine, combined chlorine in PPM, system flow rate, water chemistry balance calculations, water temperature, and other readings and control as deemed necessary for the project per this section.
    - c. The controller must have the ability to monitor and control the UV treatment system.
    - d. The controller must manage the recirculation pump with a programmable Fireman Cycle feature, which automatically turns off the Heater, UV, and Auxiliary systems prior to shutting off the recirculation pump.
    - e. Management of the recirculation pump on/off status.
    - f. Management of the heater on/off status based on real-time water temperature reading.
    - g. Management of the water level in the pool or surge tank and must provide programming to lock out chemical feed during potable water fill events.
    - h. The utilization of simultaneous ORP and PPM (bracketing) control for managing both the quantity and quality of the sanitizer/oxidizer. Controllers that do not have the ability to control simultaneously to ORP and PPM control points or that utilize an alternate chlorine set point or boost function will not be considered equal.
    - i. Actuating outputs in the following operator selectable modes: off, manual, automatic, proportional and must have a manual on fail-safe timer to ensure that if the controller is left in manual mode, the controller will revert back to automatic mode to prevent an over-feed event.
    - j. Programmable events can be time set to occur daily, weekly, or monthly.
    - k. Remote monitoring of the recirculation flow rate of the system when installed with compatible magmeters.
    - l. Provide use of flow signal as a supplemental chemical feed interlock to prevent the dosing of chemicals during a system low flow/no flow condition.

- m. The controller must continuously monitor data-log while being monitored and control via two-way remote communication.
- n. The controller must continuously calculate and display the Langelier Saturation Index and Ryznar Index using either sensor data and/or manual input for pH, temperature, total alkalinity, and calcium hardness.
- o. Programmable high and low alarm levels for control functions with operator-selectable feed lockout and alarm buzzer options.
- p. Performance and Certifications
  - 1) The controller system must be NSF/ANSI 50 listed for automatic controller equipment for swimming pools, spas, and other recreational water facilities.
  - 2) The controller system must be certified to UL61010/IEC61010, (CSA) C22.2 Number 61010-1, European Union Low Voltage Directive 73/23/EEC EN 61010-1 standards.
  - 3) The controller must automatically activate the appropriate chemical feeders in order to maintain the sanitizer/oxidizer level:
    - a) Within +/- 0.1 parts per million (PPM) or +/- 10 mV (millivolts) of oxidation reduction potential (ORP)
    - b) The pH within +/- 0.1 pH unit of the set points selected by the operator.
    - c) Set point and calibration levels must be adjustable with a keypad mounted on the front panel of the unit as well as the remote interface.
    - d) The controller must use pH sensor with +/- 0.04 accuracy in the operational range of 6.8 – 8.2 as certified by NSF.
    - e) An ORP sensor with an accuracy of +/- 3% mV as certified by NSF.
- q. System Supply
  - 1) The controller must be factory supplied with:
    - a) ORP, pH, temperature, and free chlorine and total chlorine sensors.
    - b) Provide cyanuric acid and/or hydrogen resistant free chlorine sensors available for specific application use with stabilized water or saline pools.
    - c) A relay capable of being named and programmed for controlling a UV system dosing based on a real-time combined chlorine as calculated by the readings from an amperometric free chlorine and total chlorine sensor.
    - d) A flowrate sensor to measure system flowrate.
- r. Hardware
  - 1) The controller must have:
    - a) A minimum of seven (7) fully configurable digital inputs.
    - b) A minimum of four (4) fully assignable digital outputs.
    - c) A minimum of nine (9) configurable analog inputs.

- d) A minimum of five (5), 115 VAC fully assignable relays.
  - e) The controller must be capable of expanded capabilities with an optional input/output expansion card kit.
  - f) High voltage field wiring must be through a separate NEMA 4X factory engineered and supplied enclosure that precludes direct access to controller electronics. High voltage connections must be clearly identified, and a field wiring diagram must be provided with the controller for the Contractor's reference. Controller high-voltage relay assignment parameters must be programmed at the factory prior to delivery to installation location.
  - g) The controller must include a sensing flow cell that is hydraulically designed to allow verified correct flow and consistent pressure across sensors. Flow cell will be clear PVC that is modular in concept and have the flexibility to add supplementary water chemistry sensors as desired. The sensing flow cell must include a safety flow switch sensor, water spigot, and isolation valves.
- s. Communications
- 1) The controller must have as a standard feature:
    - a) The controller must include the capability of ethernet connection and secondary wireless communication.
    - b) The controller must allow full two-way remote communication and full control of parameters.
    - c) Accessibility with a standard internet browser using a fully interactive Ethernet TCP/IP graphical interface that includes security access codes.
    - d) Real-time monitor/control with real-time auto polling, data logging, email and text alarms and providing both graphical and report formats via a personal computer, smartphone, or tablet device.
    - e) The controller must have the ability to facilitate email or text alarm notifications, historical graphing, and real-time control via a personal computer, smartphone, or tablet device.
    - f) The controller must have the ability to export a .csv file once per day with reading type, time, and reading. The export must be done via email and must include the controller serial number. Export data must include ORP, Free Available Chlorine, Total Chlorine, Combined Chlorine, pH, and Temperature.
    - g) The controller must have the ability to allow software upgrades and programming as needed in the field.
- t. The controller must communicate with the Building Automation System.
- 1) The controller must come with a standard, integral 100BaseT Ethernet connection that supports a MODBUS TCP/IP connection to 3rd party applications such as EMS, BMS, BAC and SCADA systems. The MODBUS TCP/IP connection must support access to Inputs (current readings), System

Information, Set Points, Alarm Points, Control Status and Alarms. Set Points and Alarm Points must be modifiable from the 3rd party application via the MODBUS TCP/IP interface.

u. Commissioning and Manuals

- 1) The control system must be provided with on-site start-up operator training performed by a representative trained and authorized by the controller manufacturer.
- 2) The manufacturer must supply an operation and maintenance manual describing features, operating instructions, maintenance procedures and replacement parts.
- 3) Installation of the system must be per the manufacturer's specification and no exceptions must be allowed. A factory trained/authorized representative must provide training to the owner and the training must be video recorded.

2.8 FLOW METERS

- A. Recirculation flow meter (2 required) must be provided according to the manufacturer in the filtered water return lines to each of the pools. The flow sensor must be the GF Signet 2551 insertion magmeter. Provide the coaxial cable from the sensor to the display/transmitter. Flow meter accuracy must be +/- 2% of reading. The flow instrument must have an LCD for simultaneous display of four-digit flow rate and eight-digit totalizer. Display/Transmitter capability will be part of chemical controller function or as separate Signet GF Signet 9900 display/transmitter. Signet GF Signet 9900 display/transmitter must be powered by 24VDC and provide a 4-20mA output.
- B. Backwash piping flow meter (2 required) must be a pilot, impact ball, variable area type with one piece, impact resistant machined acrylic plastic body. GPM scale must be permanently etched or imprinted on the meter. Flow rate indicator must be of stainless-steel material. The scale range must be appropriate for a specific flow rate. Pipe size to accommodate backwash rate. The backwash piping flow meter must be BLUE-WHITE series F-300 or approved equal.

2.9 WATER LEVEL CONTROLLERS

A. In Surge Tank Water Level Controller

1. Provide a water level sensing and control system for the pool(s) that will monitor the water level in the surge tank and automatically activate the auto water make-up control valve. For sensing water level and activating make-up water control valve for the pool(s), use Series ELC-810 controller housed in a watertight NEMA 4X UL94 5V UL flammability rated polycarbonate enclosure to meet IP66 and NEMA 4, 4X, 12 and 13 ratings. The controller must utilize two sensors to control water level. ELC-810 series must have a menu-driven LCD display screen and utilize a five-switch user interface for navigation through the menu. The menu must allow changing the following settings: delay to shutoff, alternate sensor option, maximum time on, manual override, delay to normal, type of sensor, high level option, flow sensor active, and sounder with alarm. Menu settings must be capable of password protection. The controller must be capable of displaying the following data: last fill time, last drain time, last alarm. The controller must be capable of determining the following: maximum time on exceeded, over current to solenoid valve, no valve/valve wiring problem, and sensor not working properly. The controller must have a low voltage interlock with auto water make-up solenoid valve and the high-level shutoff solenoid valve and must provide adjustable time delay for increasing level and manual override. The controller must require 115 VAC, 1 phase,

60 Hz power. The water level control package must be manufactured by AquatiControl Technology, model ELC-810-DS-ST-XXX (Coordinate the specific length(s) of cable required for each controller prior to ordering). Refer to drawings for additional information.

2. Provide a solenoid valve for high level sensor, normally opened, stainless-steel fitted, bronze body, 24 VAC slow closing type. Size to pipe. Interlock with automatic water level control system. Refer to the drawings for additional information. Solenoid must be by ASCO or approved equal.
3. Provide two proximity switch sensor(s) that must be sensitive to within +/- 1/8" (4mm) of nominal water level. Supply voltage to sensor must be 12V to 24V DC from controller. Current consumption must be < or = 15mA. Response frequency must be 100Hz. Maximum control output must be 200mA. The sensor operating temperature must be -25 Deg. C to 70 Deg. C. Operating humidity must range from 0% RH to 95% RH. The sensor(s) must be mounted in a 1" Schedule 80 PVC pipe (length must be determined by depth of surge tank). Sensing pipe must be mounted to surge tank wall with composite/non-metallic hangers and stainless-steel hardware. Sensing pipe(s) must be capable of being submerged under water safely. Refer to drawings for additional information.
4. Wiring from the sensor to the controller must be provided and must be connected to the terminal points mounted within a corrosion resistant, nonmetallic NEMA 4X enclosure. Wiring connections must be made through the bottom of the enclosure. The enclosure size must be no less than 8" wide x 5" high x 4" deep. The access door must be the entire front face panel of the enclosure. Confirm location in field.
5. Major components must be plugged-in using WAGO terminal blocks for ease of installation and replacement. Unit must be designed to activate a 24-volt AC solenoid valve.
6. Provide a make-up water solenoid valve, normally closed, stainless-steel fitted, bronze body, 24 VAC slow-closing type. Size to pipe. Interlock with automatic water level control system. Refer to the drawings for additional information. Solenoid must be by ASCO or approved equal.
7. Discharge of make-up water must be into a fill funnel and piping to the pool. Refer to the drawings for additional information.

**B. In Mechanical Room – Wet Well Water Level Controller**

1. Provide a water level sensing and control system for the spa that will monitor the water level in a well located in the mechanical room and which will automatically activate the auto water make-up control valve. For sensing water level and activating make-up water control valve for the spa, use Series ELC-810 controller housed in a watertight NEMA 4X UL94 5V UL flammability rated polycarbonate enclosure to meet IP66 and NEMA 4, 4X, 12 and 13 ratings. The controller must utilize two sensors to control water level. ELC-810 series must have a menu-driven LCD display screen and utilize a five-switch user interface for navigation through the menu. The menu must allow changing the following settings: delay to shutoff, alternate sensor option, maximum time on, manual override, delay to normal, type of sensor, high level option, flow sensor active, and sounder with alarm. All menu settings must be capable of password protection. The controller must be capable of displaying the following data: last fill time, last drain time, last alarm. The controller must be capable of determining the following: maximum time on exceeded, over current to solenoid valve, no valve/valve wiring problem, and sensor not working properly. The controller must interlock with auto water make-up solenoid valve and must provide adjustable time delay for increasing level and manual override. The controller must require 115 VAC, 1 phase, 60 Hz. The water level

control package must be manufactured by AquatiControl Technology, model ELC-810-DS-WW-XXX (Coordinate the specific length(s), "XXX," of cable required for each controller prior to ordering). Refer to drawings for additional information.

2. Provide a solenoid valve for high level sensor, normally opened, stainless-steel fitted, bronze body, 24 VAC slow closing type. Size to pipe. Interlock with automatic water level control system. Refer to the drawings for additional information. Solenoid must be by ASCO or approved equal.
3. Provide a proximity switch sensor that must be sensitive to within +/- 1/8" (4mm) of nominal water level. Supply voltage to sensor must be 12V to 24V DC from controller. Current consumption must be < or = 15mA. Response frequency must be 100Hz. Maximum control output must be 200mA. The sensor operating temperature must be -25 Deg. C to 70 Deg. C. Operating humidity must range from 0% RH to 95% RH. The sensor must be mounted in a 1" Schedule 80 PVC pipe 3 feet in length – the sensing pipe to then be mounted into a static line from the pool. The sensing pipe must be mounted into the static line via an adjustable collar that allows for quick level adjustments. Refer to drawings for additional information.
4. Wiring from the sensor to the controller must be provided and must be connected to the terminal points mounted within a corrosion resistant, nonmetallic NEMA 4X enclosure. Wiring connections must be made through the bottom of the enclosure. The enclosure size must be no less than 8" wide x 5" high x 4" deep. The access door must be the entire front face panel of the enclosure. Confirm location of controller in field.
5. Major components must be plugged in using WAGO terminal blocks for ease of installation and replacement. Unit must be designed to activate a 24-volt AC solenoid valve.
6. Provide a make-up water solenoid valve, normally closed, stainless-steel fitted, bronze body, 24 VAC slow-closing type. Size to pipe. Interlock with automatic water level control system. Refer to the Drawings for additional information. Solenoid must be by ASCO or approved equal.
7. Discharge of make-up water must be into a fill funnel and piping to the spa. Refer to the drawings for additional information.

## 2.10 DECK EQUIPMENT, INSERTS & ANCHOR SOCKETS

- A. The following items must be supplied unless otherwise noted. Proprietary names are to designate performance only. Equal products will be accepted.
  1. Grab rails must be provided as required in the quantities and to the dimensions as shown on the drawings. Grab rails must be fabricated of one continuous length of polished and buffed tubing. The tubing must be ASTM-A-554 grade 316L stainless-steel, 1.50-inch OD x 0.120-inch minimum wall thickness, polished and buffed to 320 grit finish and must be passivated, in compliance with ASTM A967-99, incorporating organic acid passivation techniques for maximum corrosion resistance. Bends must be smooth and free of wrinkles. Grab rails must be pretzel bend style with dimensions as indicated in the plans and as manufactured by Spectrum Products, SR Smith, Paragon or approved equal. Anchor sockets for grab rails must be of the wedge type, cast bronze or stainless-steel, 4 inches in depth and made to receive 1.50-inch OD tubing as manufactured by Paragon #28105, SR Smith #AS-200B, Spectrum #54052 or approved equal. The wedge must be cast bronze, incorporate a stainless-steel tightening bolt, and flat washer, and be designed as the sacrificial element to the anchor system. Metallic components must be passivated, in compliance with ASTM A967-99, incorporating organic acid passivation techniques for maximum corrosion resistance. Anchors



must be provided with flush closure caps and escutcheons with set screws where indicated. Escutcheons must be of the keyhole or oblong shape, similar to the casted, electro-polished stainless-steel escutcheon with set screw by Paragon #28303SS, SR Smith #IEP-200, Spectrum #35222 or approved equal.

2. Entry rails must be provided as shown on the drawings, fabricated from one continuous piece of polished and buffed ASTM-A-554 grade 316L stainless-steel, 1.50-inch OD x 0.120-inch wall thickness, polished and buffed to 320 grit finish and must be passivated for maximum corrosion resistance. Bends must be smooth and wrinkle free. Custom rails as manufactured by Spectrum Products, Paragon, SR Smith or approved equal. Custom rail submittal drawings must be complete with details of custom fabrication and installation information. Anchor sockets for railings must be of the wedge type, cast bronze or stainless-steel, 4 inches in depth and made to receive 1.50-inch OD tubing as manufactured by Paragon #28105, SR Smith #AS-200B, Spectrum #54052 or approved equal. The wedge must be cast bronze, incorporate a stainless-steel tightening bolt, and flat washer, and be designed as the sacrificial element to the anchor system. Metallic components must be passivated, in compliance with ASTM A967-99, incorporating organic acid passivation techniques for maximum corrosion resistance. Anchors must be provided with flush closure caps and escutcheons with set screws where indicated. Escutcheons must be of the keyhole or oblong shape, similar to the casted, electro-polished stainless-steel escutcheon with set screw by Paragon #28303SS, SR Smith #IEP-200, Spectrum #35222 or approved equal.
3. Spa transfer railing must be provided as shown on the drawings, fabricated from one continuous piece of polished and buffed ASTM-A-554 grade 316L stainless-steel, 1.50-inch OD x 0.120-inch wall thickness, polished and buffed to 320 grit finish and must be passivated for maximum corrosion resistance. Bends must be smooth and wrinkle free. Custom rails as manufactured by Spectrum Products, Paragon, SR Smith or approved equal. Custom rail submittal drawings must be complete with details of custom fabrication and installation information. Anchor sockets for railings must be fabricated from advanced glass reinforced copolymer, 6 inches in depth and made to receive 1.50-inch OD tubing. The anchor body must incorporate four (4) copolymer anti-rotation fins. The fins must be located on the anchor body and will prevent the anchor from spinning in the concrete. The fin must be an integral part of the anchor body. Compression anchors must be manufactured by Spectrum #42696 or approved equal from Paragon or SR Smith. Anchors must be provided with flush closure caps and escutcheons with set screws where indicated. Escutcheons must be of circular, similar to the casted, electro-polished stainless-steel escutcheon with set screw by Paragon #28303, SR Smith #EP-150, Spectrum #24095 or approved equal.
4. Stanchion posts (backstroke and false start) must be provided as required and in the quantities shown on the drawings. The posts must be a straight length of type 316L stainless-steel tubing, 1.90-inch OD x 0.145-inch wall thickness x 8-foot overall length, polished and buffed to 320 grit finish. Stanchions must be capped at one end with a closure plug containing a U-shaped hook and fitted with a stainless-steel eyebolt attached to an adjustable nickel-plated bronze sliding collar. Stanchion with sliding collar and eyebolt as manufactured by Paragon #38106 with #38301, SR Smith #10167-MG with #35-102, Spectrum Products #23614 with #23625 or approved equal. Anchor sockets for stanchions must be of cast bronze or stainless-steel, sized to receive a full 6 inches penetration of 1.90-inch OD tubing as manufactured by Paragon #38201TC, Spectrum Products #23626, Kiefer #700103, SR Smith #AS-100D or approved equal. Each anchor socket must be provided with a flush threaded, vandal proof closure cap Paragon #38201TC, Spectrum Products #23628, or Kiefer #700103C and a grounding lug with screw. Provide Paragon #38303, Spectrum Products #23630, Kiefer #700103K or

approved equal spanner wrenches for removing the closure cap. Anchors or sockets must be provided with flush closure caps and escutcheons with set screws where indicated.

5. Starting Platforms

- a. Single post starting platforms for the rollout gutter (9 required, 8 plus 1 spare) must have number plates on both sides numbered 1 through 8. Spare block must not be numbered. Platform block height must be 29-1/2" inch above water level. The platform top (24" wide x 32" deep) and intermediate sidestep (8" x 12") must be constructed of UV inhibited high density polypropylene. Confirm step is on correct side (right or left) according to plans. The surface must have a non-skid dual cross-grooved sand textured finish. The top must be permanently positioned at a 10° tilt towards the pool. Frames must be 2.5 square inch x 0.125-inch wall thickness 304 stainless-steel tubing with a powder coated finish. Refer to the Owner/Architect for color selections. Verify height of platform above water before ordering. The backstroke bar must be 1" diameter and allow both horizontal and vertical grab positions. Blocks must have raised side grip handles and adjustable back plate. Platforms must be custom blocks as detailed on the plans similar to the Track Start Quickset with adjustable backplate and hand grip kit by Paragon, Velocity with adjustable backplate and side handle option by SR Smith, Riptide with adjustable backplate and hand grip option by Kiefer, Xcellerator by Spectrum Products or approved equal. Provide starting platform with team/school logo and custom colors. Refer to the Owner/Architect for color and logo selections. Each starting platform must have two labels affixed stating "Warning – For Use by Trained Competitive Swimmers Only – Execute Shallow Racing Dives Only - Impact with Pool Bottom Can Cause Permanent Injury."
- b. Anchors sockets for single post starting platforms located on the rollout must be designed to prevent rocking. A stainless-steel cap must be provided to flush mount on the deck when platform is removed. The anchor socket must be cast T304 stainless-steel with wedge assembly consisting of a bronze wedge and T304 stainless-steel hardware. Anchors for starting platforms must be by the starting block manufacturer - Paragon Quickset Dual-wedge anchor, SR Smith Rock Solid anchor, Spectrum Products Record Breaker anchor, or Kiefer Riptide anchor.
- c. Starting platform safety covers (8 required) are designed to keep unwanted users off starting platforms. The cover is made of 1/16" thick tough, lightweight plastic with a UV stabilizer and fits 24" x 32" platform tops. The conical shape and safety orange color act as a deterrent of starting platform use. Each cover is provided with a bungee cord for securing the cover platform top.

6. Backstroke start devices (8 required) must be non-slip wedges designed to adapt to starting blocks provided. Backstroke start devices must automatically retract up and out of the water and have a 10-degree angle for secure foot placement at the race start. Backstroke start devices must be the Backstroke Start Device by Colorado Timing, Backstroke Start Device by Spectrum Products, or approved equal.

7. Lifeguard Chairs

- a. Lifeguard chairs must be constructed of UV inhibited recycled HDPE chairs. Maximum seat height must be 48"/ 66" above the pool deck. Joints must be secured using T- 316L stainless-steel screws. Refer to the Owner/Architect for color selections.

- 1) Lifeguard chairs (1 required) must be Spectrum Products Mendota #45023, Tailwind Furniture #LG510, Kiefer Forever Guard Chair #500231, SR Smith Sentry #SLGC42 or approved equal.
  - 2) Lifeguard chairs (1 required) must be Spectrum Products Mendota #45023, Tailwind Furniture #LG510, Kiefer Forever Guard Chair #500231, SR Smith Sentry #SLGC66, or approved equal.
8. Diving Stands
  - a. Diving stands for the one-meter/three-meter springboards must be provided as shown on the plans. The diving board stand must consist of heavy aluminum castings dipped in erudite chromic acid solution, followed by a 20-mil coat of baked epoxy. Finish must be touched up in the field if damaged in shipping or assembly. The roller tube and tracks must be heat-treated extruded aluminum processed by Alcoa Duranodic hard anodizing process. The bearings for the roller tube and slide must be nylon with grease fittings, adjustable and field replaceable. The diving board anchor hinges and pins must be heat treated aluminum forgings with a design tensile strength of 35,000 psi and must receive Alcoa Duranodic hard anodizing. Hinges must be designed to allow 180-deg. rotation of the diving board to the rear of the stand. Hinges must be mounted on a transverse casting machined to allow 7 leveling positions in one-inch increments. The diving board anchor bolts must be 5/8-inch diameter by 3-1/2-inch-long silicon bronze. The diving stand must be supplied with top and intermediate guard rails on two sides. The diving stand guard rails must be stainless-steel tubing firmly attached to the guard rail supports with stainless-steel band fasteners. The rails must extend to the edge of the swimming pool and the rail ends must be fitted with rubber safety tips. Fulcrum must have an adjusting wheel at one end that can be turned by hand or foot. Diving stands must be manufactured by Duraflex International Corp.
    - 1) One-meter stand (2 required) must be Durafirm #70-231-400 and included with eight (8) bronze deck anchors, Durafirm #70-231-905.
    - 2) Three-meter stand (1 required) must be Durafirm #70-231-300 and included with eight (8) bronze deck anchors, Durafirm #70-231-905.
9. Railings for the diving springboard pedestals must be provided as shown on the drawings. Rails must be custom fabricated of one continuous length of tubing wherever possible. The tubing must be Anodized Type 6061-T6 Schedule 40 Aluminum, 1.50-inch OD x 0.120-inch wall thickness – A31 Architectural Class II Clear Anodize. Surface preparation of Aluminum tubing must be M32 Medium Satin finish. Floor flanges must be J Blum #7571 heavy duty aluminum or approved equal. Anchors must be stainless-steel, Type 316L. Rails must be vented for Anodizing. Welding must be in accordance with American Welding Society Code D1.1-94. Welding electrodes must be Aluminum 5356. Welding slags, burrs and splatter must be removed from handrail surfaces and exposed welds must be ground smooth. Dimensions must be field verified prior to fabrication.
10. Diving boards (3 required) must be an aluminum extrusion type springboard. The diving boards must be a Maxi-Flex Model "B" diving board as manufactured by Duraflex International, Inc., #66-231-330 or approved equal. The diving board must be 16 feet long and 19-5/8 inches wide. The top surface must be finished with three coats combined with a mixture of sand and white aluminum oxide to affect the non-skid surface with 200 perforations.
11. Surge tank access hatch (1 required) must be provided as shown on the drawings. The access hatch must be a single door 3'-2" x 2'-6" with 1" fillable pan to receive ceramic tile

and grout or concrete fill to match the surrounding deck. The frame must be ¼ inch extruded aluminum with built in neoprene cushion and continuous anchor flange. Door must be ¼" aluminum plate reinforced with aluminum stiffeners as required. The door must be equipped with heavy continuous stainless-steel hinges and must have compression spring operators for easy operation. The door must open to 90 degrees and lock automatically in that position. The door must be built to withstand a live load of 150 lbs. per square foot and equipped with a continuous Type 316L stainless-steel hinge, tubular type, and an automatic hold open arm with release handle. Hardware must be type 316L, 18-8, stainless-steel. A flush lift handle and a snap lock with removable key wrench must be provided. Factory finish must be mill finish with bituminous coating applied to the exterior of the frame. The access door must be Type TER-3 single leaf pan type door as manufactured by the Bilco Company.

12. Sleeves for surge tank valve extensions must be Spectrum Products Valve Extension Body #1910387 with Lid and Key #36450, or Spectrum Products Bronze Anchor Kit 1.90-inch O.D. x 6-inch-deep Anchor (field modification required) with Lid and Key #23638-00.
13. Surge tank ladder must be provided for the depth of the surge tank as indicated on the drawings and include a pull-up handrail. The ladder and handrail must be constructed of polypropylene that conforms to ASTM-D4101. Ladders must meet all ASTMOC-497 load requirements and OSHA 1910.26 and 1910.27 specifications. The ladder must be fastened to the floor and wall with 1/2" x 3-3/4" 316 stainless-steel anchors and installed per manufacturer's instructions. Adjustable mounting bracket must be 8". Aluminum reinforced copolymer polypropylene rail must be 1-3/4" x 1-3/4" diameter. Steel reinforced copolymer polypropylene ladder rungs must be 1-5/8" x 1-1/4" diameter with molded finger grips, 12" O.C. The ladder must be manufactured by Lane International Corporation or approved equal.
14. Backwash catch basin ladder rungs must be ½ inch Grade 60 steel encased with co-polymer polypropylene plastic as manufactured by M.A. Industries, Inc, or approved equal.
15. Pool Lift
  - a. The pool lift (1 required) must be a battery powered handicap lift with footrest assembly. Lift must comply with the Americans with Disabilities Act Access Guidelines (ADAAG), be capable of lifting 300 lbs, and must include a seat belt assembly. The following accessories must also be provided: caddy, arm rest assembly, lift cover, extra battery, wired controls. Stainless-steel components must be 304L. Lift must be a SR Smith Splash Aquatic Lift Extended Reach #370-0000, Spectrum Products Horizon Long Reach BP 300 #2030086, Aqua Creek Products LLC Mighty 400 #F-MTY400 or approved equal. Confirm pool lift fits on pool perimeter and operates correctly.
  - b. The anchor for the pool lift must be furnished with the lift. The anchor must be an embedded sleeve made of glass reinforced copolymer, 300 series stainless-steel, or bronze. The depth of the anchor must be 6 inches, and the anchor must include a lug for proper bonding with the pool structure. The anchor must be installed in accordance with manufacturer's instructions, including required or recommended support footings. Manufacturer must provide an anchor cap and key for times when the lift is not in use. Sockets must be provided as stainless-steel or cast bronze for swimming pool accessories.

16. Provided a ship's ladder or Lapeyre Stair in the size and shape shown on the drawings. The ladder must be aluminum with aluminum stiffeners if required by OSHA. Refer to the Architect.

## 2.11 LOOSE EQUIPMENT

- A. The following items must be supplied unless otherwise noted. Proprietary names are to designate performance only. Equal products will be accepted.

1. Competition floating lane ropes must be as shown on the drawings and described in these specifications. Floating lane ropes must be a non-turbulent type with wave quelling floats and 3/16" stainless-steel coated cable. Floats must be injection-molded polyethylene. Colors to alternate the length of the pool with a contrasting solid color for the final 15 feet. Owner/Architect to select colors from standard color chart. Floating lane ropes must be provided as completely assembled and installed with take up reel, type 304 stainless-steel spring and cable lock, hooks, and wrench. 5/8" wrench must be made of a forged steel shaft with a polished chrome finish. The take up reel must be constructed of type 304 stainless-steel. The spool must be a bronze nickel-plated casting with a nylon sleeve. Floating lane ropes must be similar to Competitor Swim Products, Competitor Gold Medal 6" Racing Lanes, Kiefer Advantage II Racing Lanes, or Anti-Wave Maximum Racing Lanes, Malmsten Gold Pro Racing Lanes pre-assembled and sized to fit the length of the pool. Provide lane rope extension hooks as detailed on the drawings complete with protective sleeve. Floating lane ropes with disconnects for shorter distance is acceptable. Provide contrasting disks located 15 meters from each end to meet resurfacing requirement. This requirement must be met for each possible course length.

### Quantities:

Competition Pool:      Provide 9 at 25 yards  
                                 Provide 9 additional extension hooks

2. Cup anchors for floating lane ropes must be incorporated into the perimeter overflow system. Cup anchors must be 316L stainless-steel with stainless-steel threaded eyebolts. The heavy-duty cup anchors must be 3-3/8-inch diameter. Cup anchors must be Spectrum Products #58280, SR Smith #WA-100, Paragon #14-503 or approved equal.
3. Backstroke flags:
  - a. Backstroke flags must be made of Vinyl material, triangular in shape (12" wide x 17" long), and alternating in color, butted end to end on vinyl covered stainless-steel cable. Submit standard color samples for review and approval by the Owner/Architect. The cable must be attached to a stainless-steel take up reel at one end and a stainless-steel tension spring end-fitting at the other. Equipment must be similar to the following items by Kiefer: backstroke flag (#600808), racing lane cable (#210210), take-up reel (#210218S), and spring end fitting (#210219) or approved equal from Competitor Swim Products. Provide backstroke flags with team/school name on one side and lane identification on the other.
4. Lane Rope Storage Reel
  - a. Lane rope storage reel must be fabricated from two powder-coated enclosed aluminum wheels joined together by a 1-1/4-inch aluminum axle. This unit must ride easily on four 6" stainless-steel casters with individual brakes. The reel must have a collapsible tow handle for safe movability. The storage reel should be able to hold 902' of 4" lane

ropes or 492' of 6" lane ropes. The storage reel must come assembled. The correct number of storage reels must be provided to store the lane lines. Lane line storage reel must be Competitor Swim Products Elite Stor Lane Reel #200 850 with Competitor storage reel cover #200 861, SR Smith XL Capacity Lane Line Reel #38000 with SR Smith lane line reel cover #36100 or approved equal.

5. Pace Clocks
  - a. Battery powered pace clock (1 required) must be a portable type with stand, 31-inch octagonal face with a stabilizing foot and a built-in recessed handle. The pace clock must be the Kiefer, 31" pace clock #210403 or approved equal. Color selections made by the Owner/Architect.
6. The lifeline must be 3/4-inch blue and white polyethylene rope with floats that are 5-inch diameter by 9-inch-long. Floats must be spaced on five-foot centers. Metallic rope hooks must be stainless-steel. Provide lifeline at five-foot break between shallow and deep water as shown on the drawings. Lifeline must be equal to Recreonics #14-438.BW or Lincoln Aquatics #44-115 safety line rope, Recreonics #14-381, Lincoln Aquatics #44-190 or Competitor Swim #350EZBW locking 5" x 9" floats, and Recreonics #14-456 or Lincoln Aquatics #44-125 rope end hooks.
7. T-wrench for operation of valve extensions must be fabricated of 3/4" diameter SCH 40 stainless-steel pipe. The T-wrench must be 4'-0" in length with a 24" long welded "T" handle. The wrench must be fitted with a 3/4" square stainless-steel male end, 1" in length, for operation of valve extensions at the surge tank. Two complete T-wrenches must be provided.

## 2.12 MAINTENANCE EQUIPMENT

- A. The following items must be supplied unless otherwise noted. Proprietary names are to designate performance only. Equal products will be accepted.
  1. Wall brush (1 required) - Brush backing must be a flexible polyethylene material with five (5) rows of nylon bristles. The pool brush holder must be permanent mold cast aluminum with hydrofoil flap. The holder must have stainless-steel screws to facilitate brush changes. Handle bracket must be quick detachable mount to fit standard 1 1/4 or 1 1/2 inch diameter handles. Brush must be Recreonics #10-135, Lincoln Aquatics #31-020, or approved equal.
  2. Skimming net (1 required) - Skimmer head must consist of one-piece molded plastic frame with a reinforced, integral handle bracket suitable for quick attachment to a standard 1 1/4 or 1 1/2 inch diameter handle using bolts and wing nut. The standard nylon net must be attached to the frame using the groove and spline method. Net depth must be 16 inches minimum in the center. Skimming net must be manufactured by Recreonics #10-124, Lincoln Aquatics #31-103 or approved equal.
  3. Telescopic Poles (1 required) - Cleaning tool handle must be of the telescopic design and fabricated from corrosion resistant, high-quality anodized aluminum. Poles must be fully adjustable, to desired length, with a simple twist of a cyclac threaded locking device. Poles must consist of a 1-inch tube fitted inside a 1 1/4 inch tube and be adjustable from a range of 8 ft. to 16 ft. Handle must be adjustable from 8 ft. to approximately 16 ft. having a threaded bushing type clamp to lock handle at desired position. Poles must be Recreonics #10-323, Lincoln Aquatics #30-050 or approved equal.
  4. Portable Vacuum Poles

- a. Stainless-steel poles (1 required) –Vacuum head attachment poles are to have a heavy-duty 1¼ inch stainless-steel handle with special brass male and female threaded inserts on the ends. Poles must be 8 ft. each, totaling a 24 ft. length for vacuum head attachment. Poles must be Recreonics #10-330 with female thread adaptor Recreonics #10-335 or approved equal.
5. Test Kits
  - a. Provide two (2) test kits:
    - 1) The first test kit must feature liquid reagents, a color comparator, waterproof instructions and treatment charts, chemistry guide and water gram. Test kit to have the ability to test for free and total chlorine (0.5 – 5.0 ppm), bromine (1-10 ppm), pH (7.0 – 8.0), acid and base demand, total alkalinity, calcium hardness and cyanuric acid. The test kit must be Taylor Complete 2005 test kit or approved equal.
    - 2) The second test kit must be photometric and utilize tablet reagents for stability that will allow accurate measurement of free and total chlorine (0-10 ppm), bromine, pH, alkalinity, calcium hardness, and cyanuric acid. The test kit must have solid-state digital electronics and built-in filters. The test kit must be direct reading with automatic blank settings, automatic power cut-off, and store the last 10 results in nonvolatile memory. Provide LMP106C Pooltest 6 with Hard Carry Case Kit and LMC001 Check Standard by Lumiso, AquaPRO 6 Test Kit manufactured by Orbeco-Hellige Inc and Reference Standard Kit (LP275680) or K-2010-CH by Taylor Technologies or approved equal.
6. Vacuum Cleaner
  - a. Vacuum cleaner (filtered water return to pool) - (1 required) must be complete with a 36-inch dual manifold head with 50 feet of 1-1/2-inch floating hose. Hose must be Recreonics, #10-414, Lincoln Aquatics #29-114 or approved equal. 24 ft. stainless-steel pole must be available for attachment. The portable cartridge vacuum cleaner system must include a 155 square foot T-316 stainless-steel up-flow single cartridge filter, a 1 HP self-priming thermoplastic self-priming pump 1-1/2-inch suction and discharge connection and 110 cubic inch strainer capacity. Cartridge must be Harmsco #ST/155 or approved equal. The system must be provided with one spare cartridge filter. The pump motor is 115-volt single phase, open-drip proof and must be UL and NSF listed. The pump motor must be provided with a 120-volt Hubbell switch, weatherproof switch cover, in-line pre-wired GFCI and a 100' power cord. The cord must be wired to a 20-amp, 115-volt switch which must be mounted on the pump motor. Interconnecting pipe and fittings must be schedule 40 PVC. The entire assembly must be bolted to a T-316 stainless-steel cart and must have pneumatic wheels with grease fittings and roller bearing hubs. The unit must be Recreonics #10-806, Lincoln Aquatics #27-010 or approved equal. Accessories must include a 1-1/2-inch x 25 ft. discharge hose with stainless-steel hose clamp. Hose must be Recreonics #10-440, Lincoln #29-140 or approved equal.
7. Robotic Pool Cleaner
  - a. Provide one (1) dual pump floor, wall, and waterline only automatic commercial robotic pool cleaner. The cleaner must provide up to 5,820 square feet per hour of cleaning coverage as well as filter up to 9,000 gallons per hour. Unit must have 4-,

6- and 8-hour cleaning cycles. The pool cleaner must be provided with 131 feet of cable, PVC brushes, two (2) bottom loaded filter bags and a remote control for "spot cleaning". Features must include zero-depth entry sensor and transportation caddy. Unit requires a dedicated 120-volt circuit receptacle with GFCI to transform which provides 27 volts the automatic pool cleaner. The automatic pool cleaner must be #9999359-W120 WAVE 120 as manufactured by Maytronics USA or approved equal.

8. Stainless-steel Cleaner - Provide a stainless-steel cleaner. The cleaner must comprise of one (1) gallon of organic passivation solution. It must be complete with instructions for proper maintenance of stainless-steel surfaces and material safety data sheets for the passivation solution. The cleaner must be the Spectra-Clean System 2 as manufactured by Spectrum Products. Product must be applied with 3M scouring pad, or equivalent.
9. Stainless-steel Protective - Provide protective coating on swimming pool rail goods. The coating must provide envelope protection. Surfaces coated must be clean and dry and free of oil, films, grease, silicones polishes and waxes, anything that leaves a film on the surface. Care must be taken not to clean the surface with a type of cleaner or solvent that may leave behind a thin film. The coating must be applied at approximately ½ mil WFT yielding a dry film thickness of 3-5 microns. Three coats are required. Allow to dry to touch between coats. The coating must be ProtectaClear-AF as manufactured by Everbrite and distributed by TMI Salt Pure Corporation or Spectra Shield as manufactured by Spectrum Products.

## 2.13 SAFETY EQUIPMENT

- A. The following items must be supplied unless otherwise noted. Proprietary names are to designate performance only. Equal products will be accepted.
  1. Ring buoy and extension rope (2 required) – Buoy must be 24-inch diameter vinyl clad PVC foam with a metal ring molded inside. Buoy must have a 3/8-inch polyethylene rope attached to it at four points and be a minimum 60 feet in length. Preserver must be U.S.C.G. approved. Buoy and rope must be mounted at each lifeguard chair on hooks. Ring buoy must be Recreonics #12-252, Lincoln #44-075 or approved equal. The throw rope must be Recreonics #12-261, Lincoln Aquatics #42-050, or approved equal.
  2. Life hook and pole (1 required) – Life hook must be an anodized aluminum 3/8-inch OD "shepherd's crook" with a 1-1/8-inch OD handle attachment suitable for a 1¼-inch 16 ft. aluminum extension pole. Hook must be of looped construction. Each pole must be provided with a set of spring type stainless-steel pole clamps for mounting on each lifeguard chair. Life hook must be Recreonics #12-239, Lincoln #42-060 or approved equal. Pole clamps must be Recreonics #10-353, Lincoln #30-135, or approved equal.
  3. Spineboards (1 required) - Spineboard must be 72" long x 20" wide, constructed of 100% virgin high density polyethylene. The design must provide stiffness and torsional rigidity while remaining lightweight. The spineboard must accommodate up to 500 lbs and must feature customizable buoyancy that allows users to adjust the buoyancy by inserting polyethylene foam rods (supplied with the spineboard). There must be (10) handholds around the perimeter of the board. The spineboard must be supplied with one (1) 2-piece head immobilizer, one (1) head strap, four (4) body straps, one (1) head immobilizer with head bed, and two (2) flotation rods. The spineboard must be CJ Rescue 6 package as manufactured by CJ spineboard or approved equal. Provide one (1) set of heavy-duty stainless-steel utility hooks per spineboard for storing the spineboard at a convenient and readily accessible location near the pool (Recreonics #10-362).



4. First aid kit (1 required) - First aid kit must be a 24-unit kit per American Red Cross standards as manufactured by Swift First Aid, Recreonics #12-013, Lincoln #47-084 or approved equal.
5. Bloodborne pathogen kit (1 required) – Bloodborne pathogen kit must include a protective gown, medical-grade latex gloves, face mask with eye shield, antimicrobial hand wipes, and body fluid clean-up supplies. The kit must include a wall-mountable hard storage case. Bloodborne pathogen kit must be Recreonics #12-041, Lincoln Aquatics #48-056 or approved equal.
6. Rescue tube (4 required) - Provide one rescue tube for each lifeguard chair. Rescue tube must be Recreonics #12-293, Lincoln #42-030 or approved equal.
7. Safety eyewash station (1 required) - Safety eyewash station must be a self-contained system in which eyewash bottles are securely positioned in a portable holder. Eyewash bottles must be 32 ounces and easily removable from case, and must contain a sterile, saline solution with the ability to neutralize a varying quantity acids or caustics. Eyewash stations must be equipped with a double back screw and holes for easy mounting in location determined by the Architect. Stations must be Recreonics #12-033, Lincoln Aquatics #49-026, or approved equal.
8. Safety eyeglasses - Provided a safety eyeglass dispenser station containing ten (10) pairs of safety glasses. Eyeglasses must be ANSI/OSHA accepted.
9. Bag Valve Masks – Provide two (2) bag valve mask assistant resuscitation systems, one size Adult (1500ml tidal volume) and one size Infant/Child (450ml tidal volume). Product must be a latex free disposable bag mask unit with support strap, transparent patient valve, and textured surface to eliminate slipping. Integral swivel valve, available with a closed reservoir system. Standard pack includes resuscitator, oxygen reservoir and a transparent bag for storage. Bag Valve Masks must be Ambu SPUR II or approved equal.
10. AED – Provide one (1) Automated External Defibrillator and one (1) trainer AED corresponding to the chosen AED per facility level for the aquatic facility. Product location must be coordinated with the Owner and Architect. AED must be Recreonics #12-430, Lincoln Aquatics #48-013, or approved equal and must have an available training AED device. AED Cabinet must be Recreonics #12-434, Lincoln Aquatics #48-023, or approved equal.

#### 2.14 THERMOMETERS

- A. The following items must be supplied unless otherwise noted. Proprietary names are to designate performance only. Equal products will be accepted.
  1. Portable thermometer (2 required) must be a molded ABS plastic tube body type with the ability to measure temperature in both degrees Fahrenheit and Celsius. A 3 ft. polyethylene cord must be attached to thermometer. Thermometer must be manufactured by Pac-Fab/Rainbow #R141036 or approved equal.
  2. The inline thermometer must be near the heating loop and must have a 9-inch adjustable angle with a minimum 6-inch stem. There must be a minimum of two (2) thermometers per loop and must have ability to read temperature in both degrees Fahrenheit and Celsius. Thermometers must be Recreonics #32-702, Lincoln Aquatics #21-125, or approved equal.

#### 2.15 SWIMMING POOL FINISHES

- A. Swimming Pool Tile - Reference specification section 131103, Swimming Pool Tile.

## **2.16 WATERPROOFING**

### **A. Products**

1. Interior surfaces of gutter, surge tank and backwash pit with NO additional finishes: Apply two (2) coats of Vandex BB White, Xypex Modified, Xypex Megamix I, Miracote BC Pro or Basecrete directly to surface of gutter, surge tank and backwash pit.

### **B. Surface Preparation**

1. Surface must be structurally sound and free of foreign substances and debris that could reduce or impair adhesion. Surfaces must be roughened by sand blasting or water blasting. Shot blasting, scarifying, or grinding can also be accepted methods of surface preparation. Surface defects or holes must be patched per manufacturer's recommendations.
  - a. National Plasterers Council Surface Preparation Definitions
    - 1) Pressure Washing: The washing or cleaning of a surface by a stream of water ejected from a nozzle at high velocity, typically in the range of 1,000 psi – 4,000 psi.
    - 2) Water Blasting: The cutting, abrading, or removal of a surface or substrate by a stream of water ejected from a nozzle at ultra-high velocity, typically in the range of 10,000 psi – 40,000 psi.

### **C. Application**

1. Do not apply materials under conditions where the ambient air temperature is less than 40 degrees Fahrenheit, or to a frozen substrate.
2. The mixing of products, quantities and application procedures must be done in accordance with the manufacturer's recommendations.

## **2.17 SEALANTS**

- A. Provide sealed expansion joints as shown on the pool and pool structural drawings or noted on the construction/expansion joint layout, and as required. Expansion joints must be constructed and sealed as indicated and in accordance with the manufacturer's recommendation. Sealant must be manufactured by LATICRETE International, Inc., Mapei, or Deck-O-Seal.

1. For submerged joints:
  - a. Latasil, one component, neutral cure, high performance, 100% silicone sealant in the color(s) as selected by the Owner/Architect. Must be used in conjunction with Latasil 9118 Primer per manufacturer's recommendations.
  - b. Mapeil T, 100% silicone sealant in the color(s) as selected by the Owner/Architect.
2. For joints behind the coping, or other horizontal deck joints:
  - a. Deck-O-Seal, two component (gun-grade or pourable, self-leveling), high resilience, non-sag, non-flowing, polysulfide-based sealing compound in the color(s) as selected by the Owner/Architect. Must be used in conjunction with Rezi-Weld LV per manufacturer's recommendations.

### **B. Material Storage**

1. Materials must be stored in the original unopened factory containers in a cool dry location at 60 to 80 degrees F. Protect from the elements and the hazards of construction.

**C. Joint Preparation**

1. Clean the joints of deleterious material, to sound, clean and dry substrate.
2. If the joint is existing and part of a renovation, inspect and verify that joints have firm, solid sub-surface support up to the underside of the structural slab. Identify those joints that do not have such support and fill voids under the joint with a cement slurry (being careful not to fill the joint space itself) consisting of the following:
  - a. Two (2) parts water (by weight) 10 gallons
  - b. One (1) part Portland cement 47 lb. bag
  - c.  $\frac{1}{4}$  to  $\frac{1}{2}$  part bentonite  $\frac{1}{2}$ , 50 lb. bag
3. In mixing the slurry it is recommended that the water be added first, then the cement, and finally the bentonite. The more bentonite the faster the set. Do not get the slurry on the joint itself.
4. Joint must be formed or filled with an approved, resilient, non-asphaltic, closed cell, polyethylene joint filler material down to firm substrate. Allow space at the top of the joint for the installation of approved closed cell polyethylene backer rod and install same to the required depth below the surface of the slab to control the depth of the sealant bead to within manufacturer requirements.

**D. Surface Preparation**

1. Concrete surfaces to receive sealant must be fully cured, clean, dry, and free of dirt, dust, curing compounds and other foreign material that might compromise the adhesion and performance of the sealant. Curing aids, form release agents and joint former residue must be completely removed, if necessary, by sand blasting and/or grinding. Loose dust must be brushed off.
2. Prime surfaces to receive Latasil sealant with Latasil 9118 Primer prior to sealant application, and surfaces to receive Deck-O-Seal sealant with P/G Primer prior to application.

**E. Application**

1. Apply sealant in accordance with the manufacturer's recommendations.
2. Tool the joint immediately after application to ensure a firm, intimate contact with the joint interface.
3. Remove excess sealant and smear from adjacent surfaces with Xylol or Toluol before sealant cures.
4. After the sealant has fully cured (generally a minimum period of five days at 72 degrees and 50% humidity), paint the surface of the sealant with a chlorine resistant chlorinated rubber or equivalent pool paint, in a compatible color as selected by the Owner/Architect. NOTE: Latasil cannot be painted.

**2.18 UNDERWATER LIGHTS**

- A. Underwater lights must be equivalent to 100/500 watts of incandescent light. Underwater lights must be UL listed and, in the quantities, shown and as detailed in the construction drawings and as described in these specifications. Coordinate for proper installation. Refer to the drawings for quantities and locations.

- B. The pool underwater lights must be 120VAC or 12VAC, 31 watts LED-type, and equivalent to 500 watts of incandescent light. Fixture housing must be stainless-steel construction with minimum wall thickness of 0.020 inch per UL 676 underwater pool lighting standard. The niche must be stainless-steel with cast brass mounting ring or PVC plastic with stainless-steel mounting ring. Brass construction pressure grounding lug on interior and exterior services. Lens must be 8-3/8 diameter clear tempered heat resistant glass. The gasket must be single piece "U" shaped santoprene or silicone. Fasteners must be silicon-bronze or stainless-steel. The light fixture must be supplied with a #16-3 STW (120V) or 12-3 SJTW (12V) submersible cord with ground wire positively grounded inside the fixture. Cord entrance must be a watertight seal and epoxy encapsulated. Light fixture must be IntelliBrite Architectural Series White LED pool light series by Pentair Commercial Pool and Aquatics or approved equal. Underwater lights must be provided with cord length as required to allow for deck relamping of fixtures.
- C. The spa underwater lights must be 120VAC or 12VAC, 18 watts LED-type, and equivalent to 100 watts of incandescent light. Fixture housing must be stainless-steel construction with minimum wall thickness of 0.020 inch per UL 676 underwater pool lighting standard. The niche must be stainless-steel with cast brass mounting ring or PVC plastic with stainless-steel mounting ring. Brass construction pressure grounding lug on interior and exterior services. Lens must be clear tempered heat resistant glass. The gasket must be single piece "U" shaped santoprene or silicone. Fasteners must be silicon-bronze or stainless-steel. The light fixture must be supplied with a #16-3 STW (120V) or 12-3 SJTW (12V) submersible cord with ground wire positively grounded inside the fixture. Cord entrance must be a watertight seal and epoxy encapsulated. Light fixture must be IntelliBrite Architectural Series White LED spa light series by Pentair Commercial Pool and Aquatics or approved equal. Underwater lights must be provided with cord length as required to allow for deck relamping of fixtures.
- D. Junction boxes must be provided in the quantities required and must be located at least 8" above the pool coping and 5' from the pool edge. Refer to the Electrical drawings. Cord length must be sufficient to run from fixture to the junction box with sufficient cable in the niche to re-lamp the fixture on the deck. Provide junction boxes that must be installed by Electrical.

## 2.19 DIVE HARNESS SYSTEM

- A. Provide a complete dive harness spotting system for the 1-meter springboards. The diving harness system and all components must be supplied by Springboards and More or approved equal.
- B. Beam Clamps: Provide beam clamps as required for attachment to beams/purlins overhead. Clamps must be sized as appropriate for mounting to the roof structure (Refer to Architectural drawings) and must be constructed entirely from heavy-gauge cold-rolled steel provided with a corrosion resistant factory powder coat finish. Three (3) clamps required per dive harness. Beam clamps must be by Springboards and More or approved equal.
- C. Pulleys: Provide single and double pulleys designed for use with diving harness equipment. Pulleys must have a strong swivel mechanism attached at the top that allows spotting equipment to move effortlessly. Pulleys must be constructed of high strength aluminum alloy with a super-strong sheave and axle fitted with Oilite bushing. The single pulleys must have a working load limit of 1,000 lbs. and a break load of 10,000 lbs. The double pulleys must have a working load limit of 1,200 lbs. and a break load of 12,000 lbs. Single pulleys must be "RSI 3" Single Rescue Pulley" and double pulleys must be "RSI 3" Double Rescue Pulley" as provided by Springboards and More or approved equal. Each pulley must be provided with a quick link used to attach the pulley to the beam clamps. Quick link must be Maillon-Rapide 10mm Quick Link by Springboards and More or approved equal.

- D. Spotting Rope: Provide 3/8" spotting rope as shown on the drawings. Spotting rope must be of kernmantle construction and designed for low elongation. Spotting rope must have a nylon or polyester 16-strand sheath combined with a Type Six double-twist continuous strand core to provide high tensile strength. Core strands must have opposing twists to prevent unnecessary spinning. Spotting rope must be "Blue Water Static Kernmantle Spotting Rope" as provided by Springboards and More or approved equal. The rope must be provided with swivel hooks to attached spotting rope to spotting or twisting belt. Swivel hooks must be AAI/Spaulding Cast stainless-steel spotting belt swivel hook by Springboards and More or approved equal.
- E. Spotting Belt: Provide one (1) adjustable spotting belt per dive harness assembly. The belting, hardware and fabrics of the spotting belt must be designed for use in water. Adjustable spotting belt must be "SAM's Spotting Belt" as provided by Springboards and More or approved equal.
- F. Twisting Belt: Provide one (1) twisting belt per dive harness assembly. The twisting belt must be designed for use in water. The rotating rings must be cast of high tensile strength aircraft aluminum alloy. Inner belts must be made of high strength nylon parachute webbing and open from both the front and back for quick-fit adjustments. High strength, cinch-type buckles must be made of forged steel designed for use in parachute harnesses. Two (2) 4 ft nylon webbing straps with swivel belt clips must be provided. The twisting belt must be "AAI Padded Twisting Belt" as provided by Springboards and More or approved equal.
- G. Nylon Boat Cleat: Provide two (2) nylon boat cleats for dive harness concealment. The boat cleat will provide a tie-down point for the dive harness spotting rope (9.5mm) on each side of the pool. Each boat cleat must be located at a height of seven (7) feet above the finished pool deck. The boat cleat must be 4" in length designed to support 3/8" line. Construction must be injection molded, open base, glass-filled nylon with two mounting holes. Mounting hardware must be stainless-steel.

## 2.20 POOL HEATERS

- A. Provide the pool water heating system. Heating system to include piping, heaters, controls, gauges, thermostats, control valves and wiring required to draw water from the recirculation piping, heat the water and return it back to the recirculation piping. Interlock pool heating system with pool recirculation pumps.
  - 1. Pool heater manufacturer representative must be on site to start and adjust pool heater(s). Copies of the startup report must be sent to the Architect/Engineer.
  - 2. The heater(s) system must consist of an indirect gas fired boiler with an internal pumped bypass as shown on the drawings. Proposed substitutions must include a mechanical drawing incorporating required changes in layout, piping valves, gas, venting and electrical connections. The cost of such changes must be included in the price of the substitute. Confirm by 1/4-inch scale shop drawing that the alternate heater(s) must be provided will fit within the available space.
  - 3. The pool heater(s) must have an input rating as shown on the drawings and must be orificed for operation on (Natural Gas) (L.P. Gas).
- B. Indirect Gas Fired Boiler with Pumped Bypass
  - 1. Basis of Design: Lochinvar Aquas, Raypak XTherm Indirect, or approved equal.
    - a. The indirect heater(s) package must be as follows: A high efficiency, condensing boiler piped to a dedicated two (2) heat exchanger package. The boiler side piping

- must be stainless pipe with a circulating pump, and appropriate components and fittings for safe and efficient delivery of indirect heat transfer to the pool water.
- b. The bypass pump must be constructed of cast iron and operate on a 120-volt, 60 Hz, 1 phase power supply (unless otherwise specified). The pump must be factory wired to run with intermittent pump operation.
  - c. The expansion tank must be of a bladder type design and must be sized adequately to allow for the expansion of the boiler water when heated.
  - d. The flow switch must be of a paddle type design and must be wired to the internal boiler control safety circuitry so as not to allow the boiler to operate when there is not sufficient flow.
  - e. The automatic fill valve with pressure reducer must be factory set for 15 psi and must allow fresh water to be added to the boiler system only when the water pressure has fallen below the pressure setting.
  - f. The pressure relief valve must be ASME Certified and have a setting of 50 psi.
  - g. The temperature and pressure gauge must be capable of reading temperature in both degrees Fahrenheit and degrees Celsius. The Pressure units must be read in pounds per square inch (psi). The entire assembly must be mounted on a 3" channel iron skid to facilitate handling and installation.
  - h. The heat exchanger must be as follows:
    - 1) The standard titanium heat exchanger must be of a plate and frame, or shell and tube design constructed of a carbon steel frame and utilizing a titanium plate pack with EPDM gaskets.
  - i. The boiler must be as follows:
    - 1) The boiler must bear the ASME "H" stamp for 160 psi working pressure and must be National Board listed. There must be no banding material, bolts, gaskets, or "O" rings in the header configuration. The stainless-steel combustion chamber must be designed to drain condensation to the bottom of the heat exchanger assembly. A built-in trap must allow condensation to drain from the heat exchanger assembly.
    - 2) The boiler must be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. The boiler must comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard and the minimum efficiency requirements of the latest edition of the BTS2000 Standard. Models must operate up to 96.2% thermal efficiency with pool water temperatures below 100°F. The boiler must be certified for indoor installation.
    - 3) The boiler must be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber must be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port must be provided. The burner must be a premix design and constructed of high temperature stainless-steel with a woven metal fiber outer covering to provide modulating firing rates. The boiler must be supplied with a gas valve designed with negative pressure regulation and be equipped with

- a variable speed blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency.
- 4) The boiler must have the following turndown ratios:
    - a) On packages with 750,000 Btu/hr input must be capable of full modulation firing with a turndown ratio of 15:1.
    - b) On packages with 1,000,000 through 1,250,000 Btu/hr input must be capable of full modulation firing with a turndown ratio of 20:1.
    - c) On packages, with 1,500,000 through 2,000,000 Btu/hr input must be capable of full modulation firing with a turndown ratio of 25:1.
  - 5) The boiler must operate in a safe condition at a de-rated output with gas supply pressures as low as 4 inches of water column.
  - 6) The boiler must utilize a 24 VAC control circuit and components. The control system must have an electronic display for boiler set-up, boiler status, and boiler diagnostics. Components must be easily accessed and serviceable.
  - 7) The boiler must feature a control panel with an LCD touch screen display. The boiler must have password security, pump delay with freeze protection, pump exercise, domestic hot water prioritization and PC port connection. The boiler must allow 0-10 VDC input connection for BMS control and have built-in "Cascade" to sequence and rotate while maintaining modulation of up to eight packages without utilization of an external controller. Supply voltage must be 120 volt/60 hertz/ single phase unless otherwise noted.
  - 8) The boiler must be equipped with two terminal strips for electrical connection. A low voltage connection board for safety and operating controls. A high voltage terminal strip must be provided for supply voltage.
  - j. The heater(s) must be supplied with venting in accordance with the National Fuel Gas Code, ANSI Z223.1/NFPA 54 latest edition. Refer to Mechanical.
  - k. The boiler must have an independent laboratory rating for Oxides of Nitrogen (NOx) of 20 ppm or less corrected to 3% O<sub>2</sub>. The manufacturer must verify proper operation of the burner, controls, and the heat exchanger by connection to water and venting for a factory fire test prior to shipping.

### PART 3 - EXECUTION

#### 3.1 EXISTING CONDITIONS, INSPECTION AND PREPARATION

- A. Carefully examine the contract documents for requirements that affect the work of this section. Prior to starting work, notify the Architect of defects requiring correction. Do not start work until conditions are satisfactory.
- B. Verify that work by others, related to this section, has been completed. This includes earthwork, concrete work, and mechanical, electrical, and plumbing connections.
- C. Protect materials and work completed by others from damage while completing the work in this section.

### 3.2 FIELD MEASUREMENTS

- A. Verify benchmark and pool location prior to layout.
- B. If field measurements differ from the construction drawing dimensions, notification must be given to the Architect prior to proceeding with work.

### 3.3 EXCAVATION, REINFORCING STEEL AND SWIMMING POOL SHOTCRETE OR CAST-IN-PLACE CONCRETE

- A. Reference Division 31 - Earthwork
- B. Reference Division 3 - Concrete

### 3.4 TOLERANCES FOR CONSTRUCTION OF THE POOL SHELL

- A. The completed structures must be constructed level and to the dimensions, elevation, depths, and thickness as shown on the plans.
- B. The elevation tolerance of the pool shell and gutter lip must be plus or minus 1/8 inch.
- C. The vertical wall surface tolerance of the pool shell, for the first 36 inches from the water surface must be plus or minus 1/4 inch from plumb measured with a 6-foot straight edge.
- D. For competitive racecourses, the following pool shell tolerances must apply:

<u>Course</u>	<u>Tolerance</u>	<u>Minimum</u>	<u>Maximum</u>
25 Yard	+ 1 3/16" /- 0"	75' - 3/4"	75' - 1 15/16"

- 1. The above dimensions include allowances for a touchpad at each end of the course. The maximum dimension includes the construction tolerance. These above tolerances also apply to courses utilizing moveable bulkhead(s).
- 2. The above dimensions apply to a vertical plane extending 1'-0" above and 3'-0" below the surface of the water at points of both end walls.
- E. Provide the services of a registered engineer or land surveyor who must measure and certify the elevations of the gutter lip at 10-foot centers as well as the length of each lane for each possible racing course. Courses designed with touchpads for competition must be measured and certified with touchpads in place. Course length survey must be made with the pool filled with water between 78- and 82-degrees Fahrenheit. The Contractor to submit compliant survey measurements to the Architect for review and record.
- F. Ground wires or grade pins, if used, must be installed in such a manner that they accurately outline the section of the pool shell as indicated on the plans. They must be located at intervals sufficient to ensure proper thickness throughout and must be maintained tight. Grade pins or grounding wires must not be permanently embedded in the pool shell.

### 3.5 WATER TIGHTNESS TEST

- A. The water tightness test described within the following section is in accordance with the Hydrostatic Tightness Testing of an Open Concrete Containment Structure as required by American Concrete Institute (ACI) 350.1-10 Section 2. Test reports must be provided and must include test locations within the structure, dates of testing, water level measurements, amounts of evaporation or precipitation, measured volume corrections, retest results (if applicable), actions taken, and final results.



- B. This test applies to the pool, the spa, the surge tank, and the gutter system.
- C. The water tightness test must be completed prior to the application of the finishes.
- D. Water Tightness Test Procedure
  - 1. Preparation
    - a. For concrete pools and surge tanks: Allow the concrete structure to set 28 days for curing purposes. Once the shell has gained sufficient strength to withstand the test load and after the outlets have been securely sealed, the pool/surge tank must be filled with water.
  - 2. Fill: Fill and then isolate the pool, the spa, the surge tank, and the gutter system. The water tightness test must begin after the vessel has been filled for a minimum of three (3) days. During the filling, outlets must be monitored for water tightness and concrete joints, if applicable, must be monitored for visible leakage. If visible leakage from the vessel is observed, the condition must be corrected prior to the start of the test.
    - a. After the initial fill, ground water must be removed from the pool sight sump or the pool location de-watering system. This must be completed prior to the start of the water tightness test. De-watering of the pool sight sump must be maintained during the entire duration of the test.
  - 3. 24-hour Allowable Loss
    - a. Calculate the allowable water loss from the unlined vessel(s). This is .1% of the total vessel volume. For example, if the vessel has a volume of 200,000 gallons, the 24-hour allowable loss will be 200 gallons.

Vessel	Total Volume (Gallons)	24-hour Allowable loss (.1% or .001 of Total Volume)
EXAMPLE	200,000 gal	200 gal
Pool 1		
Spa		
Pool 1 Surge Tank		
Pool 1 Gutter		

- 4. Measurement
  - a. Measurements must be taken at the pool(s), the spa(s), the surge/balance tank(s), and the gutter system(s). Multiple test points with averaging are recommended for vessels which will be exposed to wind. Document the separate findings on the chart below. Repeat the measurements and document every 12 hours for a total of three (3) days. The Contractor must check the pool(s), the spa(s), the surge/balance tank(s), and the gutter system(s) for water loss with the Owner or a representative designated by the Owner every 12 hours. Submit photo documentation (with time stamps) of each measurement with the completed water tightness report. Example measurements are shown in the table below.
- 5. Evaporation/Precipitation Measurement Procedure
  - a. Fill a floating, restrained, partially filled, calibrated, open pan with water and allow the container to float within the pool during the testing period. This will be used to measure evaporation and precipitation.

Vessel	12 hrs. passed	24 hrs. passed	Day 1 TOTAL	36 hrs. passed	48 hrs. passed	Day 2 TOTAL	60 hrs. passed	72 hrs. passed	Day 3 TOTAL
Example Pool	0.021 ft	0.010 ft	0.031 ft	0.016 ft	0.019 ft	0.035 ft	0.022 ft	0.017 ft	0.039 ft
Example Pan	0.008 ft	0.006 ft	0.014 ft	0.008 ft	0.007 ft	0.015 ft	0.009 ft	0.007 ft	0.016 ft
Pool 1									
Spa									
Pool 1 Surge Tank									
Pool 1 Gutter									
Evaporation/ Precipitation Pan									

6. Calculate Daily Loss

- a. Calculate the total daily water loss for the vessel(s) and record in the table below. If a vessel has a daily water loss that is greater than the calculated 24-hour allowable loss, the vessel cannot be considered watertight.
  - 1)  $\text{Daily Loss} = 7.481 \times \text{Structure Surface Area (SF)} \times [\text{Total Water Loss per Day (FT)} - \text{Evaporation per Day (FT)} + \text{Precipitation per Day (FT)}]$
- b. For example, we have a body of water that is 200,000-gallon volume and 3,500 square feet of surface area. Measurements for this example body of water are recorded in the table above.
  - 1)  $\text{Day 1 Loss} = (7.481 \text{ gallons per cubic foot}) \times (3,500 \text{ SF}) \times [(.031 \text{ ft water loss}) - (.014 \text{ ft evaporation}) + (0 \text{ ft precipitation})] = \underline{445 \text{ gallons Day 1 loss}}$
  - 2)  $\text{Day 2 Loss} = (7.481 \text{ gallons per cubic foot}) \times (3,500 \text{ SF}) \times [(.035 \text{ ft water loss}) - (.015 \text{ ft evaporation}) + (0 \text{ ft precipitation})] = \underline{524 \text{ gallons Day 2 loss}}$
  - 3)  $\text{Day 3 Loss} = (7.481 \text{ gallons per cubic foot}) \times (3,500 \text{ SF}) \times [(.039 \text{ ft water loss}) - (.016 \text{ ft evaporation}) + (0 \text{ ft precipitation})] = \underline{602 \text{ gallons Day 3 loss}}$

Vessel	Daily Water Loss Day 1 (Gal)	Daily Water Loss Day 2 (Gal)	Daily Water Loss Day 3 (Gal)	Allowable Loss (calculated above, Gal)	Are daily values higher than the Allowable Loss? (Y/N)
EXAMPLE	445 gal	524 gal	602 gal	200 gal	Y, not watertight
Pool 1					
Spa					
Pool 1 Surge Tank					

Pool 1 Gutter					
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7. Absorption
  - a. Waiting 3 days after the initial water fill will allow the concrete to absorb water and must be sufficient to minimize the effect of absorption on the test results.
8. Evaporation
  - a. Evaporation must not have a significant effect on natatoria that are completely enclosed with no air circulation during the water tightness test. However, evaporation will have a significant effect on the water level in natatoria that has air movement across the water surface or are still partially uncovered.
9. If leaks are detected, repair the vessel, and make watertight in accordance with these requirements.
10. With regard to this test, the curing requirements, the final fill, and the cost of the water for two (2) complete fillings must be borne by the Owner. Expenses for subsequent fillings or partial fillings (more than 25%) of the pool must be provided and will not be borne by the Owner.

### 3.6 PIPING INSTALLATION

#### A. General

1. Provide and erect, according to the best practices of the trade, piping shown on the drawings and required for the complete installation of these systems. The piping shown on the drawings must be considered as diagrammatic in indicating the general run and connections and may or may not in parts be shown in its true position. The piping may have to be offset, lowered, or raised as required or as directed at the site. This does not relieve responsibility for the proper erection of the systems or piping in every respect suitable for the work intended as described in the specifications and approved by the Architect. In the erection of piping, it must be properly supported, and proper provisions must be made for expansion, contraction and anchoring of piping. Piping must be cut accurately for fabrication to measurements established at the construction site. Pipe must be worked into place without springing and/or forcing, properly clearing windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted. Pipes must have burrs and/or cutting slag removed by reaming or other cleaning methods in strict accordance with the manufacturer's instructions. Changes in direction must be made with fittings. Open ends of pipes and equipment must be properly capped or plugged to keep dirt and other foreign materials out of the systems. Plugs of rags, wool, cotton waste or similar materials will not be used in plugging. Piping must be arranged so as not to interfere with removal and maintenance of equipment, filters, or devices, and so as not to block access to manholes, access openings, etc. Flanges or unions applicable for the type of piping specified must be provided in the piping at connections to items of equipment. Piping must be installed to ensure noiseless circulation. Valves and specialties must be so placed to permit easy operation and access.

#### B. Pipe Hangers and Supports

1. Pipes must be adequately supported by pipe hangers and supports as specified.
2. Horizontal PVC Schedule 80 piping must be supported in accordance with the manufacturer's recommendations for fluid temperature not exceeding 120-degree F and as listed below:

Nominal Pipe Size	Hanger Support Spacing	Minimum Rod Size for Single Rod Hanger
1-1/4" and less	5'-0"	3/8"
1-1/2" to 3"	6'-0"	1/2"
4" to 6"	8'-0"	5/8"
8" to 12"	10'-0"	7/8"
Greater than 12"	12'-0"	1"

3. Horizontal CPVC Schedule 80 piping must be supported in accordance with the manufacturer's recommendations for fluid temperature not exceeding 140-degree F and as listed below:

Nominal Pipe Size	Hanger Support Spacing	Minimum Rod Size for Single Rod Hanger
1/2" and less *	4'-0"	3/8"
3/4" to 2"	6'-0"	3/8"
2-1/2" to 3"	7'-0"	1/2"
4" to 8"	8'-0"	7/8"
Greater than 12"	10'-0"	1"

4. Round rods supporting the pipe hangers must be of the following dimensions:

Nominal Pipe Size	Rod Diameter
1/2" to 2" pipe	-3/8" rod
2-1/2" to 3" pipe	-1/2" rod
4" to 5" pipe	-5/8" rod
6" pipe	-3/4" rod

- Hanger rods must be galvanized steel. Provide for controlling level and slope by turn buckles or other approved means of adjustment and incorporate lock nuts.
- Provide means of preventing dissimilar metal contact such as plastic-coated hangers, copper colored epoxy paint, or non-adhesive isolation tape.
- Provide hangers to provide a minimum of 1-inch space between finished covering and adjacent work.
- Place a hanger within 12 inches of each horizontal elbow.
- Support vertical piping independently of connected horizontal piping. Support vertical pipes at every floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.
- Where several pipes can be installed in parallel and at the same elevation, provide trapeze hangers as specified. Trapeze hangers must be spaced according to the smallest pipe size or provide intermediate supports according to the support spacing schedules. Provide heavier members as required for the load supported for the entire span distance. Hanger rods must be as specified above and properly sized for the load supported, but not less than 5/8 inches diameter.
- Piping must be rigidly supported from the building structure by means of hanger assemblies properly selected and sized for the application in accordance with the manufacturer's recommendations and specifications. Do not support piping from other pipes, ductwork or

other equipment that is not building structure. Do not modify the building structure for hanger installation.

12. Attachment of piping hangers to the building structure must be provided in a manner approved by the Architect. Provide concrete inserts installed by others in the building construction at the time the concrete is poured, and hangers must be attached to these inserts.
13. The use of pipe hooks, chains, or perforated iron for pipe hanger supports will not be permitted.
14. A design for piping in a service tunnel, if required, supported by a structure must be submitted for approval. The structure must be non-corrodible and must be of a size and configuration to rigidly support the piping as shown in the plans at a minimum spacing as shown below.

**C. Concrete Inserts**

1. Provide inserts for placement in form work before concrete is poured.
2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Where concrete slabs form finished ceilings, inserts must be flush with the slab surface.
4. Provide hook rods to concrete reinforcement section for inserts carrying pipe over 4 inches.

**D. Piping Installation – Below Grade**

1. Trench bottoms must be smooth and free of rocks and debris. If the trench is dug in ledge rock, hardpan or where large boulders are not removed, place 3 inches of sand or compacted fine-grained soil below the pipe. Pipe must be supported over its entire length with firm, stable material. Blocking will not be used to change pipe grade or provide intermittent support over low sections in the trench. Surround the pipe with backfill meeting the requirements of with a particle size of 1-1/2 inch or less and in accordance with the project geotechnical report. Compact in layers not to exceed 6 inches with vibratory method. Follow installation methods of ASTM D2774 "Underground Installation of Thermoplastic Pressure Piping".

**E. Flushing, Draining and Cleaning Pipe Systems**

1. Flush out water systems with water before placing them in operation. Other systems must be cleaned by using compressed air or nitrogen. After systems are in operation and during the test period, strainer screens must be removed and thoroughly cleaned.

**F. Expansion and Contraction**

1. Make necessary provisions for expansion and contraction of piping with offsets, loops, flexible connections, and anchors as required to prevent undue strain. Provide shop drawings for method and arrangement for control of expansion and contraction of piping.

**G. Testing**

1. Piping installation and pressure testing must be performed by the Contractor and reviewed by the Owner or a designated representative of the Owner before commencement of backfilling. A minimum notice of one (1) week is required prior to review. Results must be submitted to the Architect. Pictures with time stamps for each section of piping must be included with testing report(s) and be submitted within one (1) week of the pressure test(s).

2. Pool related piping must be hydraulically pressure tested (with water, not air) to a pressure of not less than 50 PSI for a period of no less than two (2) hours. Pressure testing must be conducted in accordance with ASTM D2774. The temperature of the water used for the test must be between 40°F and 90 °F.
3. Maintain a sustained 20 PSI pressure on pool related piping throughout the course of construction.
4. Adhere to the applicable provisions of Division 22 - Plumbing, "General Provisions" and "Basic Materials and Methods" for installation of piping system.

### 3.7 EQUIPMENT AND SYSTEMS INSTALLATION

- A. Provide and assemble equipment, special parts and accessories as shown on pool drawings, specifications, and shop drawings of the equipment suppliers.
- B. Provide anchors and inserts imbedded in the deck including fittings, inserts and structure sleeves and required anchorage as shown on the plans and as indicated in this section of the specifications. Equipment must be set true and plumb, using factory jigs where available. Removable equipment items must be easily removable from anchors and must fit without noticeable wobble.
- C. Provide templates for equipment anchors. Provide anchor bolts of the size and spacing as required by the equipment manufacturer. Anchor bolts must be stainless-steel Type 316L and of a length capable of adequate anchorage into rough slab-on-grade allowing for finish deck tile and setting bed. Anchors must be set and cast into place during building concrete work. Inspect anchor settings for horizontal and vertical alignment prior to placing concrete.
- D. Provide equipment and systems in accordance with manufacturer's directions. Equipment must be assembled and in place for final observation.
- E. Items necessary to complete this section are shown on the plans or described in the specifications including items that may be purchased by the Owner. Items are detailed and specified as a guide for dimensional purposes. Make provisions accordingly and submit shop drawings and submittals based on that data.

### 3.8 START-UP AND INSTRUCTION

- A. Supply the services of an experienced swimming pool operator/instructor for a period of not less than two days (total 16 hours) after the pool(s) have been filled and initially placed in operation. During this period, the Owner's representatives who will be operating the pool(s) must be thoroughly instructed in phases of the pool's operation. Deliver six (6) complete sets of operating and maintenance instructions for the swimming pool, structures, finishes and component equipment. Prior to leaving the job, obtain written certification from the designated Owner's representative acknowledging that the instruction period has been completed and necessary operating information provided. Include the cost of two (2) additional days (total 16 hours) of instruction and operational check out by the qualified representative during the first season of operation.
- B. Written reports of each of these visits outlining the pool's operation, competence and performance of the pool's operation personnel, and other pertinent comments must be submitted to the Owner and Architect/Engineer within one (1) week after each visit.
- C. Provide specific written procedures that must be followed for emptying and refilling the pool as mentioned previously in this section. The procedures must be included in the bound volume of operating instructions and references in the front index with a note headed by the words: "CAUTION -- VERY IMPORTANT".

END OF SECTION 131100

## SECTION 131103 - SWIMMING POOL TILE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The drawings and General Provisions of the contract, including General and Supplementary Conditions apply to the work of this section.

#### 1.2 SUMMARY

- A. Provide a ceramic tile finish on the entire interior surface of the pool and behind the pool edge as shown and detailed on the contract drawings and in strict accordance with these specifications. Contrasting color ceramic tile markings and trim at locations including the recessed wall steps, depth markings, wall targets, floor lane markings and other tile installations as shown and detailed on the contract drawings and in strict accordance with these specifications.
- B. Provide a ceramic tile finish on the entire interior surface of the spa.
- C. The Contractor must furnish and install the work of this section.

#### 1.3 RELATED SECTIONS

- A. Division 1 – Mock Ups
- B. Division 7 - Joint Sealers
- C. Division 9 - Ceramic Tile
- D. Section 131100 - Swimming Pool
- E. Section 131104 - Swimming Pool Cementitious Finish

#### 1.4 QUALITY ASSURANCE

- A. Reference Standards: Conform to the following standards unless otherwise required herein.
  - 1. American National Standards Institute (ANSI)
    - a. A108.01 – General Requirements: Subsurfaces and Preparations by Other Trades.
    - b. A108.02 – General Requirements: Materials, Environmental, and Workmanship.
    - c. A108.1, Glazed Wall Tile, Ceramic Mosaic Tile, Quarry Tile and Paver Tile installed with Portland Cement Mortar.
    - d. A108.1C – Contractor's Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry Set or Latex-Portland Cement Mortar.
    - e. A108.5 – Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar.
    - f. A108.6 – Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile Setting and Grouting Epoxy for the Epoxy Grouting Installation Process.
    - g. A108.10 – Installation of Grout in Tile Work.



- h. A108.13 – Installation of Load Bearing, Bonded, Waterproof Membranes for Thin Set Ceramic Tile and Dimension Stone for the Waterproofing Membrane Installation Process
      - i. A137.1 Standard Specifications for Ceramic Tile.
  - 2. American Society for Testing and Materials (ASTM)
    - a. C144-99, Aggregate for Masonry Mortar
    - b. C150-00, Portland Cement
    - c. C171-97a, Sheet Materials for Curing Concrete
    - d. C206-97, Finishing Hydrated Lime
    - e. C207-91 (R1997), Hydrated Lime for Masonry Purposes
    - f. D5957, Standard Guide for Flood Testing Horizontal Waterproofing Installations
    - g. F-1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
    - h. F-2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in Situ Probes
  - 3. Tile Council of North America (TCNA); 2021 Edition, Handbook for Ceramic Tile Installation.
  - 4. American Concrete Institute
    - a. ACI 302 – Guide for Concrete and Floor Slab Construction
  - 5. International Concrete Repair Institute (ICRI)
    - a. Concrete Surface Profile (CSP)
- B. The Contractor must have two years' experience in similar pool projects for which the Owner may require written proof thereof and proper tools to install tile.

#### 1.5 MANUFACTURERS

- A. Subject to compliance with requirements provide ceramic tile, mortar, and grout of the following manufacturers: American Olean Tile Co. (tile), Dal-Tile Co. (tile), Buchtal (tile), KlinkerSire (tile), Daldorado (tile), MAPEI, Inc. (thin-set, waterproofing, grout, and admixtures), and LATICRETE International Inc. (thin-set, waterproofing, grout, and admixtures) or approved equal.

#### 1.6 SUBMITTALS

- A. Submit shop drawings indicating tile layout, patterns, joint layout, color arrangement, perimeter conditions, junctions with dissimilar materials, thresholds and setting details.
- B. Submit product data indicating material specifications, characteristics, and instructions for using adhesives and grouts.
- C. Samples:
  - 1. Submit physical samples for all tile color selections by Owner/Architect.
  - 2. Submit physical samples for grout color selections by Owner/Architect.
- D. Mockups:

1. Mount tile and apply grout on 24"x24" backerboard to indicate pattern, color variation and grout joint size variations of each pattern. Furnish mounted tile samples as requested by the Architect/Owner for approval.
  - E. Submit manufacturer's installation instruction.
  - F. Submit maintenance data.
    1. Include recommended cleaning and stain removal methods, cleaning materials.
- 1.7 PRODUCT DELIVERY AND STORAGE
- A. Deliver tile materials to site in unopened factory containers sealed with grade seals bearing printed name or manufacturer and the words "Standard Grade". Keep the grade seals intact and containers dry until tiles are used. Keep cementitious materials dry until used.
- 1.8 JOB CONDITIONS
- A. Inspect and verify job conditions. Report defects in base surfaces for correction before proceeding.
  - B. Maintain environmental conditions, including temperature humidity and ventilation, within limits recommended by the manufacturer. Do not install products under environmental conditions outside the manufacturer's absolute limits.
  - C. Do not install mortar, set, or grout tile exterior when inclement weather conditions are expected within 48 hours after work is scheduled to be completed unless proper protection is provided.
  - D. Maintain a temperature range of 50 degrees Fahrenheit to 90 degrees Fahrenheit during installation of tile and grout materials. Tile installation should cure for a minimum 14 days with average a temperature of 70 degrees, while maintaining the minimum 40 degrees and maximum 90 degrees Fahrenheit, prior to filling pool with water.
  - E. Vent temporary heaters to outside to avoid carbon dioxide damage to the new tile work.
- 1.9 COLORS
- A. Colors must be selected by the Owner/Architect or Interior Designer. Note that swimming pool regulations may dictate color selections within the pool tank. See tile materials for price group breakdowns.
- 1.10 WARRANTIES
- A. The Contractor warrants to the Owner that materials and equipment provided under the contract will be of good quality and new unless otherwise required or permitted by the contract documents, that the work will be free from defects not inherent in the quality required or permitted and that the work will conform with the requirements of the contract documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, improper or insufficient maintenance, improper operation, modifications not executed by the Contractor or improper wear and tear under normal usage. If required by the Owner, provide satisfactory evidence as to the kind and quality of materials and equipment. Warranties must be for a period of five years, unless otherwise specified.
  - B. Setting materials must be provided by the same manufacturer. Mixing materials and application procedures must be done in accordance with manufacturer's recommendations and requirements. Documentation must be provided to this effect by the Contractor with verification from the

manufacturer. This documentation must be included in the operations and maintenance manual under warranties as documentation qualifying the project for a 15 Year Systems Warranty by LATICRETE International, Inc., MAPEI, Inc. or approved equal.

- C. The Contractor must contact the tile setting material manufacturer's technical representative to review installation details, job site conditions, selected materials, and their conformance to the manufacturer's warranty requirements prior to the commencement of work. Failure to follow these requirements will not relieve the Contractor of the requirement to provide specified warranties.
- D. The Contractor must agree to repair or replace work at no cost to the Owner upon written notification from the Owner within the warranty period. Pro-rated warranties are not acceptable.

## **PART 2 - PRODUCTS**

### **2.1 TILE MATERIALS**

- A. Standard grade conforming to ANSI A137.1. Provide trimmer units as indicated and specified, including special shapes as detailed or required. Tile patterns and colors must be as indicated and specified, colors of approved shades. Mesh mounted or perforated paper backed tile is not allowed where the mesh of paper remains as a permanent part of the installation. If dot mounting is used, a minimum of 67% of the depth of the tile must be free from dots to ensure proper grout curing.
- B. Tile must be "frost-proof".
- C. Unglazed Ceramic Mosaic Tile
  - 1. Slip-resistant porcelain unglazed ceramic mosaic tile, cushion, or all-purpose edges, 2" square from price group 2 for floor, walls, and stair treads unless otherwise noted. The minimum dynamic coefficient of friction must be 0.42 for wet surfaces and 0.65 for ramped surfaces. Where special shapes are required, they must be selected from price group 3. Equivalents provided by Knochtile, Dal-Tile or American Olean. For wet surfaces: Buchtal Chroma Mosaics with front mount film (seven color options) 2"x2" 7161HVF or American Olean Unglazed color-body porcelain mosaics 2"x2", price group 1-3. For ramps: Buchtal Chroma non-slip mosaics with glass fiber net (four color options) 2"x2" 7161H. Or for wet surfaces: Buchtal Chroma non-slip 5"x5" 32020H thirteen color options) or Dal-Tile or American Olean Unglazed color-body mosaics 2"x2" with 7.5% abrasive grain (7 color options). Colors must be selected by the Owner/Architect.
  - 2. Ceramic tile band below the pool gutter lip with color selected by Owner/Architect from Dal-Tile, Keystone Unglazed Mosaic, 2"x2" price group 4, American Olean Unglazed color-body porcelain mosaics 2"x2" price group 1-3, or powder glazed 2"x2" Buchtal Chroma Mosaics provided by Knochtile.
  - 3. Ceramic tile deck band that contains the depth marker letters and numerals and the 15-meter resurfacing markers with color selected by the Owner/Architect from Dal-Tile, Keystone Unglazed Mosaic, 2"x2", price group 4, American Olean Unglazed color-body porcelain mosaics 2"x2", price group 1-3.
  - 4. Contrasting ceramic tile nosings at spa steps and spa bench must be Universal Trim 2"x2" with color selected by the Owner/Architect from Dal-Tile, Keystone Unglazed Mosaic, price group 3 and 4, American Olean Unglazed color-body porcelain mosaics 2"x2", price group 1-3.

5. Recessed steps must be Universal Trim 2"x2" or 1"x1" with color selected by the Owner/Architect from Dal-Tile, Keystone Unglazed Mosaic, price group 3 and 4, American Olean Unglazed color-body porcelain mosaics 2"x2", price group 1-3.
  6. 4" wide contrasting ceramic tile stripe and 12" lane markers on the pool floor with color selected by Owner/Architect from Dal-Tile, Keystone Unglazed Mosaic, 2"x2" price group 3, American Olean Unglazed color-body porcelain mosaics 2"x2" price group 3, or from Knoxville, as 4"x4" Buchtal Chroma Colors 22010H-717, 5556 Grey Black and 5535 Blue or 2"x2" Mosaic 7160HVF 5535 Grey Black. The main racecourse wall targets and lane markers must be black.
  7. Ceramic tile at top horizontal plane of the spa and vertical face of the spa with color selected by Owner/Architect from American Olean Unglazed color-body porcelain mosaics 2"x2" with one (1) or two (2) colors from price group 1- 4, Dal-Tile Keystone Unglazed Mosaic 2"x2" from price group 1-4 or from Knoxville: Buchtal Chroma Mosaics 2"x2" 7161HVF (seven color options) or non-slip 7161H 2"x2".
- D. Handhold tiles at pool perimeter must be C701 available from Dal-Tile or DalLUX-HH-D802 from Daldorado. Color selection by Owner/Architect. Trim pieces for C701 are as follows: SCR701 (Right Termination Piece), SCL701 (Left Termination Piece), CK701 (Inside Corner), and CC701 (Outside Corner).
- E. Provide tile trim units where indicated or necessary for a complete and finished installation. Provide rounded units for external and internal corners and angles. Provide trim units of material and finish identical to the adjoining tile. Provide SCR/L701 units where the C701 hand hold is interrupted to permit draining. Color selection by Owner/Architect. The Contractor should request via non-standard production. The SCR/L701 units are available through DalTile at 314-997-6970 or 1-800-672-2086.
- F. Message Tile and Depth Markings
1. Horizontal and vertical depth markings and warning signs must be 6"x6" with 4" high numbers and letters. Horizontal depth markers must be slip resistant. Single tile abbreviations must be used for 'FT' and 'IN.'

## **2.2 SWIMMING POOL / SPA TILE SETTING MATERIALS AND INSTALLATION**

- A. Refer to section 131100, paragraph 2.16.B. The Contractor to provide tile and setting materials over a waterproof membrane as noted in this section. Refer to and coordinate with the Architectural Drawings for extent and detailing. Coordinate for installation, interface, and flashing between pool and deck waterproofing systems. Confirm installation requirements with the manufacturer.
- B. Surface Preparation
1. Surface preparation must be in accordance with ACI 302. The surface must be structurally sound and free of foreign substances and debris that could reduce or impair adhesion. Sound and remove loose concrete to firm substrate. Surfaces must be roughened by bead blasting to a CSP of 2 or 3 (reference ICRI CSP Standards for acceptable profile height). Thoroughly wash/rinse with clean potable water. Surface defects or holes in the substrate must be patched per manufacturer's recommendations.
  2. At the conclusion of surface preparation and prior to the installation of the waterproofing, the moisture vapor emissions rate (MVER) of the concrete substrate when measured with a calcium chloride test (ASTM F-1869) must be less than 5 lbs per 1000 square feet per 24 hours. Relative humidity must be measured with a probe and must be less than 75%.

3. At the conclusion of surface preparation and prior to the installation of the waterproofing, measure the pH level of the concrete substrate. Tile work components must not be installed until the pH has a value less than 10.
- C. Slurry Bond Coat
1. Horizontal surfaces to receive a thick bed mortar application with waterproofing and finishes must be installed over a slurry bond coat of either LATICRETE 254 Platinum one-step, polymer-fortified, thin-set or MAPEI Planislope RS polymer-modified pre-blended, rapid-setting mortar mixed with water only over firm concrete substrate. As manufactured by LATICRETE International, MAPEI, Inc., or approved equal. Note that slurry bond coats are not required under vertical applications of the render and scratch coat.
- D. Mortar Bed / Render and Scratch Coat
1. Bonded Thick Bed Method (Floor / Horizontal Surfaces): Provide a dry pack, thick mortar bed on horizontal surfaces consisting of either LATICRETE 3701 Fortified Mortar Bed or MAPEI Planislope RS polymer-modified pre-blended, rapid-setting mortar mixed with water only. Apply over a properly prepared slurry bond coat. Maximum lift thickness not to exceed 2".
  2. Render- Scratch and Float Coats (Wall / Vertical Surfaces): Provide wall render (scratch and float coats) on vertical competition turning surfaces to a depth of 4'-0" below the water surface, consisting of either LATICRETE 3701 Fortified Mortar Bed or LATICRETE 3701 Lite Mortar or MAPEI Planislope RS polymer-modified pre-blended, rapid-setting mortar mixed with water only or lift thicknesses up to ½". Wall render is made to a plastic consistency when used vertically. Apply scratch coat to properly prepared substrate, scratch mortar surface and allow to harden. Apply subsequent "float coat" lifts to hardened, clean and well bonded scratch coated surfaces. Fill holes and bring surface up to line and plane as required. As manufactured by LATICRETE International, MAPEI, Inc. or approved equal. Note that slurry bond coats are not required under vertical applications of the render and scratch coat. (Refer to Course Length Tolerances for competitive pools.)
- E. Waterproof Membrane
1. Waterproofing must be a modified rubber latex system intended specifically for the application. It must be part of a compatible finish system from the surface of the concrete to the tile grout / plaster finish, be of one approved manufacturer and warranted by them. Waterproofing must extend uniformly from coping to coping, without gaps or holidays, sealed at fittings and penetrations, over which must be applied tile swimming pool finishes as required.
  2. Over thick bed mortar / render and/or scratch coat apply LATICRETE HydroBan or MAPEI Mapelastic Aquadefense single component, self-curing liquid rubber polymer waterproofing membrane. Apply to twenty mils thick minimum, without gaps, holes, or holidays and three coats with reinforcing fabric over properly prepared corners, cracks, and joints. Carefully seal at pipe and equipment penetrations. Refer to drawings for additional information. As manufactured by LATICRETE International, MAPEI, Inc. or approved equal.
- F. Elastomeric Sealant
1. Use LATICRETE LATASIL sealant over LATASIL 9118 primer or MAPEI Mapesil "T" 100% silicone sealant for inside/outside corners, expansion/movement joints, and to seal lighting/plumbing fixture penetrations. The primer and sealant installation must be in accordance with the manufacturer's requirements. As manufactured by LATICRETE International, Inc., MAPEI, Inc. or approved equal. Color selection by Owner/Architect.

- G. Mixing and application procedures must be in accordance with the manufacturer's recommendations and requirements. The manufacturer's representative must visit the site to verify field conditions, confirm materials and application requirements and ascertain that materials and systems are installed, and documentation must be provided.
- H. Tile Thin-Set
  - 1. Use either LATICRETE 254 Platinum one-step, polymer fortified, thin-set mortar or MAPEI Keraflex Super one-step, polymer modified, thin-set mortar, used in accordance with the manufacturer's requirements. As manufactured by LATICRETE International, MAPEI, Inc., or approved equal.
- I. Tile Grout
  - 1. Use either LATICRETE SPECTRALOCK PRO Premium Grout or MAPEI Kerapoxy CQ Grout in accordance with the manufacturer's requirements as manufactured by LATICRETE International, MAPEI, Inc. or approved equal. Color selection by Owner/Architect.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Complete water tightness test prior to tile installation. The concrete tank must be watertight per ASTM D5957, the Tile Council of North America, and specification 131100.
- B. Clean substrates of dust, dirt, oil, grease, curing compounds and other foreign substances and mechanically roughen concrete and shotcrete for bond. Conform to applicable reference standards and to recommendations of manufacturers of materials used and meeting ICRI, CSP of 2-3.
- C. Substrates to Receive Mortar Setting Beds
  - 1. Dampen concrete substrate to receive tile work according to above referenced standards or tile manufacturer's instructions, as required.
- D. Substrates to receive thin set tile applications must meet normal construction tolerances of 1/4" in 10' where competition tolerances do not apply and must meet competition tolerances where required elsewhere in these specifications, and must be free of bumps, dips and surface irregularities that may affect the satisfactory installation of the tile.
- E. Tile Wetting
  - 1. Dampen tile according to above reference standards or tile manufacturer's instructions, as required.
- F. Screeds
  - 1. Accurately set temporary screeds to control the finish plane of mortar-bed set tile and remove as soon as setting bed is sufficiently hardened. Fill void spaces from screeds with same mortar.

#### **3.2 TILE INSTALLATION**

- A. Arrange tile according to patterns detailed. Set tile with flush well-fitted joints, finished in true planes, plumb, square, joints of uniform size. Provide approved trimmers as shown or required. Cut tile without marring. Carefully grind and joint tile edges and cuts.
- B. Follow Tile Council of North America installation methods P601 and B417 to achieve total tile system thickness for thin or thick set.

1. Thick Set
  - a. Apply specified setting bed mortar, up to 2" in thickness, on cured and dried concrete pool shell. Tamp and screed to required planes. Spread no more mortar than can be covered with tile before initial set. Do not use re-tempered mortar. Trowel 3/32" to 1/8" thick bond coat over plastic setting bed mortar just before setting tile or apply bond coat to back of each tile placed. Set tile in position and beat firmly into the setting bed mortar. Bring tile faces to a true and correct plane. Complete beating and leveling before mortar sets and in no case later than one hour after first placing. When ready, wet and remove paper and glue avoiding excess water. At this time adjust out-of-line or out-of-level tile.
2. Thin Set
  - a. Apply specified bond coat on cured and dried concrete pool shell. Trowel 3/32" to 1/8" thick bond coat over concrete pool shell just before setting tile or apply bond coat to back of each tile placed. Set tile in position and beat firmly into the setting bed mortar. Bring tile faces to a true and correct plane. Complete beating and leveling before mortar sets and in no case later than one hour after first placing. When ready, wet and remove paper and glue avoiding excess water. At this time adjust out-of-line or out-of-level tile.
- C. Finished tile surface must be level and in plane, with no sharp or protruding edges. Tiles out or plane more than 1/16" must be removed and replaced. Sharp edges must be stoned smooth.
- D. Grout Joint Sizes
  1. Unless otherwise approved, install tile with uniform 3/32" joint width. A maximum 1/8" joint width may be utilized to meet specific installation requirements, if required.
- E. Ceramic Tile Joint Grouting
  1. Mix grout to a thick creamy consistency and force into joints for entire thick depth, flush with surface. Clean off excess and fill skips and gaps before grout sets. Color selection by Owner/Architect or Interior Designer. Provide dampness for minimum 3-day curing and polish with clean dry cloths (not required when epoxy grouts are used).
- F. Expansion Joints
  1. Place expansion joint per applicable TCNA Method P601MB, P601TB, or P602 and conforming to Method EJ171. Provide shop drawings showing backer rod and joint dimensions. Expansion, control, construction, cold, and seismic joints in the pool structure should continue through the tile work, including such joints at vertical surfaces. Movement joints must be placed at changes in direction and elevation. Refer to the structural engineer for additional required movement joints. Joint size must be a minimum of 1/8". Joints through tile work directly over structural joints must not be narrower than the structural joint. The Contractor must use cement compatible coatings when using chalk lines for joint layout purposes.
- G. Fill and Empty Rates
  1. Use a fill and drain rate of 2'-0" per 24 hours to minimize thermal shock and structural movement. Maintain a temperature differential of 10 degrees Fahrenheit or less between the pool water and the substrate during fill and drain cycles.

**3.3 TESTING AND INSPECTION**

- A. Before filling of the pool, and its subsequent provisional acceptance at substantial completion, the tile installation must be visually inspected and sounded in the presence of the Architects and/or the Owner's representative to verify mortar coverage below the tile to its substrate as well as its overall compliance with the requirements of this Section.
- B. Tile work found loose, lacking proper mortar coverage, out of plane, misaligned or otherwise non-conforming must be removed and replaced at no additional cost to the Owner.
- C. Monitor the pH level of the substrate prior to laying tile. Do not install tile until the pH has a value less than 10. Properly balance the pool water immediately upon fill.
- D. At the conclusion of surface preparation and prior to the installation of tile, measure the relative humidity of the slab. The relative humidity must not exceed 75%.
- E. At the conclusion of surface preparation and prior to the installation of the tile, measure the moisture vapor emissions rate (MVER) with a calcium chloride test (ASTM F-1869). The MVER must be less than 5 lbs per 1000 square feet in 24 hours.

**3.4 CLEANING**

- A. Upon completion of placement and grouting, clean tile installation as recommended by TCNA and manufacturers of proprietary materials. Tile must be cleaned with pH neutral solutions, free of both sodium and potassium, in accordance with the tile and grout manufacturer's printed instruction.
- B. Leave finished installation clean and free of cracked, chipped, broken, un-bonded or otherwise defective tile work.
- C. Protect installed tile work with non-staining Kraft paper, polyethylene sheeting, or other approved heavy covering during the construction period to prevent damage.

**3.5 REPLACEMENT TILE**

- A. Provide the Owner with approximately 10% or 25 square feet (whichever is least) of each color and type tile used on the project for Owner's repair and replacement requirements.

**END OF SECTION 131103**



## SECTION 131106 - SWIMMING POOL TIMING SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT and applicable parts of DIVISION 1 - GENERAL REQUIREMENTS, as listed in the Table of Contents, must be included in, and made a part of, this Section.

#### 1.2 SUMMARY OF WORK

- A. Introduction
  - 1. Provide labor, materials, equipment, and services necessary to provide a complete electronic timing and scoreboard system with multi-sport capability for race swimming and diving.
- B. Work included in this section.
  - 1. It is the intent of this section to place the entire responsibility for the complete electronic timing and scoreboard system (including appropriate connections) with multi-sport capability under one vested supplier. The supplier is responsible for providing full integration of this system. Multiple suppliers for a system will not be approved.
- C. Related work specified in Electrical sections. Reference Division 26 – Electrical.
  - 1. Ground and bond pool structures, fittings, and equipment in accordance with Article 680 of the N.E.C. Test and verify that the system electrical ground is true and solid. Provide certification to this effort.
  - 2. Obtain permits, inspections, and approvals of wiring including grounding and bonding of metal components associated with the pool in accordance with Local, State and National Electrical Codes.
  - 3. Provide power, conduits, electrical boxes, ethernet connections and wiring for the Contractor provided electronic timing and scoreboard system with multi-sport capability for race swimming and diving.
  - 4. Supply junction boxes for equipment outlined in these specifications and depicted on the timing system drawings.
- D. Basis of Design:
  - 1. The complete electronic timing and scoreboard system with multi-sport capability is based upon Colorado Timing Systems, Inc.

#### 1.3 ACCEPTABLE MANUFACTURERS AND SUPPLIERS

- A. Colorado Time Systems, Inc. (Basis of Design: Timing System & Scoreboard)

#### 1.4 SUBMITTALS

- A. Submittals must include the following:
  - 1. Product data
  - 2. Shop drawings detailing system layout.

3. Operations and maintenance manuals for system. Manuals must include a complete parts list.
4. Warranty for each piece of equipment within this section.

#### **1.5 JOB CONDITIONS**

- A. Manufacturers proposing to submit a quotation for the electronic timing and scoreboard system must confirm that embedded items are compatible with the installation of their respective systems.
- B. Manufacturers must review the construction documents and must notify the architect 10 days prior to the bid date of conflicts or additions to the work of other trades for the proper installation of their system.

#### **1.6 WARRANTIES**

- A. The Contractor must warranty the completed installation of systems in this section for one year.
- B. The manufacturer must warranty the computer consoles, touchpads, pace clocks and starting system for two years.
- C. The manufacturer must warranty the titanium timing system wall plate and deck plates for five years.
- D. The manufacturer must warranty the scoreboard for five years.

### **PART 2 - PRODUCTS**

#### **2.1 SCOREBOARD SYSTEM**

- A. Full Color Video Display
  1. Full Color Video Display system must display necessary information to time swimming and diving in compliance with the appropriate sanctioning body - NCAA. Display must provide competitor's names, full matrix graphics and animation, live video, and have advertising capabilities.
    - a. Basis of Design: Multi-Sport LED Scoreboard System is based upon Colorado Timing Systems, Inc. or approved equal.
  2. Display must include the following: Full matrix LED scoreboard with computer controller and DisplayLink+ software, flat wall mounting hardware and data/fiber cable up to 500'.
  3. The display must be a full color LED matrix display. The display must be comprised of red, blue, and green LE. to form pixels. Display must be capable of 281 trillion shades of color.
  4. The display should be capable of 16-bit video processing, one hundred (100) levels of dimming capability and allow for Gamma correction.
    - a. Display intensity must be adjustable up to 3000 nits for INDOOR.
  5. The display must have a built-in graphics and animation capability with Windows- based software. Graphics and animation must have the capacity of being displayed on the entire matrix. MS Windows fonts must be compatible with the display.
  6. Display must have the ability to show live video or DVD's.
  7. Display must allow for front service access.
  8. Display must include 3% spare critical parts.

9. Operation temperature must be between 14°F – 105°F (-10°C – 40°C)
10. Humidity tolerance must be between 0%-95% non-condensing.
11. Each indoor pixel must be comprised of 3 LEDs, 1R1G1B SMD LED package.
12. Display must include LED video controller with the following functions/features at a minimum:
  - a. Dual zone, picture in picture capable with on-the-fly user defined window sizes.
  - b. Hardware controlled scaling of all video input sources; PC (computer) based scalers are not an accepted alternative.
  - c. Must have a simple to use menu architecture allowing user to switch between video inputs and layouts with minimal keystrokes.
  - d. The controller must have a minimum of five (5) user defined display layout templates capable of switching between sources as well as zone layouts accessible via the controller's main menu.
  - e. Display controller must accept the following video input signals:
    - 1) Two (2) DVI
    - 2) One (1) HDMI
    - 3) Two (2) VGA
    - 4) One (1) DP
    - 5) Two (2) composite
13. Scoreboard details must be as follows. Exact cabinet dimensions, detailed drawings, and weight must be provided with the submittals.
  - a. Pixel Spacing: 10 MM
  - b. Active Area: 8.4'(H) x 14.7'(W)
  - c. Pixel configuration must be: 114,688 pixels
  - d. Weight: 300 LBS

**B. Scoreboard Hanging Requirements**

1. Scoreboard manufacturer must provide drawings with hanging information.
  - a. Material: Scoreboard hangers must be galvanized steel for an indoor natatorium.
  - b. Coordinate scoreboard hanging requirements with structural engineer prior to the submittal process.
2. Anchors
  - a. Hollow Block Construction
    - 1) Sleeve type anchors feature a split expansion sleeve over a threaded stud bolt body and integral expander, nut, and washer. Anchors must be made of zinc plated Carbon Steel, or Type 18-8 Stainless Steel. Anchors should be installed with carbide tipped hammer drill bits made in accordance to ANSI B212.15-1994. Anchors must be tested to ASTM E488 criteria and must meet or exceed U.S. Government G.S.A. specification A-A-55614 Type 2 (Formerly GSA:

FF-S-325 Group VIII, Type 2), California State Fire Marshal, Factory Mutual and Underwriters Laboratories.

b. Filled Block or Solid Concrete Construction:

- 1) The anchor must be a torque-controlled expansion anchor, which provides consistent performance for a wide range of mechanical anchor applications. This anchor series is available in carbon steel with zinc electroplated coating, carbon steel with hot-dip galvanized coating, 304 stainless steel and 316 stainless steel versions. The threaded stud version of the anchor is available in a variety of diameters ranging from 1/4- to 1-in. depending on the steel and coating type. Applicable base materials include normal-weight concrete, structural lightweight concrete, lightweight concrete over metal deck, and grout-filled concrete masonry. Basis of design is AISI Type 316 stainless steel KWIK Bolt 3 (KB3) manufactured by Hilti, Inc.
- 2) Three anchors must have an anchor body, nut and washer that conform to AISI Type 316. The expansion wedges conform to AISI Type 316 stainless steel.
- 3) Anchor bodies smaller than 3/4-inch, excluding KWIK Bolt 3 Countersunk, are produced from AISI Type 304 or Type 316 stainless steel having the bolt fracture loads shown in table 1. Anchor bodies 3/4-inch and larger, and stainless-steel KWIK Bolt 3 Countersunk anchor bodies are produced from AISI Type 304 or Type 316 stainless steel having the mechanical properties shown in table 1. Nuts meet the dimensional requirements of ASTM F594. Washers meet the dimensional requirements of ANSI B18.22.1, Type A, plain. Stainless steel expansion wedges for AISI Type 304 are made from either AISI Type 304 or Type 316. Stainless steel expansion wedges for AISI Type 316 anchors are made from type 316. Stainless-steel nuts and washers for AISI Type 304 or Type 316 anchors are manufactured from AISI Type 304 or 316, respectively.

3. Supports

a. Unistrut (LED Board)

1) Material

- a) Fittings, unless noted, are made from hot-rolled, pickled, and oiled steel plates, strip, or coil, and conform to ASTM specifications A575, A576, A635, or A36. The fitting steel also meets the physical requirements of ASTM A1011 SS GR 33. The pickling of the steel produces a smooth surface free from scale. Many fittings are also available in stainless steel, aluminum, and fiberglass. Consult factory for ordering information.

2) Finishes

- a) Fittings are available in: Perma-Green III (GR), Electro-galvanized (EG), conforming to ASTM B633 Type III SC1; Hot-dipped galvanized (HG), conforming to ASTM A123 or A153.

4. Brackets

- a. Per ANSI B1.1- Surface roughness per ANSI B46.1- Surface roughness on holes 250 MAX unless otherwise specified. Variations in form from unmachined features are permitted within established –1 filets 0.005-0.020 (APPROX. RADIUS) – Screw threads per ANSI B1.1- Pipe threads commercial standards. Edges and corners 0.005-0.020 (approx. radius or chamfer).
    - b. Materials and components used in the assembly of this item must be RoHS complaint material: 12GA (.105) HRS. The finish must be ZINC CLEAR CHROMATE PLATED. Manufacturer must break sharp edges and corners.
    - c. Support hardware, brackets, fasteners, hangers, etc. used during installation of the scoreboard must be Zinc Clear Chromated Plated.
  - C. Software to Control Matrix / Video Display must include the following:
    1. Operates full color LED matrix displays.
    2. Receives data from all sports timers and scoring consoles.
    3. Receives data from 3rd party meet management software.
    4. Displays standard graphics formats (JPG, GIF, BMP, PNG).
    5. Playback of standard digital video (AVI, MPG, WMV).
    6. Allows creation of custom data templates with sport-specific information.
    7. Creates and plays sequences of templates and graphics, with transition effects.
    8. Stores name and team information for up to 12 lanes for an infinite number of events and heats.
    9. Stores multiple diving event orders, with name and team information.
    10. Supports any Windows font as well as custom CTS bitmap (pixel-mapped) fonts.
    11. Graphics and templates can be used to provide in-venue advertising.
    12. Multiple options for displaying team scores and full event results (standalone or in conjunction with meet management software).
    13. Quick message feature allows user-driven dynamic messaging.
    14. Provides user ability to schedule automatic display of templates and graphics, with recurrences.
    15. Allows creation of multiple outputs regions for multizone displays or multiple displays of varying resolutions.
    16. Allows creation of transparent overlay templates, facilitating sports data overlaid on still and video graphics backgrounds.
    17. Runs on Windows 8.1 and greater.
    18. Provides customer initiated remote technician assistance and fault monitoring.
- 2.2 MULTI-SPORT COMPUTER/TIMING SYSTEM
- A. Gen 7 Serial Timing System
    1. The Multi-Sport Computer/Timing System must be supplied with necessary software to time swimming in compliance with the appropriate sanctioning body - NCAA.

- a. Basis of Design: Multi-Sport Computer/Timing System is based upon the GEN7 TIMING as manufactured by Colorado Timing Systems, Inc.
2. Multi-Sport Computer/Timing System must be a standalone unit with physical connections to timing inputs. Timer must be controlled by user interface device (e.g., computer, tablet, etc.) via USB or TCP/IP. One (1) laptop must be provided.
  - a. Timer PC or tablet interface device must be supplied with necessary software to time and score swimming in compliance with the appropriate governing organization(s) - NCAA.
  - b. Configuration of racecourses must be through graphical user interface. It is unacceptable that race configurations need specific cable connections to system connections such as wall plates defining a specific end of a course.
  - c. The user interface must display complete race status. The interface must be capable of functioning as miniature scoreboard displaying information simultaneously for active lanes including lane number, current length in race or final place, split or finish time, relay judging status indicator, and backup time and backup button status.
  - d. Timer must automatically flag timing discrepancies (in the user interface, on the results printouts and in stored memory) greater than a user defined interval between touch pad and backup times.
3. Multi-Sport Computer/Timing System input/output ports must include:
  - a. Must accept inputs for up to 4 courses of up to 32 lanes each for a serial in-deck wiring installation and must be able to time them simultaneously.
  - b. Up to 8 timers must be supported to accept inputs of the same in-deck wiring installation for parallel race timing and backup.
  - c. Must accept on-deck cable harness inputs for up to 20 lanes near end and/or far end.
  - d. Must communicate with meet management peripheral software on a two-way “handshake” basis, enabling the meet manager’s resident computer to query the timer’s memory via the USB port or via the network at any time for any race results.
  - e. Must provide backup time via push button provided on a per lane basis should swimmer fail to trigger touch pad or touch pad fail to register. The timer must be capable of accepting up to three backup button times per lane.
  - f. Must automatically compare the touch pad hit of an incoming swimmer with the starting swimmer’s time of departure from the optional relay-judging platform. Results display both “plus” and “minus” takeoff times and can be printed and stored in race memory.
4. Accuracy of the Multi-Sport Computer/Timing System:
  - a. Must time to a user-selectable resolution from 1 second to .001 second. It must take starts and finishes from the near end and/or far end of the pool. It must accept inputs from the start system; touch pads, up to three manual button backup times per lane, and relay judging platforms.
  - b. Must be able to evaluate and report multiple states of timing component input condition, ranging from excellent to failure. It is unacceptable that only two states such as on or off are reported.

- c. Must have touch pad delay feature with ability to program delays from 1 to 99 seconds.
  - d. Must permit the operator to correct for an erroneous touch by adding/subtracting a touch pad hit to correct the lengths completed. The interface must not permit the operator to finish a race in any lane; timers including such a function are unacceptable because they permit the possibility of cheating.
  - e. Later recall of stored race data must allow for a re-run of a given race including changes in user decisions.
5. Multi-Sport Computer/Timing System Detection:
- a. Must be capable of detecting timing components such as pushbuttons, touchpads, RJPs, speakers, Speedlight and start systems connected to an in-deck system and capable of detecting touchpads and RJPs connected to an on-deck system.
  - b. Must be capable of reporting corrosion in the in-deck wiring installation.
6. Multi-Sport Computer/Timing System must run off a 12-volt power supply connected to a standard 110/240 VAC outlet and will automatically switch to (and display on screen of connected interface device) internal battery power source, in case of line power failure without affecting the continuity and accuracy of the timing system.
7. Multi-Sport Computer/Timing System must interface to single-line and multi-line scoreboard and must post immediate results to scoreboard in "Lane" or "Place" order (user selectable). The timer must also have the capability to pull race results from memory and post those results to the scoreboard in "Lane" or "Place" order (user selectable).
8. Multi-Sport Computer/Timing System must include internal clock calendar with self-sustaining battery to time/date stamp results.
9. Multi-Sport Computer/Timing System must meet acceptable safety standards. Must be UL approved, or equivalent.
10. Multi-Sport Computer/Timing System Storage and Internal Memory:
- a. System must store each and every timing input state change. It is not acceptable that state changes get discarded and are not available for later re-evaluation of a race.
  - b. Race data, including near and far end splits, must be stored to internal memory for later recall to facilitate meet management connectivity and printing. Printed reports must include cumulative and subtractive splits as well as relay judging times (when required).
  - c. Meet memory must be capable of being transferred to external storage (via USB) or cloud data backup services (e.g., Dropbox, Google Drive).
11. Multi-Sport Computer/Timing System must have an Automatic Event Sequencer that is capable of holding both standard and user defined event sequences. The event order will be able to be downloaded from meet management software. The desired order is user selectable. EVENT SEQUENCES with appropriate race distance and race description for high school, college meets, and two "User Defined" meets to permit construction of custom meets, NCAA. When recalled from memory, race distance and descriptions are automatically selected for the operator.
12. Multi-Sport Computer/Timing System must have a user interface software that permits operation of essential functions including Lane Off/On, Finish Arm, Split Arm, & Print

Results directly from the main screen to ensure speed and simplicity of operation during critical race times. The interface must permit the operator to edit a time when required or to disqualify a lane (DQ), automatically posting it to the scoreboard, and provide automatic re-ranking of results. Corrections generated by the operator (edit or disqualification) must be clearly identified on the results printouts.

13. Multi-Sport Computer/Timing System must include electronic beeper and LED signaling to indicate touchpad, backup button and RJP inputs. Timers which do not allow the user to configure (enable/disable) this feature are unacceptable.
14. Multi-Sport Computer/Timing System connectivity must include:
  - a. USB (Type A) port for external storage
  - b. USB (Type B) port for meet management connectivity.
  - c. USB (Type B) port for user interface computer connectivity
  - d. Ethernet port for network connectivity
  - e. 3 independent scoreboard output ports
  - f. Wireless 2.4GHz scoreboard connectivity
  - g. Connection for in-deck wiring and two connections for on-deck (near and far end) wiring.
  - h. Start system connection directly to timer.
  - i. External DC power port
15. Multi-Sport Computer/Timing System must be capable of updating internal software/firmware via Internet connection.
16. Multi-Sport Computer/Timing System software must have the ability to adjust the intensity of LED scoreboard brightness.
17. Cabling, conduit, and wiring must be provided by the manufacturer of the Multi-Sport Computer/Timing System to connect the Multi-Sport Computer/Timing System to the scoreboard should the scoreboard be provided by an alternative manufacturer to the Multi-Sport Computer/Timing System.

## 2.3 SWIMMING TIMING SYSTEM CONNECTORS

### A. General Description

1. The Multi-Sport Computer/Timing System must employ the topology of a single communication bus to which timing and connectivity nodes are connected and communicate with each other.
2. Connection points must be production items and not a one off or prototypes.
3. Exposed connectors must feature titanium contacts. They must be wet pluggable and electrically passive if not connected. No maintenance to prevent corrosion of deck plate connector contacts is needed.
4. Self-test capabilities to detect compromised timing bus wire terminations and scoreboard bus wire terminations.

### B. Wall Plates



1. Wall plates must be provided as required in the quantities as shown on the drawings. Wall plates must be the termination point for connections between deck cables, timers, start system, and other wall plates.
  - a. Basis of Design: Wall plates are based upon TITANIUM SERIAL WALL PLATE as manufactured by Colorado Timing Systems, Inc.
2. Wall plates must allow for the following connections depending on location and usage:
  - a. Connection to the timer.
    - 1) Connectivity to timing courses and one scoreboard bus with one cable connection.
    - 2) Detection of presence or absence of connected timer.
    - 3) Diagnostic capabilities to detect anomalies with connectors (corrosion, shorts).
  - b. Connection to a start system and must provide the following:
    - 1) Inputs for start system and speaker.
    - 2) Diagnostic capabilities to detect anomalies with connectors (corrosion, shorts) and anomalies with the speaker input or start system.
    - 3) Detection of presence or absence of speaker input or start system.
  - c. Connection to a scoreboard and must provide the following:
    - 1) Detection of presence or absence of connected scoreboard.
    - 2) Self-test capabilities to detect compromised timing bus wire terminations.
3. Junction Boxes (Provided by Electrical):
  - a. Wall plate components must fit into a 12" x 12" x 6" PVC junction box.
  - b. Acceptable Manufacturer: Cantex (P/N 5133713) or similar box that will fit wall plate assembly of the following dimensions: 12" x 12" x 6"  $\pm 0.05$ ", cover plate width must be 15"  $\pm 0.02$ " square.
  - c. Conduit interconnects between boxes (deck plates and wall plates) must be PVC. Refer to drawings for sizing.
  - d. Verify routing of conduit with Multi-Sport Computer/Timing System manufacturer prior to installation.

**C. Deck Plates**

1. Deck plates must be provided as required in the quantities as shown on the drawings. Deck plates to permit plug-in connection for touch pads, A, B, C, backup buttons, electronic relay judging, start light signal, start speakers and a signal to start the timing device at each lane.
  - a. Basis of Design: Deck plates are based upon TITANIUM SERIAL DECK PLATE as manufactured by Colorado Timing Systems, Inc.
2. Domed deck plate node with contacts mounted on integrated slopes that cause corrosive pool water which creates water bridges to flow off through gravity, overcoming water surface tension and therefore reducing electrolytic currents and corrosion. No maintenance for corrosion is needed.

3. Titanium contacts as exposed connectors.
4. Inputs for button A, B, C, touchpad, start system, speaker, RJP and Speedlight (RJP as separate input, not piggy backed on another input).
5. Speedlight must be controlled in synchronicity and individually per lane (requires RJPs).
6. Diagnostic capabilities to detect anomalies with connectors (corrosion, shorts) and anomalies with the timing components push buttons, touchpad, RJP, Speedlight, speaker or start system.
7. Ability to detect presence or absence of push buttons, touchpad, RJP, Speedlight, speaker or start system.
8. Plate must have self-test capabilities to detect compromised timing bus wire terminations.
9. Junction Boxes (Provided by Electrical):
  - a. In deck system components must fit into a 4" x 4" x 6" PVC junction box.
  - b. Conduit interconnects between boxes (deck plates and wall plates) must be PVC. Refer to drawings for sizing.
  - c. Verify routing of conduit with Multi-Sport Computer/Timing System manufacturer prior to installation.

**D. Start System Deck Plate**

1. Start system deck plates must be provided as required in the quantities as shown on the drawings.
  - a. Basis of Design: Start system deck plates are based upon TITANIUM SERIAL START SYSTEM DECK PLATE as manufactured by Colorado Timing Systems, Inc.
2. Connection to start system that must provide the following:
  - a. Inputs/outputs for start system and speaker.
  - b. Detection of presence or absence of speaker input or start system.
  - c. Diagnostic capabilities to detect anomalies with connectors (corrosion, shorts) and anomalies with the speaker or start system.
3. Junction Boxes (Provided by Electrical):
  - a. In deck system components must fit into a 4" x 4" x 6" PVC junction box.
  - b. Conduit interconnects between boxes (deck plates and wall plates) must be PVC. Refer to drawings for sizing.
  - c. Verify routing of conduit with Multi-Sport Computer/Timing System manufacturer prior to installation.

**2.4 SWIMMING TIMING START SYSTEM**

- A.** Swimming Timing Start System (1 required) must be provided to start the automatic swim Multi-Sport Computer/Timing System. The start system must drive speakers mounted under the starting blocks, the relay judging platform strobe lights and deck side start indicators, with microphone.
1. Basis of Design: Swimming Timing Start System is based upon the CHAMPIONSHIP START SYSTEM as manufactured by Colorado Timing Systems, Inc.

- B. System must drive up to twenty 6-watt (reflex) corrosion resistant speakers located under the individual starting blocks as well as be able to drive individual speed lights on each starting block.
- C. System must have the capability to use either wired or wireless microphones and must have a volume control on each microphone input.
- D. Start system must have a high impact resistant plastic molded enclosure.
- E. The system must have external connections for additional strobe light, speaker output and start output.
- F. The system must run off of an external 12-volt power and have 2 internal gel cell batteries. The internal batteries will automatically be recharged while the starter is plugged in to the external power supply.
- G. There must be an LED warning light on the system showing when the internal batteries are starting to get low on power.

## 2.5 DIVING

### A. Diving Scoring Software:

1. The diving scoring system must be supplied with necessary software to score diving in compliance with the appropriate sanctioning body - NCAA.
  - a. Basis of Design: The diving scoring system is based upon GEN7 DIVING as supplied by Colorado Timing Systems, Inc.
2. The diving scoring system must utilize the scoreboard to display diving scores and results without modification from swimming configuration.
3. Diving scoring system software must support standard and artistic scoring.
4. Accept seven (7) judges' input scores and compute award based upon proper formulas for seven (7) judges. Software must be operable with either remote judges' terminals or manual input of flash card scores.
5. System must be expandable to use up to eleven judges scoring terminals.
6. Permit display of the lead diver number, current diver number, dive number, degree of difficulty, judges' scores and diver's calculated award and total score.
7. Permit entry of diving data into non-volatile memory for storage or receive data from meet management computer without additional modifications. Data must include diver number, round number, dive number, and position. Degree of difficulty must be automatically calculated based upon dive number per current NCAA regulations. Dive degree of difficulty can also be manually input.
8. Automatically recall the diver with round number, dive number and DD using minimal keystrokes. Systems which require live entry of dive information are unacceptable.
9. Permit storage of diver's point totals and provide ranking of the divers at the end of each round.
10. Permit editing of judges' scores if required by meet officials.
11. Provide an output for computer data handling of diving events.
12. Permit a two-point deduction from the judges' scores and zero points for a failed dive. Such changes must be clearly shown on the printout.

13. Printout must provide preliminary data, diver ranking by rounds, and results of individual dives with judges' scores.
  14. Judges' terminals must be housed in sealed, water-resistant, shockproof housing.
  15. The terminals must provide a signal to inform the judge that the diving console has requested a score. Signal must cease when an appropriate score is transmitted. They must also allow each judge to input a score with a minimum of keystrokes, review that score via a built-in LCD display, and correct a score if needed before transmitting to the Judging Software.
  16. The Software must provide a switchable mode for sending data to the scoreboard display.
    - a. Mode-Automatic: In this mode the software must send the judges scoring information to the display with no software operator interaction.
    - b. Mode-Hold for Authorization: In this mode the software must receive authorization from a referee terminal or an assistant referee terminal prior to sending the scoring data to the display.
- B. Remote Judging Terminal:
1. Interface hub must plug into a user interface device (e.g., computer, tablet, etc.) via USB 2.0 or greater. One (1) laptop/tablet must be provided.
  2. Judges' terminals must include a quick release mating connector for connection to the Diving Cable Breakout Box.
  3. Judges' terminals must include rugged communications cable to connect to the diving interface box. The cable should be removable for easy cost-effective replacement of the cable.
  4. Judges' terminals must utilize sealed keyboards with a 128x64 Pixel Backlit LCD display suitable for indoor and sunlight readability.
  5. Judges' terminal LCD must be capable of displaying Divers Name.
  6. Judges' terminal LCD must be capable of displaying Divers Team or Country Name.
  7. Judges' terminal LCD must be capable of displaying scores of other judges once the scores have been accepted.
  8. Judges' terminal LCD must be capable of displaying Dive and Dive Degree of Difficulty
  9. Judges' terminal LCD must be capable of displaying the terminal number, so they can be easily identified to the judge.
  10. Judges' terminals must include a request change button to notify the software that the judge's input is requesting permission to correct the submitted score.
  11. Judges' terminals must be able to be assigned as a Referee's terminal or Assistant Referee's terminal allowing the device to control when the judging data is transmitted to the scoreboard display.
  12. Provide seven (7) Judging Terminals (JT-01) with associated cables. Provide one interface hub box (IH-01) with associated cables. Provide one (1) cable breakout box (CB-01) with associated cables.

## 2.6 SWIMMING TIMING COMPONENTS

### A. Gutter Hung Touchpads

1. Provide 9 touchpads (9 required, 8 plus 1 spare) to time swimming, in compliance with the appropriate sanctioning body.
  - a. Basis of Design: The gutter hung touchpad is based upon the AQUAGRIP GUTTER HUNG TOUCHPAD as manufactured by Colorado Timing Systems, Inc.
2. Touchpad must be constructed of an all-plastic exterior with only electrical connector metal exposed. Touchpad must be the following dimensions:
  - a. Touch pad must be the TP-78G AQUAGRIP, 78" wide x 22" tall x 0.3" thick.
3. Touchpad must have a uniform fine grit and non-abrasive surface that prevents swimmer slippage in any direction.
4. Touchpad markings must have contrasting colors with a 2" black border and black end-wall cross pattern for portion covered by touchpads.
5. Touchpad brackets must be custom made to fit the pool. The Contractor to provide sufficient number of brackets for support of each touchpad.
  - a. The Contractor to provide an additional 2 spare touchpad brackets.
6. Touchpad must have a two-year warranty without a requirement to purchase a protective touchpad cart.
7. Touchpad caddy for storing the number of touch pads supplied must be CAD-TP/P.

### B. Relay Judging Platforms

1. Provide 1 relay judging platforms to time swim start reaction in compliance with the appropriate sanctioning body. Platform must electronically indicate when a swimmer has left the starting block in relation to the incoming swimmer's touch of the timing pad. Accuracy must be 1/100<sup>th</sup> of a second.
  - a. Basis of Design: The relay judging platform as manufactured by Colorado Timing Systems, Inc.
2. Relay Judging Platform must have a non-skid surface to prevent swimmer slippage.
3. The top and front surface must be sensitive to the swimmer's push off.
4. Each platform must be capable of securing to starting blocks.
5. Refer to starting block specification for starting block top size. The relay Judging Platform must be sized to adequately cover the starting block.
6. LED Speed Light
  - a. Platforms must be equipped with speed light, LED lights that flash with the start signal.

### C. Push Buttons

1. Provide two (2) back-up buttons for each touchpad provided.
2. Back-up buttons must be plunger style buttons with a 5' cable.

### D. Swimming Timing Systems Caddies

1. Provide touchpad caddy for storing touch pads. The correct number of touchpad caddies must be supplied to store touchpads. Caddy must be sized to match timing system touch pad widths. Touchpad caddy must consist of an aluminum frame with four freewheeling casters. The Contractor is responsible for assembly. Touchpad caddy must be CAD-TP as manufactured by Colorado Timing Systems, Inc.

## **2.7 PACE CLOCKS**

### **A. Slim Pace Clocks**

1. Pace clocks must be provided as required in the quantities as shown on the drawings.
  - a. Basis of Design: SLIM PACE CLOCKS as manufactured by Colorado Timing Systems, Inc.
2. The pace clock must include thirteen (13") high visibility LED digits, with variable intensity settings. The pace clock must include a rugged powder-coated aluminum enclosure, conformal coated to protect against corrosion, a real time of day clock, and must be suitable for indoor or outdoor use.
3. Pace clock must include twelve (12) operating channels to eliminate interference.
4. Pace clocks have an integrated real time of day chip (RTC). If multiple pace clocks are used in a facility, they will synchronize the time automatically.
5. Pace clock must include a wireless frequency of 2.4 GHz and have autosensing power capabilities for 120/240 VAC.
6. The pace clock must have four (13") digits.
  - a. Overall Size (H x W x D): 19.25" x 42.25" x 2.8"
  - b. Weight: 15 lbs

### **B. Tripod Mounting Kit, TR-3**

1. Provide one tripod mounting bracket for third pace clock not mounted to natatorium wall.

## **PART 3 - EXECUTION**

### **3.1 EXISTING CONDITIONS**

- A. Verify that work by others, related to this section, is installed.
- B. Carefully examine the construction documents that affect the work of this section.
- C. Prior to starting work, notify the Architect of defects requiring correction.
- D. Protect other materials and installed work against damage while completing work in this section.

### **3.2 INSTALLATION**

- A. Provide custom cables, connectors, scoreboard mounting brackets, and fasteners.
- B. Provide scaffolding and labor for mounting scoreboard and pulling cables.
- C. Provide equipment in accordance with the manufacturer's drawings and instructions.
- D. Provide scoreboard mounting, Multi-Sport Computer/Timing System cable terminations, system checkout, and local operator training at time of installation. Training must consist of one 4-hour session.

- E. Provide as-built drawings precisely locating items.
- F. Wiring and grounding must be installed in strict accordance with the latest edition of the National Electric Code – Article 680.

END OF SECTION 131106

## **Section 131250 Continuous Elevated Angle Frame Bleachers**

### **Part 1 General**

#### **1.01 SPECIFICATION INCLUDES**

- A. Design, fabrication and installation of angle frames bleachers for use in the Natatorium only.

#### **1.02 REFERENCES**

- A. ASTM A36 – Specification for Structural Steel.
- B. ASTM A123 – Specification for Zinc (Hot Dip Galvanized Coatings and Iron and Steel Products.
- C. ASTM A307 – Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.

#### **1.03 SUBMITTAL**

- A. Submittal Drawings: Submittal drawings sealed by a registered professional engineer indicating location, size, details, and quantity of all concrete, steel, and aluminum components and accessories. Drawing will indicate the locations of all exits stairs, ramps, aisles, seat locations, decking configuration, and general materials to be supplied.
- B. Design Calculations: Design calculations sealed by a registered professional engineer for the State of New Jersey and shall present an analysis which will indicate that the structural members will have sufficient strength to support the required loads and ability to resist the loads subjected, without exceeding the allowable stresses of the materials.
- C. Color Chart: Submit color finishes for selection, if applicable.
- D. Manufacturer's product data. Submit product brochure and descriptive data.

#### **1.04 QUALITY ASSURANCE**

- A. Codes and Standards: Design, fabrication, and installation shall be in accordance with International Building Code, 2021 – New Jersey Edition. Owner will verify code, requirements.
- B. Manufacturer Qualifications: Minimum 10 years existence under current ownership and experience in the design and manufacture of bleachers.
- C. Manufacturer Installer Qualifications: Employ persons trained and experienced in the installation of bleachers.
- D. Welders: AWS certified.
- E. AISC Certification: All structural steel shall be fabricated in an AISC certified plant at the time of the bid. The manufacturer must be listed on the AISC's website as a certified fabricator.



### 1.05 DESIGN CRITERIA

- A. Applicable Codes: All design, materials and workmanship shall be in accordance with the International Building Code 2021 – New Jersey Edition and ICC 300 Bleachers, Folding and Telescopic Seating and Grandstands. (or current edition)
- B. Design Loads:
  - Live Loads:
    - Uniform Loading-Structure=100 PSF
    - Uniform Loading-Seat=120 PLF
  - Sway Loads:
    - Perpendicular to Seating=10 lbs PLF
    - Parallel to seats= 24 PLF
  - Wind Loads: not applicable, interior installation
  - Snow Loads: not applicable, interior installation
  - Seismic Loads: Per Local Building Code
  - Handrail and Guardrail: 200 lbs concentrated in any direction

### 1.06 WARRANTY

- A. Guarantee bleachers to be satisfactory as to design, workmanship, and materials for five years beginning after completion of project.

### 1.07 MAINTENANCE

- A. Annual inspection and evaluation to be conducted by a qualified person retained by the owner. Required maintenance of grandstand to insure safe conditions by owner.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

- A. Basis of Design:
  - a. Sturdisteel Company
- B. Other Manufacturers subject to performance requirements of this specification and the basis of design:
  - a. Southern Bleacher
  - b. Or approved equal

### 2.02 ANGLE FRAME BLEACHERS

- A. Design shall be in accordance with American Institute of Steel Construction and Specifications for Aluminum Structures.
- B. Shop Connections: Welded.
- C. Welding: AWS standards.

- D. Framework: Space prefabricated aluminum angle bleacher frames at 6 foot intervals and connect by cross braces.
- E. Rise and Depth Dimensions:
  - 1. Vertical Rise and Horizontal Depth per Row: 8 inches by 24 inches.
  - 2. Seat Above its Respective Tread: 17 inches.
- F. Riser:
  - 1. Nominal 1 by 6.25 at all rows .
- G. Seats: Nominal 2 by 10 anodized aluminum plank, with 2 by 10 end caps.
- H. Decking is to be a closed deck utilizing an Interlocking No Through Bolt Decking System. The aluminum extrusions shall interlock together lengthwise while allowing for expansion and contraction of individual planks. The interlocking design will minimize the deflection of individual planks and cause the deck planks to react together at all treads and walkways. This decking system shall be such that the attachment of seat brackets, step brackets, mid-aisle rails and all other components is accomplished without any deck penetrations. This system also allows for seats and aisle reconfiguration at anytime without evidence of the previous configuration. No drilling of the aluminum deck will be permitted. (Tongue and Groove boards do not meet this specification)
- I. Guardrail: To be on all sides of the bleachers and shall be secured to structural angle post/vertical members attached to the understructure. Attachment of guardrail posts to aluminum planking (seats or footboards) is prohibited.
  - 1. Back and Side Top Rails: 42 inches above its adjacent seat.
  - 2. Guardrail to consist of clear anodized aluminum picket rails with 4" maximum spacing
- J. Aisle Width: 48 inches in accordance with IBC 2021-NJ, ICC 300, unless greater width specified by local code requirements. Each aisle extension boards to have a 2-inch dark bronze anodized nosing.
- K. Anchor to concrete slab, designed by manufacturer, using 2 3/8 x 3 screw anchors for each frame.
- L. Wheelchair provisions, quantity and locations shown on the plans. Wheelchair locations shall be such that a 4-inch sphere will not pass through to grade, and shall have guardrails directly behind the wheelchair section.

## 2.03 MATERIALS

- A. Framework
  - 1. Mill Finish aluminum angle frames, cross bracing, guardrail posts:
- B. Extruded Aluminum:
  - 1. All planking to be extruded aluminum alloy 6063-T6.
  - 2. Seats and risers shall be clear anodized 204R1, AA-M10C22A31, Class II
  - 3. Tread planks intended for walking surfaces Seats and risers shall be clear anodized 204R1, AA-M10C22A31, Class II
- C. Accessories:
  - a. Channel End caps: aluminum alloy 6063-T6, clear anodized finish to match the seats
  - b. Hardware
    - i. Bolts, nuts and washers are galvanized
    - ii. Hold-down clip assembly is aluminum alloy 6061-T6
  - c. Guardrailing: sides and rear to be clear anodized aluminum picket rails with pickets 4" max o.c. | Provide Manufacturers Standard Powder Coat Color Options
  - d. Handrails: Anodized aluminum pipe 1-5/8 inch o.d.

- e. Polymer seat Topper with number tag at all net seat locations: EAGLE SERIES 1000 in color “orange” or approved equal.
- f. Bleacher end curtains with printed design/logo

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Install angle frame bleachers complete in accordance with manufacturer’s written instructions and approved shop drawings

#### **3.02 CLEAN UP**

- A. Clean all surfaces after installation, in accordance to manufacturer’s recommendations
- B. Remove and properly dispose of all packaging and construction debris

END OF SECTION

## **SECTION 142100 TRACTION ELEVATORS**

### **PART 1 – GENERAL**

#### **1.1 SECTION INCLUDES**

- A. One, Gearless, machine-roomless electric traction passenger elevators.

#### **1.2 RELATED SECTIONS**

- B. Section 033000 – Cast-in-Place Concrete: Elevator pits.

#### **1.3 REFERENCES**

- A. ANSI/ASME A17.1/CAN/CSA B44 – Safety Code for Elevators and Escalators.
- B. ADAAG – Americans with Disabilities Act Accessibility Guidelines.
- C. ANSI/NFPA 70 – National Electrical Code.
- D. ANSI/NFPA 80 – Fire Doors and Windows.
- E. ANSI/UL 10B – Fire Tests of Door Assemblies.
- F. CAN/CSA C22.1 – Canadian Electrical Code.
- G. Model and Local Building Codes. ISO 9001: 2000 - Quality Management Systems - Requirements.

#### **1.4 DESIGN REQUIREMENTS**

- A. Arrange elevator components in control closet or machinery space so equipment can be removed for repairs or replaced with minimal disturbance to other equipment and components.
- B. Where permitted by code, provide all elevator equipment including controls, drives, transformers, and rescue features within the elevator hoistway.

#### **1.5 SUBMITTALS**

- A. Comply with Section 013300 – Submittal Procedures.
- B. Product Data: Submit manufacturer/installer's product data, including,
  - a. Descriptive brochures or detail drawings of car and hall fixtures, cab ceilings, and product features.
  - b. Power Information: Horsepower, starting current, running current, machine and control heat release, and electrical requirements.

- C. Shop Drawings: Submit manufacturer/installer's shop drawings, including plans, elevations, sections, and details, indicating location of equipment, loads, dimensions, tolerances, materials, components, fabrication, fasteners, hardware, finish, options, accessories, and other information to render totally functional elevators.
- D. Samples: Submit manufacturer/installer's samples of standard colors and finishes of finish materials.
- E. Operation and Maintenance Manual: Submit manufacturer/installer's operation and maintenance manual; including operation, maintenance, adjustment, and cleaning instructions; trouble shooting guide; renewal parts catalogs; and electrical wiring diagrams.
- F. Warranty: Submit manufacturer/installer's standard warranty.

#### 1.6 PERMITS AND INSPECTIONS

- A. Obtain and pay for all necessary municipal and State inspections and permits and make such tests as are required by the regulations of such authorities. These tests shall be made in the presence of the authorized representatives of such authorities.

#### 1.7 QUALITY ASSURANCE

- A. Manufacturer/Installer's Qualifications: Specialize in manufacturing and installing elevator equipment, with a minimum of 10 years successful experience.
- B. Regulatory Requirements:
  - a. Elevator design, clearances, construction, workmanship, materials, and installation, unless specified otherwise, shall be in accordance with ANSI/ASME A17.1, handicap accessibility, Americans with Disabilities Act, and other codes having legal jurisdiction.
  - b. ANSI/ASME A17.1 shall govern, except where codes having legal jurisdiction include more rigid requirements or conflict with ANSI/ASME A17.1.
  - c. Elevator shall follow design and manufacturing procedures certified in accordance with ISO 9001-2000 to meet product and service requirements for quality assurance for new products.
- C. Comply with all requirements of the State of New Jersey.
- D. Tolerance for Elevator Travel: Plumb and secure guide rails within an overall tolerance of 1/4" (measured with no wind or solar load on building) and within 0.01" joint offset on rail surface. Limit short-span tolerance (measured between upper and lower car guides, continuously) to the following:
  - 1. Plumb Tolerance: 1/8".
- E. Tolerance for Car Leveling: Position stopping car within following tolerance, up or down, regardless of load and direction of travel:
  - 1. Car Floor to Landing: 1/4" out of level.
- F. Fire Resistance: Except as otherwise indicated, comply with NFPA Standard No. 80 for construction and installation of hoistway entrance. Provide each door unit bearing UL label of approval ("B" label, except as otherwise indicated) as a "Fire Door" if horizontal sliding or vertical bi-parting, and as a "Frame and Fire Door Assembly" if swinging. Where required by NFPA Standard No. 80, provide separate UL labels of approval on hardware, sills, closers, and other accessory items of hoistway entrance.

G. Pre-installation Meeting:

- a. Convene pre-installation meeting before start of installation of elevators.
- b. Require attendance of parties directly affecting work of this section, including Contractor, Architect, and elevator manufacturer/installer.
- c. Review examination, installation, field quality control, adjusting, cleaning, protection, and coordination with other work.

**1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Delivery: Deliver materials to site in manufacturer/installer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer/installer.
- B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer/installer's instructions.
- C. Handling: Protect materials during handling and installation to prevent damage.

**1.9 PROJECT CONDITIONS**

A. Temporary Electrical Power:

- a. General Contractor to coordinate and provide for temporary 220 VAC, single-phase, 60 Hz., GFCI-protected electricity to be available for installation of elevator components or as required by elevator manufacturer
- b. Comply with Section 015100 – Temporary Utilities.

B. Installation of the Elevator:

- a. General Contractor will provide permanent three-phase power prior to installation start.
- b. General Contractor will provide clear, rollable access to a 20' x 10' secure and dry storage area prior to delivery or as required by elevator manufacturer.
- c. General Contractor will provide a clean, dry, and complete hoistway along with temporary installation platform and all required OSHA-compliant barricades prior to delivery.

**1.10 SCHEDULING**

- A. Coordinate elevator work with work of other trades, for proper time and sequence to avoid construction delays.

**1.11 WARRANTY**

- A. Manufacturer/installer shall guarantee materials and workmanship of equipment installed under these specifications and make good, defects not due to ordinary wear or to improper use, which may develop within 1 year after completion of installation or acceptance thereof by beneficial use, whichever is earlier.

**1.12 MAINTENANCE SERVICE**

- A. Elevator maintenance service shall be performed by elevator manufacturer/installer.

- B. Elevators shall receive regular maintenance on each unit for period of 12 months after completion of work specified herein or acceptance thereof by beneficial use, whichever is earlier.
- C. Trained employees shall make periodic examinations but not less than quarterly with final visit less than 30 days prior to expiration of warranty period and perform work including necessary adjusting, greasing, oiling, and replacing parts to keep elevators in operation, except parts that require replacement because of accidents, vandalism, misuse, or negligence by parties other than manufacturer/installer.
- D. Manufacturer/installer shall perform all Work, except emergency minor adjustment call-back service, during regular working hours. Manufacturer/installer shall provide emergency minor adjustment call-back service, during regular working hours.
- E. Maintenance Options
  - Regular Maintenance: During Regular Working Hours, not less than quarterly.
  - Callback Service: During Regular Working Hours
  - Maintenance Period: 12

## **PART 2 – PRODUCTS**

### **2.1 MANUFACTURER/INSTALLER**

- A. Elevator shall be installed by elevator manufacturer. Passenger Elevators, Basis of Design: Provide "Schlinder 3300 XL" gearless, machine-roomless elevator as manufactured by Schlinder or approved equal with the following characteristics specified herein.
- B. Other manufacturers: TK elevator, Fujitec, Kone, Otis or approved equal

### **2.2 ELEVATOR SYSTEM AND COMPONENTS**

- A. Elevator Equipment Summary:
  - a. Application: Machine Room Less (MRL)
  - b. Counterweight Location: Side
  - c. Machine Location: Top of the hoistway mounted on car and counterweight guide rails
  - d. Control Space Location: Top landing entrance frame or entrance frame at one floor below the top landing
  - e. Service: Hospital/service
  - f. Quantity: 1 Unit
  - g. Capacity: 4500 lbs
  - h. Speed: 150 fpm
  - h. Travel: 16' 0"
  - i. Landings: 2
  - j. Front Openings: 1
  - k. Rear Openings: 1

- l. Rear Door Hand: Left
- m. Operation: Microprocessor Single Car Automatic Operation
- o. Clear Inside Dimensions: 5' 4-1/4" Wide X 8' 2 1/2" Deep
- p. Cab Height: 7' 9"
- q. Guide Rails: Equivalent to 12 lb. per foot
- r. Entrance Type and Width: Two Speed Side Opening 4' 0" Wide X 7' 0" High doors
- t. Power Supply: 480 Volts 3 Phase 60 Hz

**C. Performance:**

a. Car Speed: -10% to +5% of contract speed under any loading condition or direction of travel.

b. Car Capacity: Safely lower, stop and hold up to 125% of rated load per code.

**D. Ride Quality:**

- a. Vertical Vibration (maximum): 25 mg
- b. Horizontal Vibration (maximum): 15 mg
- c. Vertical Jerk (maximum): 2 ft/sec<sup>3</sup>
- d. Acceleration (maximum): 1.6 ft/sec<sup>2</sup>
- e. In Car Noise: 53-60 dB(A)
- f. Stopping Accuracy: ±5mm
- g. Starts per hour (maximum): 180

**E. Elevator Operation:**

a. Simplex Collective Operation: Using a microprocessor based controller, operation shall be automatic by means of the car and hall buttons. When all calls have been answered, the car shall park at the last landing served.

**F. Operating Features - Standard:**

- a. Door Light Curtain Protection
- b. Static AC Drive
- c. Phase Monitor Relay
- d. Cab Overload with Indicator
- e. Load-weighing
- f. Central Alarm
- h. Firefighter's Operation
- i. Standby Emergency Operation / Automatic Generator Tie-In. Upon activation of fire alarm system car shall return to first floor and remain in the open position or if alarm on first floor raise to the 2<sup>nd</sup> floor position and remain open.



- j. Independent Service
- k. Top of car inspection
- l. fan and light protection

## **2.3 EQUIPMENT: CONTROL COMPONENTS AND CONTROL SPACE**

- A. Controller: Provide microprocessor based control system to perform all of the functions of safe elevator operation, as well as perform car and group operational control.
  - a. All high voltage (110v or above) contact points inside the inspection and test panel shall be protected from accidental contact in a situation where the access panels are open.
  - b. The controller shall be distributed throughout the elevator system located in the overhead, cab and inspection and test panel. The inverter will be mounted in the overhead adjacent to the hoist machine and an inspection and test panel will be located in the door jamb at the top floor or one floor below the top floor. No elevator equipment mechanical rooms or closets are required.
  - c. Provide multi-bus control architecture to reduce cabling, material and waste.
- B. Drive: Provide a Variable Voltage Variable Frequency AC Closed Loop drive system. Provide stable start without high peak current, quickly reaching a low energy consumption level.
- C. Inspection and Test Panel: Integrated control equipment, main inspection and test panel in door frame at top level served or at one floor below the top level served.

## **2.4 EQUIPMENT: HOISTWAY COMPONENTS**

- A. Machine:
  - a. Gearless asynchronous AC motor with integral drive sheave, service and emergency brakes.
  - b. Design machine to enable direct power transfer, thereby avoiding loss of power.
  - c. Design machine to be compact, lightweight and durable to optimize material usage and save space.
  - d. Mount to structural support channels on top of guide rail system as applicable in hoistway overhead.
- B. Governor:
  - a. Tension type over-speed governor with remote manual reset.
  - b. Mount to structural support channels as applicable in hoistway overhead.
- C. Buffers, Car and Counterweight: Polyurethane buffers shall be used.
- D. Hoistway Operating Devices:
  - a. Emergency Stop switch in the pit.
  - b. Terminal stopping switches.
  - c. Emergency stop switch on the machine.

- E. Positioning System: System consisting of proximity sensors and door zone vanes.
- F. Guide Rails and Attachments: Provide Tee-section steel rails with brackets and fasteners. Side counterweight arrangements shall have a dual purpose bracket that combines both counterweight guide rails, and one of the car guide rails to building fastening.
- G. Suspension System: Non circular Elastomeric coated suspension media with high tensile grade steel cords.
- H. Governor rope: Steel wire rope with 6 mm diameter.

## **2.5 EQUIPMENT: HOISTWAY ENTRANCES**

- A. Hoistway Doors and Frames:
  - a. UL rated with required fire rating minimum 1-1/2 hours.
  - b. Doors: Rigid flush panel construction with reinforcement ribs.
  - c. Frames: Securely fasten at corners to form unit frame. Frames shall be bolted.
    - 1. Full depth (Sematic) entrance jambs each floor.
- B. Finish:
  - a. Exposed Areas of Corridor Frames: Stainless Steel - All Floors
  - d. Doors: Stainless Steel - All Floors
  - g. Sills: Aluminum - All Floors
- C. Entrance Markings and Jamb Plates: Provide standard entrance jamb tactile markings on both jambs, at all floors. Plate Mounting: Refer to manufacturer drawings.

## **2.6 EQUIPMENT: CAR COMPONENTS**

- A. Car Frame and Safety: Provide car frame with adequate bracing to support the platform and car enclosure. The safety shall be integral to the car frame and shall be flexible guide clamp type.
- B. Platform: Provide platform of steel construction with plywood subfloor and aluminum threshold.
- C. Car Guides: Provide sliding guide shoes mounted to top and bottom of both car and counterweight frame. Arrange each guide shoe assembly to maintain constant contact on the rail surfaces. Provide retainers in areas with Seismic design requirements.
- D. Provide central guiding system to reduce mechanical friction and energy consumption.
- E. Steel Cab:
  - a. Fire rating: Provide Class B fire rating for cab, or Class A fire rating where required by local Code.
  - b. Subfloor: Exterior, C-C Plugged grade plywood, not less than 7/8" nominal thickness.
  - c. Car wall finish: Hung 5WL Panels textured stainless steel panels.

- d. Base and frieze: Aluminum.
- e. Car front finish: Brushed stainless steel.
- f. Car door finish: Brushed stainless steel.
- g. Ceiling: Canopy ceiling, finished in #4 Stainless Steel With Down Lit Led Lighting.
- h. Handrail: Round Bushed Stainless Steel. Locate on-all Walls without door
- i. Flooring: By others. Not to exceed 3/4" finished depth.
- j. Ventilation: Provide one-speed fan in canopy.
- k. Emergency Car Lighting: Provide an emergency power unit employing a 12 volt sealed rechargeable battery and static circuits to illuminate the elevator car and provide current to the alarm bell in the event of building power failure.
- l. Emergency Siren: Provide siren mounted on top of the car that is activated when the Alarm button in the car operating panel is engaged.
- m. Emergency Exit Switch: Provide an electrical contact to open the safety circuit when the emergency car top exit is opened. When the exit door is opened, the top exit switch shall signal the control and the car will be unable to move.
- n. Emergency Exit Lock: Provide an emergency exit lock where required by local code.
- o. Emergency Exit Guard: Provide emergency exit guard on top of car when required for hoistway wall to platform clearance exceeds 12" or for multiple cars in hoistway.
- p. Fan: A two-speed 120 VAC fan will be mounted to the structural ceiling to facilitate in-car air circulation, meeting A17.1 code requirements. Two-speed fan shall produce airflow rates of 5.8 and 7.4 m<sup>3</sup>/min on low and high setting respectively. The fan shall be rubber mounted to prevent the transmission of structural vibration and will include a baffle to diffuse audible noise. A switch shall be provided in the car-operating panel to control the fan.
- q. maintenance and protection pad mounting hooks with set of pads provided.

## **2.7 DOOR OPERATOR AND REOPENING DEVICES**

A. Door Operator: Provide a closed loop VVVF high performance door operator with frequency controlled drive for fast and reliable operation to open and close the car and hoistway doors simultaneously.

B. In case of interruption or failure of electric power, the doors can be readily opened by hand from within the car, in accordance with applicable code. Provide emergency devices and keys for opening doors from the landing as required by local code.

C. Doors shall open automatically when the car has arrived at or is leveling at the respective landings. Doors shall close after a predetermined time interval or immediately upon pressing of a car button. Provide door open button in the car operating panel. Momentary pressing of this button shall reopen the doors and reset the time interval.

D. Provide door hangers and tracks for each car and hoistway door. Contour tracks to match the hanger sheaves. Design hangers for power operation with provisions for vertical and lateral adjustment. Hanger sheaves shall have polyurethane tires and pre-lubricated sealed for life bearings.

E. Electronic Door Safety Device: Equip car doors with concealed transmitter and receiver infrared beam devices to detect presence of object in process of passing through hoistway entrance and car doorway (light curtain device).

a. Use multi-beam scanning without moving parts to detect obstructions in door opening.

b. Detector Device: Prevent doors from closing, or if they have already started closing, cause doors to reopen and remain open while object is within detection zone.

c. Horizontal Beams: Minimum of 33 infra red beams to fill doorway from ground level to a height of 6 feet.

## **2.8 EQUIPMENT: SIGNAL DEVICES AND FIXTURES**

A. Car Operating Panel: Provide a car operating panel with all push buttons, key switches and message indicators for elevator operation.

a. Full height car operating panel shall be surface-mounted on front return.

b. Comply with handicap requirements.

c. Push Buttons: Mechanical, illuminating using long-lasting LEDs for each floor served.

d. Emergency Buttons: Provide in accordance with code. Emergency alarm button, door open and door close buttons.

B. Features of the Car Operating Panel Shall Include:

a. Audible chime to signal that the car is either stopping at or passing a floor served by the elevator.

b. Raised markings and Braille provided to the left hand side of each push button.

c. Car Lantern: Provide LED illuminated car lantern with direction arrows to comply with local code when hall lanterns are not provided.

d. Door open and close push buttons.

e. Firefighter's hat and Phase 2 Key-switch

f. Inspection key-switch.

g. Key-switch for optional Independent Service Operation

h. Illuminated alarm button with raised marking.

i. Elevator Data Plate marked with elevator capacity and car number.

j. Help Button: Activation of help button will initiate two-way communication between car and a location inside the building, switching over to alternate location if call is unanswered, where personnel are available to take the appropriate action. Visual indicators are provided for call initiation and call acknowledgement.

k. Certificate Frame.

- C. Hall Fixtures: Provide hall fixtures with necessary push buttons and key switches for elevator operation. (Vandal Resistant)
  - a. Push buttons: Metallic tactile push buttons, up button and down button at intermediate floors, single button at each terminal floor. (Vandal Resistant)
  - b. Height: Comply with handicap requirements.
  - c. Illumination: Illuminating using long-lasting low power LEDs.
- D. Hall Lanterns and Position Indicators.
  - a. LED illuminated direction arrows with audible and visible call acknowledgement. (wall-mounted above entrance frame at typical landings)
- E. Hoistway access switches: Provide key-switch at top and/or bottom floor in entrance jamb as required by local code.
- F. Firefighter's Phase 1 Service: Key switch in brushed stainless steel cover plate.
- G. Fixture Cover Plates: For push buttons, hall lanterns and position indicators, resistant white back-printed glass, no screws required for mounting. Provide stainless steel cover plates for Firefighter's Phase I switch and hoistway access switches, with tamper resistant screws in same finish.
- H. Mounting: Mount hall fixtures in (entrance frames)

## **PART 3 – EXECUTION**

### **3.1 EXAMINATION**

- A. Examine hoistways, hoistway openings, and pits before starting elevator installation.
- B. Verify hoistway, pit, overhead, and openings are of correct size, within tolerances, and are ready for work of this section.
- C. Verify walls are plumb where openings occur and ready for entrance sill installation. Traditional sill angle or concrete sill support shall not be required.
- D. Verify hoistway is clear and plumb, with variations not to exceed -0 to +1 inch at any point. Verify projections greater than 4" must be beveled not less than 75 degrees from horizontal. No negative tolerance is permitted for minimum hoistway dimensions.
- E. Verify minimum 2-hour fire-resistance rating of hatch walls.
- F. Notify Architect in writing of dimensional discrepancies or other conditions detrimental to proper installation or performance of elevators.
- G. Do not proceed with elevator installation until unsatisfactory conditions have been corrected in a manner acceptable to manufacturer/installer.

### **3.2 INSTALLATION**

A. Install elevators in accordance with manufacturer/installer's instructions and ANSI/ASME A17.1.

B. Set entrances in vertical alignment with car openings and aligned with plumb hoistway lines.

### 3.3 FIELD QUALITY CONTROL

A. Perform tests of elevator as required by ANSI/ASME A17.1 and governing codes. (including one pre-test with fire alarm vendor and one final elevator inspection test per elevator)

### 3.4 ADJUSTING

A. Adjust elevators for proper operation in accordance with manufacturer/installer's instructions.

B. Adjust elevators for smooth acceleration and deceleration of car so not to cause passenger discomfort.

C. Adjust doors to prevent opening of doors at landing on corridor side, unless car is at rest at that landing, or is in leveling zone and stopping at that landing.

D. Adjust automatic floor leveling feature at each floor to within 1/4 inch of landing.

E. Repair minor damages to finish in accordance with manufacturer/installer's instructions and as approved by Architect.

F. Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

### 3.5 CLEANING

A. Clean elevators promptly after installation in accordance with manufacturer/installer's instructions.

B. Do not use harsh cleaning materials or methods that could damage finish.

### 3.6 PROTECTION

A. Protect installed elevators from damage during construction in accordance with the negotiated temporary use agreement between Owner and manufacturer's installer.

END OF SECTION

## SECTION 200000 - COMMON MECHANICAL/ELECTRICAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. This section of the specifications covers additional general requirements for Division 21 - 28.
- B. The basic general requirements for these Divisions are specified in Division 01, the entirety of which is applicable to the MEP Divisions.
- C. The following sections of Division 01 are particularly relevant:
  - 1. 01 31 00 PROJECT MANAGEMENT AND COORDINATION
  - 2. 01 32 33 PHOTOGRAPHIC DOCUMENTATION
  - 3. 01 33 00 SUBMITTAL PROCEDURES
  - 4. 01 42 00 REFERENCES
  - 5. 01 73 00 EXECUTION
  - 6. 01 77 00 CLOSEOUT PROCEDURES
  - 7. 01 78 23 OPERATION AND MAINTENANCE DATA
  - 8. 01 78 39 PROJECT RECORD DOCUMENTS
  - 9. 01 81 13.xx SUSTAINABLE DESIGN REQUIREMENTS LEED

#### 1.2 SUPPLEMENTARY MEP DEFINITIONS

- A. "Architect means the "Prime Design Consultant." If R.G. Vanderweil Engineers, LLP is not the Prime Design Consultant, the Architect may authorize R.G. Vanderweil Engineers, LLP to act on the Architect's behalf in matters concerning the systems Vanderweil has designed.
- B. The words "Architect" and "Engineer" may be used interchangeably in the mechanical and electrical Division specifications.
- C. The terms "Contractor," "General Contractor," "Construction Manager," and "Design-Builder," may appear in the mechanical and electrical Divisions. Wherever such a term is used, it shall mean the entity that is directing all the construction.
- D. "AHJ" means "Authorities Having Jurisdiction."
- E. "MEP" as used herein means the work specified in Divisions 20 through 28, as follows:
  - 1. Divisions 21 (Fire Suppression), 22 (Plumbing), 23 (HVAC), 26 (Electrical), 27 (Communications), 28 (Electronic Safety and Security)

#### 1.3 ADDITIONAL PROVISIONS RELATING TO THE MEP DOCUMENTS

- A. The two-dimensional drawings govern the construction. They show the design intent and are part of the Contract Documents. BIM models are not part of contract documents. They are developed for convenience only.
- B. In spaces used by building occupants, but not in mechanical rooms, the architectural drawings shall govern the location of visible mechanical and electrical components. In order to obtain the intended aesthetics in such spaces, prior to installation of visible material and equipment

(including access panels), review Architectural Drawings for desired locations and where not definitively indicated, request information from Architect.

- C. Maintain maximum headroom at all locations. All piping, duct, conduit, and associated components to be as tight to underside of structure as possible.
- D. Systems shall be run in a rectilinear fashion.
- E. Requirement for complete MEP systems and coordination adjustments:
  - 1. The two-dimensional drawings and the BIM model are diagrammatic, whether furnished electronically or in hard copy. They indicate general arrangements of mechanical systems and other work, and are intended to convey sufficient information for skilled contractors and tradesmen to furnish and install complete systems. They are not intended to be absolutely precise or at the level of detail of coordination or shop drawings. They are not intended to show every offset, fitting, and component. The purpose of the drawings and BIM model is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on this information Contractor shall provide all other components and materials to make the systems fully complete, coordinated with other systems, the structure and space available, and operational.

#### 1.4 ADDITIONAL REQUIREMENTS FOR MEP DISCREPANCIES

- A. Provide systems and components that are fully complete and operational and fully suitable for the intended use.
- B. Where Drawings or Specifications conflict or are unclear, or do not coincide with manufacturers' recommendations or with applicable codes and standards, submit clarification request in form of an RFI before installation. Otherwise, make changes in installed work required for compliance with manufacturer instructions or codes and standards within Contract Price. Similarly, where insufficient information exists in the documents to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements submit clarification request in the form of an RFI before installation.
- C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specs, provide material, installation or work that is of the higher standard.
- D. Where discrepancies exist between the mechanical, plumbing, fire protection, and electrical drawings in regards to what trade owns disconnects or starters, the discrepancy shall be brought to the Architect's attention in accordance with paragraph (b) above. If the scope is not resolved prior to the Award of Contract, Division 26 shall provide such items.

#### 1.5 MEP CLASH DETECTION

- A. As part of the coordination effort, Contractor shall resolve any clashes detected in his/her clash detection analysis. The great majority of these are non-clashing adjacencies or interferences of small MEP components like piping 2 inches or less in diameter (excluding insulation). Such clashes shall be worked out by the contractor as part of his coordination effort. If a clash consists of major routing or other impasse, upon submittal of an RFI, the engineer will provide guidance.

#### 1.6 SUPPLEMENTARY PROVISIONS FOR MEP COORDINATION DRAWINGS

- A. For main mechanical and electrical rooms, show the paths of egress and for equipment removal and replacement.



- B. The MEP coordination drawings shall start with the sheet metal subcontractor's BIM model. This model shall include sheet metal (in its own color), structure, access panels, fire walls, smoke partitions, cross sections where congested, and other information required by Division 01. They shall also show elements of Architect's reflected ceiling plan, exposed ductwork, walls, partitions, diffusers, registers, grilles, fire dampers, sleeves and other aspects of construction for coordination. Show horizontal and vertical offsets and changes of direction.
- C. Each of the mechanical, electrical and other specialty trades shall electronically add its work to the model in a separate color, with appropriate offsets, elevations and grid dimensions, and showing access panels. Drawings shall indicate horizontal and vertical dimensions to avoid interference with structural framing, ceilings, partitions, and other services.
- D. The 2-D PDFs are considered the coordination drawings. The engineering review is based on these, not on the 3-D model, which the engineer may need to refer to for clarification in congested spaces.

#### 1.7 MEP DIGITAL DATA TRANSFER REQUIREMENT

- A. Electronic BIM files for Fire Protection, Plumbing, HVAC, Electrical, Communication, or Electronic Safety and Security systems will be furnished by Engineer at contractor's request. These files will be provided on Engineer's FTP site in the software release used by the Engineer. If other media or software version is requested, Engineer will require advance reimbursement of processing costs. Requests for electronic files will be honored after receipt of a signed licensing agreement acceptable to Vanderweil.

#### 1.8 MEP CODES, STANDARDS, AUTHORITIES AND PERMITS

- A. Perform MEP work in accordance with rules, regulations, standards, codes, ordinances, and laws of local, state, and Federal governments, and other authorities that have legal jurisdiction over the site.
- B. Prior to beginning work, secure and pay for all permits and inspections required by the AHJ.
- C. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of applicable publications, standards, rulings and determinations of: Applicable local and state codes, NFPA, OSHA, UL, FM, American Insurance Association (AIA) (formerly National Board of Fire Underwriters), Owner's Insurance Underwriter.
- D. Specific reference is made to the following NFPA standards which contain an exceptionally high quantity of mechanical, electrical, and fire protection requirements. These standards as referenced by the applicable building, fire, and mechanical codes shall apply: No. 13 - Installation of Sprinkler Systems, No. 14 - Installation of Standpipe and Hose Systems, No. 20 - Installation of Centrifugal Fire Pumps, No. 30 - Combustible Liquids, No. 37 - Installation of Use of Stationary Combustion Engines and Gas Turbines, No. 45 - Fire Protection for Laboratories Using Chemicals, No. 70 - National Electric Code, No. 72 - National Fire Alarm Code, No. 101 - Life Safety Code
- E. Material and equipment shall be listed by UL.
- F. When requirements cited in the various parts of the Contract Documents conflict with each other, most stringent shall govern work. Architect may relax this requirement when relaxation does not violate ruling of AHJ. Approval for relaxation shall be obtained from AHJ in writing.
- G. Unless indicated otherwise, the most recent editions of applicable specifications and publications of the following organizations form part of these Contract Documents. Material and Equipment shall be approved by the relevant organizations for intended service: AGI,

ANSI, ASME, NEMA, ASTM, AWWA, ASHRAE, AMCA, SMACNA, ARI, IEEE, Thermal Insulation Manufacturers Association (TIMA), Insulated Cable Engineers Association (ICEA), Manufacturer's Standardization Society of the Valve & Fittings Industry (MSS)

**1.9 ADDITIONAL REQUIREMENTS FOR MEP WARRANTIES**

- A. Part 2 paragraphs of all specification Sections may specify warranty requirements that exceed those of this Paragraph.
- B. Warranty the Work of the MEP Divisions of the specifications in writing for one year following the date of Substantial Completion. If the equipment is used for ventilation, temporary heat, or other use prior to initial beneficial occupancy by the Owner, the bid price shall include an extended period of warranty covering the one-year of beneficial occupancy by the Owner. The warranty shall be for satisfactory system operation as well as to repair or replace defective products, materials, equipment, workmanship and installation that develop within this period, promptly and to Architect's satisfaction, and to correct damage caused in making necessary repairs and replacements under warranty within Contract Price.
- C. Additionally, obtain written equipment and material warranties offered in manufacturer's published data, without exclusion or limitation, in Owner's name.
- D. Replace material and equipment that require excessive service during warranty period. Excessive service shall be defined as more than three service calls for the same material or equipment within a 12 month period.
- E. Provide 24-hour service beginning on the date of Substantial Completion and lasting until the termination of the warranty period. Service may be provided by a separate service organization subject to Owner approval. Submit name and a phone number that will be answered on a 24-hour basis each day of the week, for the duration of the service.
- F. Use of systems provided under this Section for temporary services and facilities shall not constitute Final Acceptance of work nor beneficial use by Owner, and shall not institute warranty period.
- G. Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during warranty period immediately. If problems cannot be rectified immediately to Owner's satisfaction, advise Architect in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Architect will recommend course of action.

**1.10 SUBMITTALS - SUPPLEMENTARY REQUIREMENTS FOR MEP SYSTEMS**

- A. These supplemental requirements apply only to the MEP systems and are in addition to the requirements in Division 01.
- B. Besides shop drawings, which are submitted relatively early in the project, code-required information on life safety and other systems is required to be submitted prior to claiming construction completion and filing for an occupancy permit. Refer to the specification section covering "Closeout Procedures."
- C. Contractor review of MEP submittals shall confirm that the submittal item physically fits into the space available.
- D. On the submittal cover sheet, provide the following additional information: (a) Contract Drawing Reference Number, (b) Equipment Tag (from Schedules on drawings), (c) Identify Submission Number (first, second, third, fourth).

- E. Also on the submittal cover sheet provide the following: (a) Product representative's contact information, (b) Do all submitted items exactly match scheduled/specified items (Yes, No)?, (c) Is this item a substitution or deviation from the contract documents (Yes, No)?, (d) Does equipment fit space on construction documents, coordination drawings, and actual field conditions (Yes, No)?, (e) Does this material/equipment add expense to other trades or project costs?, (f) Is control interface coordinated (Yes, No)?, (g) List electrical characteristics (Voltage/Phase/Hz/Amps).
- F. Provide shop drawings showing details of piping connections to ALL equipment.
- G. Division 23 shop drawings and installation layout drawings for heating, pumping, process piping, and refrigeration systems prepared by the Installer shall note name(s), license number(s), and license expiration dates of the installing firm.
- H. Sheet metal shop drawings shall show the same content as coordination drawings, but without the fire protection, plumbing and electrical layers superimposed.
- I. Engineer will return MEP submittals notated as follows:

"APPROVED AS NOTED"

"Reviewed and found generally acceptable. Minor deviations may be noted. Contractor shall submit:"

- ☐ No further submittal required if notations are complied with.
- ☐ Line-item confirmation of compliance with notations

"PROVISIONALLY APPROVED -

CONFIRMATORY RESUBMITTAL  
REQUIRED"

Submittal shall be considered approved when notations have been incorporated and a resubmittal with explanatory cover letter has been made.

"REJECTED; REVISE AND  
RESUBMIT"

"Submittal contains deviations which shall be corrected and confirmed by a new submittal."

"REJECTED"

Submittal is incorrect to such an extent that material is unacceptable or is incomplete to such an extent that a complete review cannot be made. Resubmit in accordance with requirements of the Contract Documents."

"NO ACTION"

Submittal not reviewed.

"REVIEWED FOR INFORMATION"

This Submittal is for information only.

1.11 ADDITIONAL REQUIREMENTS FOR MEP PHOTOGRAPHIC DOCUMENTATION

- A. The MEP record photos are specifically for the mechanical and electrical trades in concealed areas.
- B. Take photographs of all concealed systems and equipment in inaccessible ceilings, shafts, underground (buried) piping routes and other concealed, not readily-accessible areas. At completion of work, submit digitally, with explanatory information for each. These are information submittals.

1.12 SUPPLEMENTARY REQUIREMENTS FOR MEP OPERATION AND MAINTENANCE MANUALS

- A. Provide lubrication instructions for each item that requires lubrication.
- B. Incorporate system one-line and flow diagrams, to indicate how each component relates to the whole.

- C. Include valve directory showing each valve with I.D., and show I.D.'s on respective one line or flow diagrams.
- D. Include copy of HVAC balancing report.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 LIFE SAFETY SYSTEMS - REQUIREMENTS FOR CERTIFICATE OF OCCUPANCY

#### A. Scheduling Life Safety Work

- 1. Schedule work so life safety systems are complete in advance of other systems. This requirement is to allow the Engineer to conduct a final project visit and correction of issues found without affecting issuance of a Substantial Completion Certificate or a Certificate of Occupancy.

#### B. Life Safety Systems Include

- 1. Fire Suppression Systems
- 2. Fire Notification (Alarm) and Detection Systems
- 3. Smoke Control Systems and Special Inspections
- 4. Egress Signage and Lighting Systems
- 5. Emergency Power Systems

#### C. Engineering Certification

- 1. Contractor shall ascertain from the AHJ whether Engineer must certify completion as a prerequisite for the Occupancy Permit. If so, confirm all systems are complete and notify Engineer in writing at least 10 working days before the Occupancy Certificate is requested.

#### D. Meaning Of "Complete" for a Life Safety System

- 1. No further work is required to satisfy the requirements of the drawings, specifications and applicable codes and standards.
- 2. Systems are fully operational with power to components, valves open, status indicators in "normal" condition and otherwise ready "as-is" to perform required functions.
- 3. Required product data and shop drawing submittals have been submitted and returned with a "Reviewed" status.
- 4. Test certificates have been submitted and returned with an "Approved as Noted" status.
- 5. Project visit report observations and "punch list" items have been addressed and/or corrected.
- 6. "O&M" documentation and "as-built" plans have been submitted and returned with a "Reviewed" status.

### 3.2 SPECIAL INSPECTIONS FOR SMOKE CONTROL SYSTEMS, INCLUDING ATRIUMS AND STAIR PRESSURIZATION SYSTEMS.

#### A. General

1. Special inspections for all smoke control systems shall be accomplished, in accordance with the version of the International Building Code in effect in the jurisdiction in which the project is located. The inspection shall cover associated mechanical systems, controls, and interface with building fire alarm system and smoke control panel.
2. In addition to special inspection for smoke control systems, documentation of completion of MEP systems is required to obtain an occupancy permit. The required documentation is detailed below.

**B. Special Inspections Team**

1. The special inspections team shall consist of:
  - a. A 3<sup>rd</sup> party Smoke Control Special Inspector (“SCSI”).
  - b. The Contractor’s Project Manager (“CPM”), plus the Project Manager for the Controls Vendor, plus designated representatives of sheet metal, electrical and fire alarm subcontractors.
  - c. A representative of the HVAC and Fire Alarm Engineers.
  - d. A representative of the Owner.
2. Coordinate the timely hiring by the Owner of the SCSI. The SCSI shall meet the requirements for the SCSI as defined in the applicable building code; namely have expertise in mechanical engineering, fire protection engineering and be a certified air balancer and approved by the AHJ. The SCSI may be comprised of multiple building professionals.
3. The CPM shall serve as the construction team’s single point of contact for the SCSI. The CPM shall be responsible for Contractor oversight and direction of the inspections effort and for communications to all contractors’ and subcontractors’ representatives on the inspections team. This includes coordinating the SCSI’s work with the TAB contractor and startup efforts. It shall be the CPM’s responsibility to ensure that all required parties, including technical representatives of equipment vendors, are present at smoke control and fire alarm inspections-related efforts when required by this specification and/or when requested by the SCSI. The CPM shall witness all inspection activities and shall initial inspection forms to indicate satisfactory completion.

**C. Special Inspection Requirements and Team Responsibilities**

1. Perform the testing, as directed by the SCSI. Prior to testing, Contractor shall submit proposed test protocol for approval by SCSI and Engineer.
2. Include all meetings, planning, scheduling, coordination, special inspection, testing, adjustment, re-testing, and material and labor to ensure that all smoke control systems operate according to the Construction Documents.
3. A report of all testing shall be prepared by the SCSI, submitted to the Engineer and the AHJ and stored at an approved location in the building upon completion of the inspections. The report shall include device identification by manufacturer, nameplate data, design values, measured values and identification tags.
4. The HVAC and Fire Alarm Engineers will review the report, and when satisfied that the design intent has been achieved, stamp the report with applicable PE seal. Any modifications to the testing, installation or documentation required by the PE must be made by the inspection team prior to stamping.

5. Special inspector shall review and comment on all related shop drawings. Submit SCSi comments on the reviewed shop drawings to Engineer in time for engineer to incorporate into design team review.
6. The phases and overall scope of testing are as follows:
  - a. Planning. Meeting, scheduling, and coordination to ensure that all parties, including vendors' representatives, know in advance the scope and schedule of what is required of them in the testing process.
  - b. Pre-Inspection (leakage testing and device location documentation). After equipment is installed, connected, and ready to operate, but before walls are sealed, the Contractor shall conduct and the SCSi observe pre-inspection to validate the installation of all equipment, ductwork, controls, smoke control panel and fire alarm being inspected. The CPM and the respective contractor's inspection team members shall witness and shall certify the results of the pre-inspection by initialing the respective forms. The CPM shall advise the SCSi and Engineer of the exact schedule for pre-inspection so that the SCSi and Engineer can witness parts or all of the pre-inspection.
  - c. After equipment has been successfully started up and operated, the Contractor shall have the systems tested and balanced. Testing shall include testing and verification of all controls sequences and pressure differentials. The SCSi shall witness the testing and balancing and controls verification.
  - d. Performance Tests (pressure-difference testing, flow measurements, detection and control verification). After systems are complete and equipment pre-inspection, startup, and testing and balancing have been completed, and test protocols have been approved, Contractor shall conduct performance testing, in order to validate component and systems performance. The CPM and the respective contractor's inspection team members shall witness and shall certify the results by initialing the respective forms. The CPM shall ensure that representatives of equipment vendors are present to observe and assist in the testing of respective equipment. The CPM shall advise the SCSi and Engineer of the exact schedule for functional performance testing so that the SCSi and Engineer can witness parts or all of it. The inspections effort shall be continuous day to day for whatever duration is required to complete it, and the CPM and other contractor team members must be consistently available for the testing. Performance tests shall be conducted under normal building power and repeated under emergency power.
  - e. Final system overall testing and acceptance by the Fire Department.
  - f. Acceptance of Special Inspections
    - 1) Acceptance shall be accomplished when the following has been satisfactorily completed by the contractor and certified by the SCSi and Engineer:
      - a) Pre-inspection
      - b) Startup, testing, and balancing
      - c) Performance Testing
      - d) Completed testing report, approved and stamped by the Engineer.
      - e) Acceptance of system by Fire Department, and issuance of final occupancy permit.

### 3.3 MEP CONTRACTORS' SPECIAL RESPONSIBILITIES

- A. Cooperate and coordinate with work of other Sections in executing work of this Section.
  - 1. For equipment provided under any division or section which has connections made under the mechanical or electrical sections, obtain detailed installation and hookup information from the equipment manufacturers.
  - 2. Obtain final roughing dimensions or other information needed for complete installation of items furnished under other Sections or by Owner.
  - 3. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under all Sections. Give full information so that openings required by work of this Section may be coordinated with other work and other openings and may be provided for in advance.
  - 4. Provide information requested as to sizes, number and locations of concrete housekeeping pads necessary for floor-mounted vibrating and rotating equipment.
  - 5. Notify Architect of location and extent of existing piping, conduit, ductwork and equipment that interferes with new construction. In coordination with and with approval of Architect, relocate piping, ductwork and equipment to permit new work to be provided. Remove non-functioning and abandoned piping, ductwork and equipment. Dispose of or store items.
- B. Building Expansion Joints and Firewalls
  - 1. Ductwork, conduit, cable tray, piping, and other horizontal distribution systems shall be provided with expansion provisions when passing across building expansion joints. Provide copper ground jumper across expansion joints for electrical components. Systems shall be run through rated walls, partitions, and floors via approved fireproofed sleeves.
- C. Installation Shall Provide Access to Systems
  - 1. Installation shall allow clearances for easy access to systems for routine maintenance, for repairs, and for installing new cable in conduit and cable trays.
  - 2. Access panels shall be installed in ceilings that are not composed of removable tiles. These shall be located where system components exist that have moving parts, motors, or other components requiring periodic maintenance, adjustment, or replacement. Access panels shall be shown on Coordination Drawings and shall be of the type and finish approved by the Architect.
- D. Installation Only Items
  - 1. Where a Contractor is required to install items that it does not purchase, coordinate the delivery and be responsible for their unloading from delivery vehicles and for safe handling and field storage up to the time of installation.
    - a. Provide field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of dunnage supporting members and fastenings to adapt them to architectural and structural conditions.
    - b. Provide connection to building systems including the purchase and installation of terminating fittings necessary to adapt and connect them to the building systems.
  - 2. Carefully examine items upon delivery. Claims that items have been received in a condition that their installation will require procedures beyond the scope of work of this

contract will be considered only if presented in writing within one week of their date of delivery. Unless claims have been submitted, fully recondition or replace damaged items.

**E. Surveys and Measurements**

1. Base measurements, both horizontal and vertical, on reference points established by Contractor and be responsible for correct layout of work.
2. In event of discrepancy between actual measurements and those indicated, notify Architect in writing and do not proceed with work until written instructions have been issued.

**F. Fireproofing**

1. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.
2. Ducts, piping and other items that would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.
3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for an extra to Owner.

**G. Air Bound Systems**

1. If, after systems are operational, piping systems, coils or other apparatus are stratified or air bound (by vacuum or pressure), they shall be repiped with new fittings, air vents, or vacuum breakers at no extra cost. If connections are concealed in furring, floors, or ceilings, installing trade shall bear all expenses of tearing up and refinishing construction and finish, leaving same in as good condition as before it was disturbed.

**H. Site Logistics**

1. Unload materials and equipment delivered to site. Pay costs for rigging, hoisting, lowering and moving equipment on and around site, in building or on roof.

**I. Continuity of Services**

1. Do not interrupt existing services without Owner's approval.
2. Schedule interruptions in advance, according to Owner's instructions.
3. Interruptions shall be scheduled at times of day and work so that they have minimal impact on Owner's operations.
4. Include premium time work associated with interruptions of services and/or shutdowns to avoid disruption to Owner's operations.

**3.4 MEP - CLEANING OF PIPING**

- A. Furnish pipe cleaning chemicals, chemical feed equipment, materials and labor necessary to clean piping.
- B. Chemicals shall conform to LEED standards for environmental compatibility.
- C. Permanently install necessary chemical injection fittings complete with stop valves.
- D. After piping systems have been pressure tested and approved for tightness, clean and flush piping as specified and in accordance with applicable codes.



- E. Maintain continuous blowdown and make-up during flushing operation.

### 3.5 MEP AND FIRE PROTECTION COMPLETION REQUIREMENTS

#### A. Special Provisions for MEP Completion Punchlists

1. When the contract work is substantially complete, if requested by the Contractor, the Engineer will inspect the relevant work to confirm completion status. Prior to the inspection, the Contractor shall submit a punch list of remaining items to be completed as well as the Testing, Adjustment, and Balance report. In the course of the review the Engineer will add a supplement to the Contractor's punch list with any observed remaining work that is not already on the list and provide the modified punch list, in a medium selected at the Engineer's discretion, for the Contractor's convenience in closing out the work.
2. Regardless of what the Engineer observes and does not observe in the inspection, the responsibility for successful completion of the contract in all of its details remains with the Contractor.
3. If, when the Engineer arrives at the site certain areas are not complete and ready for review at the substantial completion stage, the Engineer will not review these areas.
4. Confirmation of Punch List Remediation. Once the engineer has submitted the supplement to the Contractor punch list, it shall be the responsibility of the Contractor to confirm that all the listed items have been correctly remedied. Upon receipt of such confirmation, and at the request of the Contractor, the engineer will perform an additional inspection to confirm completion.

#### B. Supplementary MEP Provisions for Obtaining Occupancy Permit

1. Contractor shall coordinate with the approved agency (commissioning agent) and owner regarding the preliminary commissioning report and acknowledgement letter, as required by the IBC and IECC as a condition for final inspection.
2. Contractor shall prepare and submit the below life-safety related items as a prerequisite for construction completion and occupancy. These shall be submitted to the Engineer prior to filing for the occupancy permit so that the Engineer can provide the completion documentation to the AHJ in a timely fashion. Provide a copy of all documents to Architect and to Owner. The required Contractor submittals include:
  - a. Contractor certification that MEP systems have been installed in compliance with the Permit Documents
  - b. Contractor statement of compliance of (a) the fire protection and fire alarm installation with the contract documents, and (b) testing of the fire alarm in accordance with the manufacturer's specifications.
  - c. Contractor certification that acceptance tests of the fire protection and life safety systems have been successfully completed.
  - d. Contractor Test and Material Certificates (per NFPA) for fire protection, fire alarm, smoke control and emergency power systems.
  - e. As-builts of the fire protection system.
  - f. Special Inspector Reports (smoke control system testing).
  - g. HVAC Air and Water Balancing Reports.

- h. Contractor certification of successful emergency and standby power test and inclusion of NFPA 110 test report.
- i. Contractor certification of successful functional testing of lighting controls system.
- j. Contractor certification of successful emergency egress lighting test.
- k. Domestic water systems testing, chlorination and water quality documentation.
- l. Contractor certification of completion of code-related items on contractor's punch list and supplemental architectural and engineering punch lists.
- m. List of remaining punch list items for 100 percent MEP completion.
- n. Final as-built drawings, operations and maintenance manuals, final system balancing report and final commissioning reports must be provided to the Owner within 90 days of the receipt of the Certificate of Occupancy.

END OF SECTION

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## SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
  - 1. For example, prior to requesting an occupancy permit, the MEP documentation listed in Part 3 of Division 20 (in paragraph "MEP and Fire Protection Completion Requirements", subparagraph "Occupancy Permit" must be submitted and approved so the Engineer can certify that the MEP systems and life safety provisions are completed.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes elements common to Division 21 Fire Suppression Sections:
  - 1. Common Division 21 Product requirements:
    - a. Pipe, tube, fittings, and joining materials.
    - b. Pipe hangers and fasteners.
    - c. Sleeves, stack-sleeve fittings, and sleeve-seal systems.
    - d. Escutcheons.
    - e. Grout.
  - 2. Common Division 21 General and Execution requirements.

#### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

**1.4 SUBMITTALS**

- A. All Division 21 submittals shall be in accordance with Division 20 for common mechanical and electrical requirements.
- B. Submit Division 21 for action submittals prior to applying for authority having jurisdiction installation permits (where required) and system installation.
- C. Submit Division 21 for informational submittals related to testing and inspections after successful system testing and prior to scheduling authority having jurisdiction final approval demonstration testing.
- D. Submit Division 21 for closeout submittals as part of project closeout procedure.

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

**1.6 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.

**1.7 CLOSEOUT SUBMITTALS**

- A. Not used.

**1.8 QUALITY ASSURANCE**

- A. Division 21 Drawings are diagrammatic. They are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting and component. The purpose of the drawings is to indicate a system concept, the main components of the system and the approximate geometrical relationships, provide all other components and materials necessary to make the systems fully complete and operational.
- B. Where conflicts between referenced standards, codes, Division 21 Drawings, and Division 21 Specifications exist the most stringent shall apply unless approved in writing by the Engineer.
- C. Division 21 Product Standards: Listed in the "Fire Protection Equipment Directory" published by UL or the "Approval Guide" published by FM Global.
  - 1. Subject to compliance with requirements, indication of a UL product requirement within Division 21 shall be construed to be inclusive of a corresponding FM Global approved product, with or without UL listing.
- D. Division 21 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 1. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- E. Division 21 Steel Pipe Welding Qualifications: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- F. Division 21 Steel Support Welding Qualifications: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

#### 1.9 COORDINATION

- A. Definition, "Coordinate": Where Sections of the Work interact, the Contractor responsible for this Section of the Work initiates verbal and/ or written communication with one or more different Contractors responsible for other interacting Sections of the Work for the purposes of establishing a coordinated approach of product selections and installation sequencing that satisfies the individual requirements of the interacting Sections of the Work as well as the requirements of the Work as a whole.
- B. Coordinate construction operations with those of other Sections of the Work and other entities to ensure efficient and orderly installation of each part of the Work.
  1. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.
  2. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate operations and product selections of this Section with operations and product selections included in different Sections that depend on each other for proper installation, connection, and operation.
- D. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
- E. Coordinate installation of different components with other Sections of the Work to ensure maximum performance and accessibility for required maintenance, service, and repair.
  1. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.
- F. Make adequate provisions to accommodate items scheduled for later installation.
- G. Coordination Drawings: Contribute to preparation of Coordination Drawings in the sequence established under Division 01 and Division 20; indicate water-based fire suppression system Work coordinated with other Sections of the Work.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- C. Pipe and fittings shall be protected from moisture. Pipe and fittings shall not be stored directly on ground. Pipe and fittings exposed to moisture and showing significant rust shall be removed from site, and shall not be installed.

## PART 2 - PRODUCTS

### 2.1 PIPE, TUBE, AND FITTINGS

- A. Comply with individual Division 21 Sections for pipe, tube, and fitting materials.

### 2.2 PIPE JOINING MATERIALS

- A. Comply with individual Division 21 Sections for joining materials.

### 2.3 PIPE HANGERS AND FASTENERS

#### A. Pipe Hangers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Tolco.
  - b. Cooper B-Line.
  - c. Anvil International.
  - d. Or approved equal.
2. Material: Steel, galvanized.
3. Type: Adjustable band type and clevis; comply with Part 3 "Piping Support Installation" for applications.

#### B. Hanger Rod:

1. Material: Carbon steel, galvanized.

#### C. Attachments to Steel:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Tolco.
  - b. Cooper B-Line.
  - c. Anvil International.
  - d. Or approved equal.
2. Material: Carbon or malleable steel, galvanized.
3. Type: Beam clamp.

#### D. Drop in Anchors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hilti Corp.
  - b. ITW Red Head.
  - c. Powers Fastners, Inc.
  - d. Or approved equal.

2. Standard: UL 203.
3. Material: Mild steel with zinc plating.

E. Concrete Inserts (Cast-In):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Tolco.
  - b. Hilti Corp.
  - c. Powers Fasteners, Inc.
  - d. Or approved equal.
2. Material: Carbon steel, galvanized.

2.4 SLEEVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Advance Products & Systems, Inc.
  2. Calpico, Inc.
  3. GPT, an EnPro Industries Co.
  4. Or approved equal.
- B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.
- C. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.5 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Jay R. Smith Mfg. Co.
  2. Zurn Industries, LLC.
  3. Or approved equal.
- B. Description: Manufactured, Dura-coated, Duco-coated, or galvanized cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
  1. Underdeck Clamp: Clamping ring with set screws.

2.6 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Advance Products & Systems, Inc.
  2. Calpico, Inc.

3. Metraflex Co.
4. Or approved equal.

**B. Description:**

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: Nitrile (Buna N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Stainless steel, Type 316. Include two for each sealing element.
5. Connecting Bolts and Nuts: Stainless steel, Type 316, of length required to secure pressure plates to sealing elements.

**2.7 ESCUTCHEONS**

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Galvanized-Steel Type: With hot-dipped galvanized-steel wall plate and setscrew fastener.
- C. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

**2.8 GROUT**

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

**PART 3 - EXECUTION**

**3.1 REMOVAL OF EXISTING FIRE-SUPPRESSION SYSTEMS**

- A. Comply with Division 01 and Division 02 for general demolition requirements and procedures.
- B. Prepare, in narrative and drawing format as directed by the authority having jurisdiction (AHJ), a formal impairment plan identifying at a minimum the following:
  1. Status of building occupancy (or vacancy) during construction.
  2. Duration and timing of fire suppression system shutdowns.
  3. Necessary provisions for temporary water supplies and connections to existing fire suppression systems to remain in service.
  4. Provisions for temporary fire protection systems such as linear heat detection.



- C. Coordinate impairment plan with the NPFA 241 Fire Safety Program prepared by the General Contractor's Fire Safety Program Manager.
- D. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
  - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
  - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- E. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

### 3.2 PIPING INSTALLATION

- A. Install piping according to the following requirements and individual Division 21 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
  - 1. Deviations from approved Shop Drawings require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- C. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- D. Refer to equipment specifications in other Sections for rough-in requirements.
- E. Field-verify final equipment locations of equipment for rough-in.
- F. Select system components with pressure rating equal to or greater than system operating pressure.
- G. Install provisions to accommodate building expansion joints. Provide for expansion at building expansion joints with assemblies listed for that purpose. Coordinate the maximum value of building deflection with the appropriate Structural Section of the Work.
- H. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- K. Install piping to permit valve servicing.
- L. Install piping at indicated slopes.
- M. Install piping free of sags and bends.
- N. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- O. Install piping to allow application of insulation.
- P. At the end of each working day all pipe openings shall be covered or capped to minimize the likelihood of introduction of foreign materials into piping. All piping not covered or which has had covering damaged shall be visually inspected internally to confirm no obstructions have been introduced to the piping.

### 3.3 JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- E. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- F. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- G. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Join flanges with gasket and bolts according to ASME B31.9.
- I. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
  - 1. Shop weld pipe joints where welded piping is indicated.
  - 2. Do not use welded joints for galvanized-steel pipe.

- J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

### 3.4 PIPING SUPPORT INSTALLATION

- A. Install hangers, fasteners, and structural attachments:
  - 1. NPS 6 and larger: Use clevis type hangers only.
  - 2. NPS 4 and smaller: Use clevis or adjustable band type hangers.
  - 3. Install beam clamps with retaining straps regardless of seismic classification.
  - 4. Powder-driven or pre-expanded inserts shall not be used.
  - 5. Threaded connections shall not be used for attachments to concrete.
- B. Install seismic restraints and flexible couplings. Comply with Division 21 for seismic controls for fire suppression piping and equipment.

### 3.5 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
  - 1. Exterior Concrete Walls above Grade: Use steel pipe sleeves.
  - 2. Exterior Concrete Walls below Grade: Use steel pipe sleeves with sleeve-seal systems.
  - 3. Concrete Slabs on Grade: Use steel pipe sleeves with sleeve-seal systems.
  - 4. Concrete Slabs above Grade: Use steel pipe sleeves.
  - 5. Interior Wall Partitions: Use galvanized-steel sheet sleeves.
  - 6. Slabs with Waterproof Membrane: Comply with Part 3 "Stack-Sleeve Fitting Installation".
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to accommodate annular clear space required for installation of sleeve-seal system.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors 2 inches above finished floor level.
  - 2. Using grout, seal space outside of sleeves in slabs and walls.
- D. Install sleeves for pipes passing through interior wall partitions.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Division 07.

### 3.6 STACK-SLEEVE FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs to be provided with membrane waterproofing as slabs are constructed.
  - 1. Install fittings that are large enough to provide necessary annular clear space between sleeve and pipe or pipe insulation.
  - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07.
  - 3. Install section of cast-iron sleeve fittings to extend sleeve to 2 inches above finished floor level.
  - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 5. Use silicone sealant to seal around the outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07.

### 3.7 SLEEVE-SEAL SYSTEM INSTALLATION

- A. Install sleeve seals systems in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.8 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
  - 1. Bare Piping at Exterior Wall Penetrations: One-piece galvanized-steel wall plate.
  - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with chrome-plated finish.
    - a. Corrosive Environments: One-piece stainless steel with polished stainless steel finish.
  - 3. Bare Piping in Unfinished Service Spaces and Equipment Rooms: No escutcheon.
- C. Escutcheons for Existing Piping:
  - 1. Bare Piping at Exterior Wall Penetrations: Split-Plate Stamped Steel with polished chrome plate finish.
  - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-Plate Stamped Steel with polished chrome plate finish.
  - 3. Bare Piping in Unfinished Service Spaces and Equipment Rooms: No escutcheon.

3.9 PAINTING

- A. Comply with Division 09 for painting of fire-suppression systems, equipment, and components.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

END OF SECTION

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## **SECTION 210553 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Valve tags.
  - 5. Warning tags.
  - 6. Information signs.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device
- C. Information Sign Proofs: Proposed information signs completed with required data and installation details.
- D. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
- E. Valve Schedules: Valve numbering scheme.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For each piping system to include in maintenance manuals.

#### **1.5 QUALITY ASSURANCE**

- A. Identification products for fire suppression piping and equipment compliant with this Section except as modified and approved by the authority having jurisdiction (AHJ).

### **PART 2 - PRODUCTS**

#### **2.1 EQUIPMENT LABELS**

- A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032 inch (0.8 mm) thick, with predrilled holes for attachment hardware.
  2. Letter Color: White.
  3. Background Color: Red.
  4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
  5. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  6. Fasteners: Stainless-steel rivets.
  7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, with predrilled holes for attachment hardware.
  2. Letter Color: White.
  3. Background Color: Red.
  4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
  5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
  6. Minimum Letter Size: 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  7. Fasteners: Stainless-steel rivets.
  8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- D. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, with predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inch (38 mm) high.
- D. Pipe-Label Colors:
  - 1. Background Color: Red.
  - 2. Letter Color: White.

## 2.4 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch (6.4 mm) letters for piping-system abbreviation and 1/2-inch (13 mm) numbers.
  - 1. Tag Material: Brass, 0.032 inch (0.8 mm) thick, with predrilled holes for attachment hardware.
  - 2. Fasteners: Brass wire-link chain, beaded chain, or S-hook.
  - 3. Valve-Tag Color: Natural Brass.
  - 4. Letter Color: Black.
- B. Valve-Tag Size and Shape: 2 inches (50 mm), round.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.



**2.5 WARNING TAGS**

- A. Description: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
  - 1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
  - 2. Fasteners: Brass grommet and wire.
  - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  - 4. Color: Yellow background with black lettering.

**2.6 INFORMATION SIGNS**

- A. Material and Thickness: Multi-layer, multi-color plastic, mechanically engraved, 1/8 inch (3.2 mm) thick.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Letter Size: 1/4 inch (6.4 mm).
- F. Adhesive: Contact type permanent adhesive, compatible with label and with substrate.
- G. Minimum Indications for NFPA 13 General Information Signs:
  - 1. Name and location of facility protected.
  - 2. Occupancy classification.
  - 3. Commodity classification.
  - 4. Presence of high-piled and/or rack storage.
  - 5. Maximum height of storage planned.
  - 6. Aisle width planned.
  - 7. Encapsulation of pallet loads.
  - 8. Presence of solid shelving.
  - 9. Flow test data.
  - 10. Presence of flammable/combustible liquids.
  - 11. Presence of hazardous materials.
  - 12. Presence of other special storage.
  - 13. Location of auxiliary drains and low point drains on dry pipe and preaction systems.
  - 14. Original results of main drain flow test and date conducted.
  - 15. Name of installing contractor and contact information.
- H. Minimum Indications for NFPA 13 Hydraulic Design Information Signs:
  - 1. Location of design area.
  - 2. Discharge density over the design area.

3. Required flow and residual pressure at the fire pump discharge, or if no pump is present at the connection to the water supply.
4. Occupancy classification, or commodity classification, maximum storage height, and configuration.
5. Hose stream allowance.
6. Installing Contractor's name and contact information.
- I. Minimum Indications for NFPA 14 Hydraulic Design Information Signs:
  1. Location of the two hydraulically most remote hose connections.
  2. Design flow rate for the hydraulically most remote hose connections.
  3. Design residual inlet and outlet pressures for the hydraulically most remote hose connections.
  4. Design static pressure and design system demand at the system control valve or fire pump discharge, and at each fire department connection.
- J. Minimum Indications for NFPA 14 Water Supply Pump Signs:
  1. Minimum pressure and flow required at the pump discharge flange to meet the system demand.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Obtain authority having jurisdiction (AHJ) approval for identification materials, lettering, colors, indications, quantity, and locations.
- B. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

#### **3.2 GENERAL INSTALLATION REQUIREMENTS**

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

#### **3.3 EQUIPMENT LABEL INSTALLATION**

- A. Install or permanently fasten labels on each major item of mechanical equipment including pumps, controllers, releasing control units, packaged systems, air compressors, nitrogen generators, and similar.
- B. Locate equipment labels where accessible and visible.

#### **3.4 PIPE LABEL INSTALLATION**

- A. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

### 3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems. List tagged valves in a valve-tag schedule.

### 3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

### 3.7 INFORMATION SIGN INSTALLATION

- A. Permanently mount information signs in locations as required by NFPA and authority having jurisdiction (AHJ).
- B. Install NFPA 13 General Information Signs at each system control riser.
- C. Install NFPA 13 Hydraulic Design Information Signs at each system riser.
  1. Provide separate hydraulic design information signs for each design performance criteria.
- D. Install NFPA 14 Hydraulic Design Information Signs at system control valves.
- E. Install NFPA 14 Water Supply Pump Signs in the immediate vicinity of fire pumps or connected controllers.

END OF SECTION

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PIPING AND EQUIPMENT.DOC

## **SECTION 211300 - WATER BASED FIRE SUPPRESSION SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Piping applications
  - 2. Steel pipe and fittings
  - 3. Flexible connections
  - 4. Fire protection valves
  - 5. Trim and drain valves
  - 6. Specialty fire protection pipe fittings
  - 7. Alarm devices
  - 8. Pressure gauges
  - 9. Sprinkler applications
  - 10. Sprinklers
  - 11. Fire department inlet connections

#### **1.3 DEFINITIONS**

- A. Standard-Pressure System Piping: Water-based fire suppression system piping designed to operate at working pressure of 175 psig maximum.

#### **1.4 SYSTEM DESCRIPTIONS**

- A. Sprinkler System Types:
  - 1. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water that is connected to an automatic water supply. Each sprinkler opens when heat from fire melts the sprinkler fusible link or destroys the sprinkler frangible bulb. Water discharges immediately from open sprinklers.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content and chemical components.

C. Shop Drawings: For water-based fire suppression systems. Include plans, elevations, sections, details, and attachments to other work. Include all information required by the applicable NFPA water-based fire suppression standard(s) for “Working Plans”. Comply with Part 3 “Technician Design and Layout”.

1. Hydraulic Calculations: Perform calculations in accordance with applicable NFPA water-based fire suppression Design and Installation Standard(s) for “hydraulic calculations”.

D. Delegated Design Submittals – RESERVED.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and Delegated Design Professional.

B. Water Supply Evaluation Report: Include water supply flow test report and Delegated Design Professional evaluation report confirming adequacy of water supply and significant deviations from historical data or Contract Documents.

C. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA water-based fire suppression system Design and Installation Standards. Include "Contractor's Material and Test Certificate for Aboveground Piping" corresponding to each water-based fire suppression system.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Record Drawings: Complete Shop Drawing re-submittal updated to reflect actual final system installation.

B. Operation and Maintenance Data: For water-based fire suppression system specialties to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Personnel licensed by the governing licensing authority for the installation of water-based fire suppression systems. Successfully installed, tested, obtained approvals for, and put into service no less than three (3) water-based fire suppression systems similar in type, size, and complexity to that of the Work of this Section.

B. Certified Engineering Technician Qualifications:

1. Shop Drawings and Calculations prepared by personnel licensed as a Professional Fire Protection Engineer by the governing licensing authority or, where permitted by local authorities having jurisdiction, NICET certified as a Fire Protection, Water-Based Systems Layout Level III or IV Technician.

C. Delegated Design Professional Qualifications:

1. Shop Drawings and Calculations prepared by personnel licensed as a Professional Fire Protection Engineer by the governing licensing authority.

- D. Source Limitations: Obtain products for each product category from a single manufacturer.
- E. Product Standards: Listed in the "Fire Protection Equipment Directory" published by UL and the "Approval Guide" published by FM Global.
  - 1. Subject to compliance with requirements, indication of a UL product requirement within Part 2 shall be construed to be inclusive of a corresponding FM Global approved product, with or without UL listing.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

#### 1.9 COORDINATION

- A. Definition, "Coordinate": Where Sections of the Work interact, the Contractor responsible for this Section of the Work initiates verbal and/ or written communication with one or more different Contractors responsible for other interacting Sections of the Work for the purposes of establishing a coordinated approach of product selections and installation sequencing that satisfies the individual requirements of the interacting Sections of the Work as well as the requirements of the Work as a whole.
- B. Coordinate construction operations with those of other Sections of the Work and other entities to ensure efficient and orderly installation of each part of the Work.
- C. Coordinate operations and product selections of this Section with operations and product selections included in different Sections that depend on each other for proper installation, connection, and operation.
- D. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
- E. Coordinate installation of different components with other Sections of the Work to ensure maximum performance and accessibility for required maintenance, service, and repair.
- F. Make adequate provisions to accommodate items scheduled for later installation.
- G. Coordination Drawings: Contribute to preparation of Coordination Drawings in the sequence established under Division 1 and Division 20; indicate water-based fire suppression system Work coordinated with other Sections of the Work.

#### 1.10 MAINTENANCE MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for a minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.
  - 2. Custom-finish Sprinklers: Provide a minimum of six spare cover-plates or sprinklers for each custom finish in addition to spares required by NFPA 13.
- B. Furnish drain hose assembly for conducting sprinkler drain outlet discharge-to-grade away from building façade and adjacent hard-scape subject to staining; include:
  - 1. Brass hex nipple fitting: Furnish one fitting for each drain outlet fitting size used.

2. Brass swivel hose adapter fittings for connection to 2-1/2 inch hose coupling; furnish one adapter fitting for each hex nipple outlet size used.
3. Industrial double-jacket EPDM rubber-lined interior / exterior fire hose with hose-coupling ends; 2-1/2 inch , 75 ft .
4. Galvanized-steel, wall-mount, hose and coupling storage rack. Mount adjacent to main system riser.

#### 1.11 UNIT-COST ALLOWANCES

- A. Definition: Unit-cost allowance is a quantity of work established in lieu of additional requirements, used to defer the installation of materials and equipment to a later date when direction may be provided to Contractor by the Architect or Authorities Having Jurisdiction (AHJ) to provide labor and materials pursuant to final field coordination or AHJ final inspections.
- B. Unit-cost allowance shall include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- C. Include the following Unit-cost Allowances:
  1. Sprinkler concealed: Total quantity equal to twenty (20) installed.
  2. Sprinkler upright: Total quantity equal to twenty (20) installed.
  3. Sprinkler, dry pendant: Total quantity equal to five (5) installed.
- D. Unused Materials: After installation has been completed and accepted by authorities having jurisdiction return unused materials to manufacturer or supplier and credit Owner for materials and labor.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Design and Installation Standard(s):
  1. Sprinkler Systems: Comply with NFPA 13.
  2. FM Global: Comply with FM Global Datasheets for the design, installation, and testing of water-based fire suppression systems.
- B. Standard-Pressure Piping System Component: Listed for 175 psig minimum working pressure.
- C. Seismic Performance: Piping systems shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

#### 2.2 PIPING APPLICATIONS

- A. Comply with Part 3 "Piping Schedule" for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

#### 2.3 STEEL PIPE AND FITTINGS

- A. Schedule 40 Steel Pipe: ASTM A 53, A795 or A135; Schedule 40. Pipe ends may be factory or field formed to match joining method.

- B. Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795. Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
- C. Steel Pipe Nipples: ASTM A 733 steel pipe nipples; made of Schedule 40, ASTM A 53 seamless steel pipe with threaded ends.
- D. Steel Pipe Couplings: ASTM A 865 steel couplings; threaded.
- E. Threaded Fittings: ASME B16.4, cast-iron threaded fittings, Class 125 and Class 250.
- F. Malleable- or Ductile-Iron Unions: UL 860.
- G. Cast-Iron Flanges: ASME 16.1, Class 125 and Class 250.
- H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150 and Class 300.
- I. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
  - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
  - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
  - 3. Pipe-Flange Bolts and Nuts: ASME B18.2.1 carbon steel unless otherwise indicated.
- J. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
  - 1. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- K. Steel Welded Outlet Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. Victaulic Company.
    - c. Or approved equal.
  - 2. Pressure Rating: 175 psig minimum.
  - 3. Description: UL 213B; forged steel, Schedule 40 wall thickness, with threaded or grooved-end outlet.
- L. Grooved-Joint, Steel-Pipe Appurtenances:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. Tyco Fire & Building Products LP.
    - c. Victaulic Company.
    - d. Or approved equal.
  - 2. Pressure Rating: 175 psig minimum.
  - 3. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M malleable-iron casting or ASTM A 536 ductile-iron casting; with dimensions matching steel pipe.



4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
- M. Coatings for Steel Pipe and Fittings: Steel pipe, steel pipe nipples, steel pipe couplings, and threaded fittings factory hot-dipped galvanized.

## 2.4 FLEXIBLE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. AnvilStar, Division of Anvil International.
  2. Metraflex Company.
  3. Victaulic Company.
  4. Or approved equal.
- B. Standard: UL's "Fire Protection Equipment Directory" listing and/or "Approval Guide," published by FM Global, listing.
- C. Pressure Rating: 175 psig minimum.
- D. Design: Factory assembled flexible loop assembly of elbow fittings, steel pipe spool sections, and flexible steel corrugated pipe section with braided steel cover sheathing; capable of accommodating differential movement of spanned expansion joint minimum  $\pm 8$  inches movement.
- E. Size: Match pipe connections.
- F. End Connections: Flanged and/or Grooved.

## 2.5 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
  1. Isolation valves shall be indicating type and shall include integral or external valve position tamper switches as indicated.
  2. Valve -inlets and -outlets shall include plugged threaded taps for the installation of pressure gauges, alarm devices, drains, and similar trim.
  3. Iron valves shall include factory applied interior and exterior epoxy coating in compliance with ANSI/AWWA C550 and NSF-61.
- B. Iron Butterfly Valves:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. Tyco Fire & Building Products LP.
    - c. Victaulic Company.
    - d. Or approved equal.
  2. Standard: UL 1091.
  3. Minimum Pressure Rating: 250 psig.

4. Body Material: Cast or ductile iron.
5. Disc: Ductile iron, nickel plated.
6. Actuator: Worm gear or traveling nut with external indicator.
7. Supervisory Switch: Integral to valve actuator.
8. End Connections: Grooved.

## 2.6 TRIM AND DRAIN VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Conbraco Industries, Inc.; Apollo Valves.
  2. Fire-End & Croker Corp.
  3. Kennedy Valve; a division of McWane, Inc.
  4. Milwaukee Valve Company.
  5. NIBCO INC.
  6. Tyco Fire & Building Products LP.
  7. United Brass Works, Inc.
  8. Victaulic Company.
  9. Watts Water Technologies, Inc.
  10. Or approved equal.
- B. Standard: UL 258.
- C. Description: Brass or bronze body ball-, globe-, and angle-valves for fire protection trim and drain applications.
- D. Standard-Pressure Applications, Minimum Pressure Rating: 175 psig.

## 2.7 SPECIALTY FIRE-PROTECTION PIPE FITTINGS

- A. Flexible Sprinkler Connections:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. FlexHead Industries, Inc.
    - b. Victaulic Company.
    - c. Reliable Sprinkler.
    - d. Or approved equal.
  2. Standard: UL 1474.
  3. Description: Flexible hose for connection to sprinkler, with bracket for connection to ceiling grid, partition framing, or masonry construction. Connection shall be minimum NPS 1 corrugated stainless steel tubing with braided stainless-steel jacket. Assembly shall be UL-listed and FM approved.
  4. Minimum Pressure Rating: 175 psig.

**B. Flow Detection and Test Assemblies:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AGF Manufacturing Inc.
  - b. Reliable Automatic Sprinkler Co., Inc.
  - c. Tyco Fire & Building Products LP.
  - d. Victaulic Company.
  - e. Or approved equal.
2. Standard: UL's "Fire Protection Equipment Directory", Category VEOY.
3. Minimum Pressure Rating: 175 psig.
4. Description: Cast- or ductile-iron housing with connected flow switch, pressure gauge, and combination test-and-drain valve fitting; include integral pressure relief valve with discharge connected to assembly drain.
5. End Connections: Threaded and grooved.

**C. Test-and-Drain Fittings:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AGF Manufacturing Inc.
  - b. Reliable Automatic Sprinkler Co., Inc.
  - c. Tyco Fire & Building Products LP.
  - d. Victaulic Company.
  - e. Or approved equal.
2. Standard: UL's "Fire Protection Equipment Directory", Category VEHZ.
3. Minimum Pressure Rating: 175 psig.
4. Description: Brass body 3-position single-handle ball valve with sight glass, discharge test orifice, and integral pressure relief valve with discharge connected to outlet.
5. End Connections: Threaded and grooved.

**D. Inspector's Test Fittings:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AGF Manufacturing Inc.
  - b. Reliable Automatic Sprinkler Co., Inc.
  - c. Tyco Fire & Building Products LP.
  - d. Victaulic Company.
  - e. Or approved equal.
2. Standard: UL's "Fire Protection Equipment Directory", Category VEHZ.

3. Minimum Pressure Rating: 175 psig.
4. Description: Brass body single-handle ball valve with sight glass and discharge test orifice.
5. End Connections: Threaded.

E. Automatic Air Release Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AGF Manufacturing Inc.
  - b. Potter Electric Signal Co., LLC.
  - c. Or approved equal .
2. Standard: UL 2573.
3. Minimum Pressure Rating: 175 psig.
4. Description: Brass body automatic air release vent with strainer.
5. End Connections: Threaded.

2.8 ALARM DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Potter Electric Signal Co., LLC.
  2. System Sensor; a Honeywell Company.
- B. Or approved equal. General: NEMA enclosure suitable for application, metal cover, 250-psi rated, two sets of SPDT (form C) contacts.
  1. Explosion-Proof Applications: Listed and labeled for use in “Hazardous (Classified) Locations”; Class and Division listing appropriate to intended location and application.
- C. Flow Switches: UL 346, paddle type with field adjustable 0-90 second delay adjustment.
- D. Pressure Switches: UL 753, field adjustable for operation upon pressure increase or pressure decrease.
- E. Tamper Switches: UL 753, mounting brackets suitable for valve type, with normally closed contacts for supervision of valve stem position.

2.9 PRESSURE GAUGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. AMETEK; U.S. Gauge Division.
  2. Ashcroft, Inc.
  3. Brecco Corporation.
  4. WIKA Instrument Corporation.
  5. Or approved equal.

- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gage Range: 0 to 250 psig.
- E. Water System Piping Gauge: Include "WATER" or "AIR/WATER" label on dial face.
- F. Air System Piping Gauge: Include "AIR" or "AIR/WATER" label on dial face.

## 2.10 SPRINKLER APPLICATIONS

- A. Comply with Part 3 "Sprinkler Schedule" for applications of sprinklers for specific services and service locations.

## 2.11 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Reliable Automatic Sprinkler Co., Inc.
  - 2. Tyco Fire & Building Products LP.
  - 3. Victaulic Company.
  - 4. Viking Corporation.
  - 5. Or approved equal.
- B. General: Brass body automatic sprinklers for fire-protection service; when applicable, listed for use in NFPA 13 Light or Ordinary Hazard occupancies as required by application; minimum K-factor of 5.6.
  - 1. Corrosion Resistant Sprinklers: Stainless steel body, or ENT-plating, or polyester coating; listed as corrosion resistant.
- C. Minimum Pressure Rating: 175 psig.
- D. Minimum Pressure Rating for High-Pressure Applications: 250 psig.
- E. Temperature Ratings:
  - 1. Ordinary: 135 deg F to 170 deg F .
  - 2. Intermediate: 175 deg F to 225 deg F .
  - 3. High: 250 deg F to 300 deg F .
- F. Standard Spray-Pattern Sprinklers:
  - 1. Standard: UL 199.
  - 2. Frame Styles: Upright, pendent, horizontal-sidewall, vertical-sidewall, concealed pendent, and concealed horizontal-sidewall.
  - 3. K-factors: 5.6, 8.0.
  - 4. Response Characteristics: Quick response (QR), unless standard response (SR) is indicated or otherwise required by application.
  - 5. Concealed Sprinkler Cover-plates: Flat, non-perforated; for ceiling- and wall-mount.
    - a. Finishes: Polished chrome-plated, painted, and special application.

- b. Concealed sprinklers shall be provided in locker rooms to prevent corrosion of sprinkler.
      - c. Seismic Applications: Oversized to conceal sprinkler ceiling penetration including required 1 inch annular clearance around penetrating sprinkler assembly.
    - 6. Sprinkler Finishes: Brass, polished chrome-plated, and painted.
    - 7. Escutcheons: Single-piece steel; flush and recessed for ceiling- and wall-mount.
      - a. Finishes: Polished chrome-plated and painted.
  - G. Dry-type Sprinklers:
    - 1. Standard: UL 199; standard and extended coverage spray-pattern.
    - 2. Description: Factory-assembled dry-pipe barrel and sprinkler with threaded connection to wet-pipe sprinkle piping.
    - 3. Frame Styles: Upright, pendant, horizontal-sidewall, and concealed pendent.
    - 4. K-factors: 5.6.
    - 5. Response Characteristics: Quick response (QR), unless standard response (SR) is indicated or otherwise required by application.
    - 6. Concealed Sprinkler Cover-plates: Flat, non-perforated; for ceiling- and wall-mount.
      - a. Finishes: Polished chrome-plated, painted, and special application.
    - 7. Sprinkler Finishes: Brass, polished chrome-plated, and painted.
    - 8. Escutcheons: Single-piece steel; flush and recessed for ceiling- and wall-mount.
      - a. Finishes: Polished chrome-plated and painted.
  - H. Sprinkler Guards:
    - 1. Standard: Listed for use with attached sprinkler.
    - 2. Type: Single-piece, wire cage with fastening device for attachment to sprinkler.
- 2.12 FIRE-DEPARTMENT INLET CONNECTIONS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1. American Fire Hose & Cabinet.
    - 2. Elkhart Brass Mfg. Company, Inc.
    - 3. Fire-End & Croker Corp.
    - 4. Guardian Fire Equipment, Inc.
    - 5. Potter Roemer Fire Pro.
    - 6. Or approved equal.
  - B. Standard: UL 405.
  - C. Minimum Pressure Rating: 175 psig.
  - D. Body Material: Cast brass.
  - E. Connection Style: Horizontal NHS, flush wall-mount.

- F. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- G. Caps: Brass, lugged type, with gasket and chain.
- H. Escutcheon: Brass; with brass pipe sleeve for free-standing applications.
- I. Escutcheon Marking: Similar to "AUTO SPKR" as approved by authority having jurisdiction.
- J. Exposed Parts Finish: Polished chrome-plated.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Schedule and conduct water supply flow tests promptly to establish available water supply flow and pressure characteristics.
- B. Schedule and sequence water supply flow tests and Shop Drawing preparation such that the flow test date is no more than twelve (12) months prior to the Shop Drawing submittal date.
- C. Tests shall be conducted during time of seasonal and daily peak demand based upon review with local water authority.
  - 1. Where testing during time of peak demand is not permitted or feasible, obtain historical data regarding seasonal and daily system pressure variations from local water authority.

#### **3.2 WATER SUPPLY HYDRANT FLOW TESTS**

- A. Perform water supply evaluation testing in accordance with NFPA 291 "Recommended Practice for Fire Flow Testing and Marking of Hydrants" for hydrant flow tests.
- B. Comply with Division 21 for hydrant flow tests.

#### **3.3 TECHNICIAN DESIGN AND LAYOUT**

- A. General:
  - 1. Roles and responsibilities shall be as set forth in NSPE Position Statement No. 1749 "SFPE/NSPE/NICET Joint Position of the Engineer and the Engineering Technician Designing the Fire Protection System", available at nspe.org. As applied to the Work, the Contract Documents have been prepared by the "Engineer" and Shop Drawings required by this Section of the Work are prepared by the "Certified Engineering Technician".
  - 2. As the Certified Engineering Technician, prepare Shop Drawings indicating system layout and sizing in accordance with the requirements of the Contract Documents, including but not limited to:
    - a. Evaluation of water supply adequacy.
    - b. Detailed sizing and layout of piping and appurtenances including feed-mains, risers, cross mains, branch lines, valves, drainage provisions, hangers, restraints, supports, and similar.
    - c. Detailed sprinkler layouts.

- d. Hydraulic calculations.
  - e. Installation details for the specific equipment being furnished.
- B. Design and Installation Standard(s): Comply with Part 2 Article "Performance Requirements".
  - 1. Comply with the performance requirements indicated by the Contract Documents where such requirements are more stringent than those of the Design and Installation Standard(s); otherwise, comply with the performance requirements of the Design and Installation Standard(s).
- C. Water Supply Evaluation:
  - 1. Evaluate water supply flow test data obtained as part of the Work of this Section against historical data obtained from the water authority and, where included, water supply flow test data indicated by the Contract Documents.
  - 2. Promptly report in writing significant deviations between water supply test results obtained as part of the Work of this Section and those indicated by the Contract Documents or historical data, and anticipated system design impacts.
  - 3. Complete the evaluation of water supply flow test data prior to preparing Shop Drawings and associated hydraulic calculations.
- D. Design and layout fire suppression piping to satisfy performance requirements:
  - 1. Rectilinear fire suppression piping arrangement with respect to building partitions and structural elements.
  - 2. Concealed fire suppression piping installation throughout finished spaces and maximum headroom beneath exposed fire suppression piping in areas exposed to structure above.
  - 3. No fire suppression piping within electrical, information technology, or similar spaces other than branch piping serving sprinklers protecting such electrical, information technology, or similar space spaces.
  - 4. No fire suppression piping directly above electrical equipment, electrical panels, information technology equipment, or similar energized equipment.
  - 5. No fire suppression piping within exit enclosures except standpipes supplying hose valves within the exit enclosure, sprinkler zone control assemblies and piping immediately downstream, branch piping supplying sprinklers within the exit enclosure, and associated drain connections and risers.
  - 6. No fire suppression piping within or in proximity to hazardous materials storage or processing operations other than branch piping serving sprinklers protecting such hazardous materials storage or processing operations.
  - 7. Fire suppression piping supported from primary building structural elements or approved supplemental supports capable of supporting the attached load.
  - 8. Fire suppression piping crossing building expansion joints provided with expansion fittings appropriate to the joint design deflection value.
  - 9. Fire suppression feed-main, standpipe, and system riser piping supplied by fire pumps rigidly restrained against movement resulting from pump-induced system pressure increases and water velocity induced forces.
  - 10. Fire suppression piping protected against damage where subject to earthquakes.



11. Fire suppression piping protected against damage where subject to freezing without the use of heat-trace cables unless indicated otherwise.
  12. Fire suppression piping arranged such that piping drains back to main drains and drain risers without the use of auxiliary drains.
  13. Fire suppression drain risers, system riser main-drain piping and other equipment drains discharge at a safe location outside the building or at an approved, adequately sized interior drain receptacle if outside discharge is not feasible.
- E. Design and layout sprinklers to satisfy performance requirements:
1. Sprinklers located to provide automatic sprinkler protection throughout as required by the Contract Documents and the requirements of the Design and Installation Standards.
    - a. Comply with graphic sprinkler layouts and narrative layout parameters indicated by the Contract Documents. Where sprinkler layouts or layout parameters are not indicated by the Contract Documents, comply with Design and Installation Standard(s).
  2. Sprinklers located according to the per-sprinkler protection area limitations corresponding to the protected occupancy hazard and construction type.
  3. Sprinklers within finished-spaces flush or recessed mount as indicated; located in the center of suspended ceiling tiles, along the centerline of ceiling features, and in-line with adjacent ceiling fixtures.
  4. Sprinklers located with respect to structural members and construction type and beam pocket arrangement within spaces exposed to structure above.
  5. Sprinklers located with respect to obstructions to sprinkler discharge; considering all obstructions such as ductwork, piping, lighting, cable trays, floating ornamental ceilings, and similar.
    - a. Sprinkler protection provided above and below such obstructions where protection cannot be provided in accordance with the Design and Installation Standards via sprinklers located solely above or below obstructions.
  6. Sprinklers located within construction voids or enclosed spaces that do not meet the NFPA 13 definition of concealed spaces due to openings or similar features.
  7. Sprinklers located within combustible concealed spaces including attics, ceiling voids, and similar.
  8. Sprinkler locations at water curtains coordinated with corresponding draft stops or protected glazing assemblies.
  9. Specific-application sprinklers located in accordance with corresponding sprinkler listing requirements and restrictions.
- F. Hydraulically design water-based fire suppression system piping using the Hazen-Williams or Darcy-Weisbach formulas in accordance with the Design and Installation Standard(s).
1. Sprinkler System Occupancy Hazard and Discharge Criteria: Comply with criteria indicated by Drawings as approved by authorities having jurisdiction.
    - a. Calculation areas shall not be reduced for quick response sprinkler applications.
  2. Standpipe System Flow and Pressure Criteria: Comply with criteria indicated by Drawings as approved by authorities having jurisdiction.

3. Margin of Safety Between Available and Required Pressure at Design Flowrate: 10 psi minimum, including losses through water-service piping, valves, and backflow preventers.
4. Include pressure losses associated with specialty fittings and assemblies such as seismic separation assemblies and flexible sprinkler connections.

**G. Hydraulic Calculations for Sprinkler Piping:**

1. Sprinkler mains including zone control and riser valve assemblies shall be no smaller than as indicated by the Drawings.
  - a. Hydraulically determine pipe sizes for sprinkler branch piping.
2. Sprinkler zone control and riser valve assemblies shall be no smaller than as indicated by the Drawings.
  - a. Hydraulically determine pipe sizes for sprinkler piping downstream of zone control assemblies.
3. Where sprinkler systems are supplied by two (2) risers, pipe sizing shall be based upon supply from the hydraulically most remote riser only.
4. Include additional hydraulic calculations as required when the hydraulically most remote area is not clear (not the geometrically most remote).
5. Include a minimum of three (3) calculation areas for gridded systems demonstrating that the hydraulically most demanding area is identified.
6. Do not utilize NFPA 13 area reduction for quick response sprinklers unless otherwise indicated.

**H. Flexible Sprinkler Connections:**

1. Hydraulic Calculations: Include pressure losses through flexible sprinkler connections. Indicate installation parameters for maximum hose length, maximum bend radius, maximum quantity of bends, and fitting patterns associated with the calculated pressure loss.
2. Shop Drawings: Include locations of flexible sprinkler connections with limiting installation parameters as determined via hydraulic calculations clearly indicated.

**3.4 ON-SITE AS-BUILT DRAWINGS**

- A. As work progresses and for the duration of the construction operations, maintain complete and separate set of prints of Shop Drawings (Working Plans) at project site at all times. Record work completed and all deviations from reviewed Shop Drawings (Working Plans) clearly and accurately. Include actual locations of existing utilities if they differ from design documents. Record valve tag designations as installed.

**3.5 EXAMINATION**

- A. Examine sleeved penetrations through concrete and structural penetrations through steel and verify that they are suitable for intended piping installation.
- B. Examine walls and partitions and verify that they are suitable for installation of piping, cabinets, inlet connections and similar products.

- C. Examine areas to contain standpipe hose outlets including stairwells and vestibules and verify that door swings or other obstructions will not interfere with the installation or future operation of hose valves.
- D. Report conflicts with proposed solutions. Proceed with installation after conflicts have been resolved.

### 3.6 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated.
  - 1. Deviations from approved Shop Drawings require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of piping in NFPA 13 and NFPA 14.
- C. Install hangers and supports: Comply with Division 21 for common work results for fire suppression.
- D. Install seismic restraints and flexible couplings. Comply with Division 21 for seismic controls for fire suppression piping and equipment.
- E. Install provisions to accommodate building expansion joints. Provide for expansion at building expansion joints with assemblies listed for that purpose. Coordinate the maximum value of building deflection with the appropriate Structural Section of the Work.
- F. Install sleeves, sleeve-seals, fire-stopping, and pipe escutcheons. Comply with Division 21 for common work results for fire suppression.
- G. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
  - 1. Hole-Cut Fittings: Where used, use two-piece cast type fittings only; fittings utilizing straps, U-bolts, or similar are not permitted.
- H. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- I. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- J. Install water-based fire suppression piping with drains for complete system drainage.
- K. Install water-based fire suppression piping such that piping drains back to main drains and drain risers without the use of auxiliary drains.
- L. Pipe drain risers, system riser main drain piping and other equipment drains to discharge at a safe location outside the building or at an approved interior drain receptacle if outside discharge is not feasible.
- M. Use threaded-end galvanized-iron 45-degree elbow with galvanized-iron wall plate for exterior drain outlet terminations at building exterior. Threads shall match drain hose adapter and coupling required under Part 1 Article "Extra Materials".
- N. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

- O. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- P. Install alarm devices in piping systems.
- Q. Install automatic air release vents.
- R. Install pressure gages at locations indicated and as required by the Design and Installation Standards. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they will not be subject to freezing.
- S. With air release vents in service, fill water-based fire suppression system piping with water.

### 3.7 JOINT CONSTRUCTION

- A. Comply with Division 21 for common work results for fire suppression.

### 3.8 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to the Design and Installation Standards and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install valves in locations that are readily accessible. Install system control valves in areas that allow for safe fire department access during emergency conditions.
- D. Install indicating valves such that indicator is clearly visible from the floor level below.
- E. Pipe pressure relief valve- and air release fitting-discharge to sprinkler drain risers.
- F. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- G. Install alarm valves in vertical position unless otherwise indicated.
- H. Install alarm valve trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
- I. Install dry-pipe and deluge valves with trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
  - 1. Install air-pressure maintenance device(s) with shutoff valves to permit servicing without shutting down system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175 psig maximum inlet pressure.

### 3.9 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels with no visible deviation.
- B. Do not install pendant or sidewall, wet-type sprinklers in areas subject to freezing. Install dry-type sprinklers with water supply from heated space.

- C. Where pendent sprinklers are indicated for dry-pipe or preaction sprinkler systems, use dry-type sprinklers.
- D. Piping used for sprinkler connection return-bends, drop-nipples, and riser-springs shall be no smaller than NPS 1.
- E. Supply pendent sprinklers using a return-bend piping arrangement with connection at the top of the branch pipe to prevent the accumulation of piping corrosion, scale, and sediment at the sprinkler.
- F. Install sprinklers such that cover plate or escutcheon is flush and uniform with respect to penetrated ceiling or wall finish and complies with manufacturer installation requirements. Correct sprinklers that are not flush by adjusting them in accordance with the manufacturer's instructions and/or re-installing sprinklers.
  - 1. Adjustable sprinkler drop nipples are not permitted.
- G. Install sprinklers in accordance with the requirements of NFPA 13 regarding obstructions to sprinkler discharge. Consider all obstructions such as structural elements, ductwork, piping, lighting, cable trays, and floating ornamental ceilings. Adjust sprinkler locations and/or add sprinklers as a Unit-Cost Allowance where installations are not coordinated, and obstructions cannot be relocated to accommodate sprinklers as installed.
  - 1. Coordinate the installation of solid barriers beneath "non flat", "non-solid", or "non continuous" obstructions required by FM Global with the Construction Manager.
- H. Provide and install guards on sprinklers susceptible to mechanical damage. At a minimum provide guards for pendent and upright sprinklers located in the following locations: electrical rooms and closets, near adjacent to ceiling mounted equipment requiring maintenance, beneath obstructions such as ductwork or catwalks, walk-in freezers or cold rooms, and beneath stair landings.
- I. Where not provided under other Sections of the Work, provide and install non-combustible baffles between sprinklers less than 6 feet apart to prevent cold-soldering.

### 3.10 INSTALLATION OF FLEXIBLE SPRINKLER CONNECTIONS

- A. Install flexible sprinkler connections in accordance with manufacturer's recommendations.
- B. Install each flexible sprinkler connection according to the criteria and limitations established by the submitted Product Data, Shop Drawings and Hydraulic Calculations with respect to quantity and type of fitting connections, maximum hose length, maximum quantity of bends, and minimum bend radius.
- C. Branch connections shall be made a minimum 45 degrees from horizontal. Where connections from the side or bottom of branch are required due to coordination, locations shall be clearly indicated on shop drawings and approved by the Engineer.

### 3.11 FIRE HOSE VALVE INSTALLATION

- A. Install fire hose valves in readily accessible locations and with sufficient operational clearances for connection of fire hose and operation of valve handwheel.
  - 1. Do not locate fire hose valves that require the operator to stand within a door-swing path or similar obstruction or hazard.
  - 2. Install exposed fire hose valves orientated to minimize projection into adjacent walking surfaces.

- B. Install fire hose valves in cabinets where indicated. Include pipe escutcheons with finish matching valves and firestopping if required.
  - 1. Coordinate with Division 10 requirements for "Fire Protection Cabinets".
- C. Install NPS 2-1/2 fire hose valves with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter.

### 3.12 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install fire department connections in readily accessible with sufficient operational clearances for connection of fire hoses.
- B. Install fire department inlet connections such that they are readily visible from the roadway or accessway designated for fire department pumper apparatus access.
- C. Coordinate locations of fire department inlet locations with locations of Division 28 exterior waterflow alarm bells such that bells are adjacent to connections.
- D. Install automatic (ball drip) drain valve at each check valve for fire department inlet connection, to drain piping between fire department inlet connection and check valve. Install drain piping to spill over floor drain or to outside building; drain piping to stone dry-well for free-standing connection applications.

### 3.13 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to Division 21 for identification for fire suppression piping and equipment.

### 3.14 FIELD QUALITY CONTROL

- A. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
- B. Flush, test, and inspect standpipe hose valve systems according to NFPA 14, "Systems Acceptance" Chapter.
- C. Hydrostatically test system piping in accordance with the applicable NFPA water-based fire suppression system design and installation standards. Repair leaks and retest until no leaks exist.
- D. Inspect system components in accordance with the applicable NFPA water-based fire suppression system Design and Installation Standards. Adjust settings or replace damaged or malfunctioning components and retest until proper operation is achieved.
- E. Inspect and adjust alarm and delay settings of alarm devices.
- F. Inspect and adjust alarm valve trim settings.
- G. Inspect and adjust air / nitrogen supply and delivery system settings.
- H. Inspect and adjust pressure relief valves such that no water is discharged under normal system working conditions.
  - 1. Adjust standpipe fire hose valves in accordance with the minimum and maximum pressure requirements indicated in NFPA 14.
  - 2. Adjust sprinkler system regulating devices in accordance with the maximum pressure requirements of NFPA 13 and the minimum pressure requirements as indicated by hydraulic calculations.

- I. Verify that equipment hose threads are same as local fire-department equipment.
- J. Functionally test water-based fire suppression systems, including required full-flow tests, in accordance with the applicable NFPA water-based fire suppression system Design and Installation Standards. Combine tests to conserve water. Correct deficiencies and retest satisfactory results are achieved.
- K. Conduct backflow preventer forward-flow tests.
- L. Conduct main-drain tests.
- M. Conduct standpipe flow tests; automatic and manual operation.
- N. Conduct pressure-regulating valve flow tests.
- O. Coordinate with fire-pump tests. Operate as required.
- P. Coordinate with fire-alarm tests. Operate as required.
- Q. Water-based fire suppression system will be considered defective if it does not pass tests and inspections.
- R. Prepare test and inspection reports. Use NFPA "Contractor's Material and Test Certificate" format.

### 3.15 CLEANING

- A. Clean dirt and debris from system components including backflow preventers, listed fire protection valves, trim and drain valves, specialty fittings, alarm devices, pressure gauges, air compressors, and nitrogen generators.
- B. Clean dirt and debris from hose valves and specialties.
- C. Clean dirt and debris from sprinklers. Remove and replace sprinklers with paint other than factory finish or similar.
- D. Clean dirt and debris from fire department inlet and outlet connections.

### 3.16 DEMONSTRATION

- A. Train Owner's maintenance personal to adjust, operate, and maintain water-based fire suppression systems; including the following:
  - 1. NFPA 25 inspection, testing, and maintenance activities and frequencies.
  - 2. Location and function of system isolation valves.
  - 3. Location and function of system drain valves and test valves.
  - 4. Location of drain discharge outlets and procedure for connection of exterior drain hose.
  - 5. Location and contents of spare sprinkler cabinet and procedure for emergency replacement of sprinkler.
  - 6. Procedure for conducting backflow preventer forward-flow tests.
  - 7. Procedure for conducting main-drain flow tests.
  - 8. Procedure for conducting sprinkler waterflow alarm tests.
  - 9. Procedure for conducting fire hose valve standpipe flow tests.
  - 10. Procedure for conducting pressure-regulating valve flow tests.

- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the following:
  - 1. Wet-pipe, dry-pipe, and deluge alarm valves.

### 3.17 PIPING SCHEDULE

- A. Standard-pressure wet-pipe water-based fire suppression shall comply with the following:
  - 1. Applications:
    - a. Wet pipe sprinkler and standpipe.
  - 2. Pipe and Fittings (shall be one of the following):
    - a. Schedule 40 steel pipe with threaded ends; uncoated threaded fittings; and threaded joints.
    - b. Schedule 40 steel pipe with cut-grooved ends; grooved-end fittings; grooved-end pipe couplings; and grooved joints.
    - c. Permitted for NPS 2-1/2 and larger: Schedule 10 steel pipe with roll-grooved ends; grooved-end fittings; grooved-end pipe couplings; and grooved joints.

### 3.18 SPRINKLER SCHEDULE

- A. Unless otherwise indicated or required by application, sprinkler pressure rating shall be 175 psig.
  - 1. Minimum Pressure Rating for High-Pressure Applications: 250 psig.
- B. Unless otherwise indicated or required by application, sprinkler K-factor and thermal sensitivity shall comply with the following:
  - 1. Light Hazard: Quick response, minimum 5.6 K-factor.
  - 2. Ordinary Hazard: Quick response, minimum 8.0 K-factor.
- C. Unless otherwise indicated or required by application, sprinklers shall be NFPA 13 Ordinary temperature classification.
  - 1. Sprinklers shall be higher temperature classification in accordance with NFPA 13 for maximum ambient ceiling temperatures greater than 100 deg F
  - 2. Sprinklers shall be High temperature classification for Extra Hazard or high pile / rack storage occupancies where corresponding NFPA 13 high temperature sprinkler design criteria is utilized for hydraulic calculations.
- D. Finish indications shall apply uniformly to sprinkler assembly components exposed to view including frame, escutcheon, and cover plate.
- E. Corrosion Resistant Sprinklers: Sprinklers for the following applications shall be corrosion resistant:
  - 1. Pool.
  - 2. Pool equipment / mechanical rooms
- F. Sprinklers for Ceiling Applications shall be: Standard-spray concealed-pendent; chrome-plated finish.
- G. Sprinklers for Ceiling Exposed Applications shall be: Standard-spray, upright; bronze finish.



- H. Sprinklers for Dry-type Sprinkler Applications shall be: Standard-spray, concealed-dry-pendent and sidewall; chrome-plated finish.

END OF SECTION

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## SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
  - 1. For example, prior to requesting an occupancy permit, the MEP documentation listed in Part 3 of Division 20 (in paragraph "MEP and Fire Protection Completion Requirements", subparagraph "Occupancy Permit" must be submitted and approved so the Engineer can certify that the MEP systems and life safety provisions are completed.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Manufacturers.
  - 2. Pipe Tube and Fittings
  - 3. Joining Materials
  - 4. Transition fittings.
  - 5. Dielectric fittings.
  - 6. Mechanical sleeve seals.
  - 7. Sleeves.
  - 8. Escutcheons.
  - 9. Grout.
  - 10. Containment room sealing requirements.

#### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

#### 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Transition fittings.
  - 2. Dielectric fittings.
  - 3. Mechanical sleeve seals.
  - 4. Escutcheons.
- B. Welding certificates.

#### 1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

#### 1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Division 22; specified products found throughout Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
    - a. This is largely intended for use when commodity products are specified, similar to pipe, fittings, valves, sundries, escutcheons, gaskets, flanges, et al.
    - b. This spec allows substitutions, as long as they meet the requirements outlined for the product and comply with the standards.
    - c. There may also be included an actual model number and manufacturer shown to establish comparable quality level for the product.
  - 2. Manufacturers where Basis-of-Design Product is displayed: Subject to compliance with requirements, provide the product indicated on Drawings and specs, or a comparable product by one of the following:
    - a. This restricts products be furnished based on the list of manufacturers stated, a manufacturer's model number and product will be specified to establish a level or product quality and grade desired

### **2.2 PIPE, TUBE, AND FITTINGS**

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### **2.3 JOINING MATERIALS**

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
  - 2. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
  - 3. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 4. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
  - G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
  - H. Solvent Cements for Joining Plastic Piping:
    - 1. ABS Piping: ASTM D 2235.
    - 2. CPVC Piping: ASTM F 493.
    - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
    - 4. PVC to ABS Piping Transition: ASTM D 3138.
  - I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.
- 2.4 TRANSITION FITTINGS
- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
    - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work provide products by one of the following, or approved equal.
      - a. Cascade Waterworks Mfg. Co.
      - b. Dresser Industries, Inc.; DMD Div.
      - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
      - d. JCM Industries.
      - e. Smith-Blair, Inc.
      - f. Viking Johnson.
      - g. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
      - h. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
      - i. Aboveground Pressure Piping: Pipe fitting.
      - j. Or Approved Equal.
  - B. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
    - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work provide products by one of the following, or approved equal.
      - a. Cascade Waterworks Mfg. Co.
      - b. Fernco, Inc.
      - c. Mission Rubber Company.
      - d. Plastic Oddities, Inc.

- e. Or Approved Equal.

## 2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work provide products by one of the following, or approved equal.
    - a. Eclipse, Inc.
    - b. Epco Sales, Inc.
    - c. Hart Industries, International, Inc.
    - d. Watts Industries, Inc.; Water Products Div.
    - e. Zurn Industries, Inc.; Wilkins Div.
    - f. Or Approved Equal.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work provide products by one of the following, or approved equal.
    - a. Capitol Manufacturing Co.
    - b. Central Plastics Company.
    - c. Epco Sales, Inc.
    - d. Watts Industries, Inc.; Water Products Div.
    - e. Or Approved Equal.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work provide products by one of the following, or approved equal.
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Central Plastics Company.
    - d. Pipeline Seal and Insulator, Inc.
    - e. Or Approved Equal.

- f. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
  - F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
    - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work provide products by one of the following, or approved equal.
      - a. Calpico, Inc.
      - b. Lochinvar Corp.
  - G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
    - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work provide products by one of the following, or approved equal.
      - a. Perfection Corp.
      - b. Precision Plumbing Products, Inc.
      - c. Sioux Chief Manufacturing Co., Inc.
      - d. Victaulic Co. of America.
      - e. Or Approved Equal.
- 2.6 MECHANICAL SLEEVE SEALS
  - A. Refer to Division 22.
- 2.7 SLEEVES
  - A. Refer to Division 22.
- 2.8 ESCUTCHEONS
  - A. Refer to Division 22.
- 2.9 GROUT
  - A. Refer to Division 22.
- 2.10 CONTAINMENT ROOM SEALING REQUIREMENTS
  - A. Description: Field applied joint sealant conforming to ASTM C920 "Specifications for Elastomeric Joint Sealants".
    - 1. Manufacturers:
      - a. Dow Chemical, 732-RTV silicone rubber
      - b. GE
  - B. Sealant shall be mildew resistant and shall be specifically design for exposure to a high degree of moisture. Sealant shall be compatible with and adhere to substrate and materials that are in

direct contact with the sealant. Sealant shall maintain seal under normal expected movements of substrates.

- C. Color shall be clear or white.

### **PART 3 - EXECUTION**

#### **3.1 PLUMBING DEMOLITION**

- A. Refer to Division 01 and Division 02 for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
  - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
  - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

#### **3.2 PIPING SYSTEMS - COMMON REQUIREMENTS**

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.



- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through penetrations in floors, partitions, roofs, and walls.
- N. Verify final equipment locations for roughing-in.
- O. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### 3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. PVC Non-pressure Piping: Join according to ASTM D 2855.
  - 3. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.
- K. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- L. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### 3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
  1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

### 3.6 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

### 3.7 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 5000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03.

### 3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

### 3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

### 3.10 CONTAINMENT ROOM SEALING REQUIREMENTS INSTALLATION

#### A. General

1. Work that penetrates or is mounted on ceilings, walls, floors or other surfaces throughout containment rooms shall be sealed as outlined below in addition to sealing specified elsewhere in the Specifications. Sealing shall include, but not be limited to, the following:
  - a. All penetrations where faucets, valves and equipment stop valves are mounted on walls.
  - b. Equipment penetrations.
  - c. Emergency eyewash/shower equipment
  - d. All floor penetrations including floor drains and/or cleanouts
  - e. Piping and tubing (including control tubing).
  - f. Access doors.
  - g. Conduits.
2. Completely seal the perimeter joints around insulated and uninsulated penetrations and surface-mounted items.

#### B. Installation

1. Preparation, priming, application, curing and protection of the sealant shall be in conformance with the recommendations of the sealant manufacturer.
2. If necessary, fill voids with backer rods as recommended by the sealant manufacturer.

3. Mask edges of exposed joints if required to make neat joints and prevent excessive misplacement of sealant onto exposed surfaces adjacent to joints.
4. Clean surfaces so that no foreign matter of loose particles or dust detrimental to adhesion are present.
5. Perform sealant work after adjacent painting work is complete and dry.
6. Sealant shall be free of voids, be applied in one continuous bead and be tooled concave and smooth.
7. Strip off protective masking tape after sealant has been applied, strip toward the joints.
8. Protect sealant from damage during and after curing period. If damage occurs, repair.
9. Clean off excess sealant or sealant smears adjacent to joints by methods and with cleaning materials approved by the manufacturers of the sealant.

3.11 GROUTING

- A. Refer to Division 22.

END OF SECTION

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## SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes:
  - 1. General motor requirements.
  - 2. Motor characteristics.
  - 3. Polyphase motors.
  - 4. Motors served by variable frequency controllers.
  - 5. Polyphase motors with additional requirements.
  - 6. Single phase motors.
  - 7. Motor starters.

#### 1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

### PART 2 - PRODUCTS

#### 2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

## 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

## 2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F for motors with variable speed controllers. Class B for ODP motors of nominal efficiency
- J. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

## 2.4 MOTORS SERVED BY VARIABLE FREQUENCY CONTROLLERS

- A. Motors served by variable frequency controllers (VFC) (also known as variable frequency drives (VFDs)) shall be "inverter-duty" or "drive duty" motors. Motors shall meet or exceed all requirements of NEMA MG-1 Parts 30 and 31 for AC induction motors powered from adjustable speed controls. Use of the motor with a VFD shall not adversely affect the operation, useful life, or warranty of the motor.
- B. Motors shall have Class H insulation.
- C. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters. Motor windings shall be spike resistant to withstand a minimum of 1,600 peak volts.
- D. Motors shall have shaft grounding system to protect bearings from induced voltage. Shaft grounding system shall have very low drag, less than 1/2 percent of motor HP, and shall operate

for a minimum of three (3) years without periodic adjustments. All consumables of the shaft grounding system shall be replaceable without a shutdown of the motor or VFD. The shaft grounding system shall be as manufactured by AEGIS or equal.

- E. Motors used with VFD shall have a minimum three (3) year warranty

## **2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS**

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
  - 1. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- B. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

## **2.6 SINGLE-PHASE MOTORS**

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
  - 1. Permanent-split capacitor.
  - 2. Split phase.
  - 3. Capacitor start, inductor run.
  - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Pre-lubricated, anti-friction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

## **2.7 MOTOR STARTERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work by one of the following, or approved equal.
  - 1. Eaton Electrical (Cutler Hammer).
  - 2. General Electric Company.
  - 3. Siemens Energy and Automation.
  - 4. Or Approved Equal.
- B. Provide starters for motors without variable frequency drives.
- C. Provide magnetic starter with HAND-OFF-AUTO switch (fast-slow-off-auto for two speed motors) in cover for starters that require interlocks or remote control. Provide magnetic starters, with auxiliary contacts, buttons, and switches.

- D. Each three phase, 60 Hz motor shall be provided with magnetic starter with hand -off-automatic switch.
- E. Other motors shall be provided with a manual starter with on-off switch.
- F. Control relay for each starter shall be for operation on 120V, 1 phase. Provide Transformer of sufficient capacity within starter case.
- G. Provide inverse time limit overload and under voltage protection in each leg and with pilot lights. Provide red and green on/off pilot lights
- H. Provide nameplates with engraved white lettering to designate area and equipment served.
- I. Furnish for all single speed motors, 25 hp and above, 95 percent power factor correction capacitors. Capacitors shall be in NEMA enclosure of the same rating as the motor's starter.

**PART 3 - EXECUTION (NOT APPLICABLE)**

**END OF SECTION**

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## SECTION 220514 - COMMON CONTROL PANEL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes:
  - 1. General control panel requirements.
  - 2. Programmable Logic Controllers
  - 3. General Control Panels (not PLC)

#### 1.3 DEFINITIONS

- A.  $I_n$ : Nominal Discharge Current.
- B. IP Ingress Protection
- C. MCOV: Maximum Continuous Operating Voltage.
- D. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- E. MOV: Metal Oxide Varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- F. NEMA National Electrical Manufacturers Association
- G. OCPD: Overcurrent Protective Device.
- H. SCCR: Short Circuit Current Rating.
- I. SPD: Surge Protective Device.
- J. VPR: Voltage Protection Rating.

#### 1.4 COORDINATION

- A. Short-circuit current rating (SCCR) is the amount of available fault current that an electrical component or equipment can safely withstand, when properly applied.
- B. SCCRs are required to be marked on industrial control panels and other equipment in accordance with the product standards and the NEC.
- C. Comply with UL 508A to ensure the quality and construction of the control panels

- D. For proper protection and compliance with NEC 110.10, the short-circuit current rating for a component or equipment shall be equal to or greater than the available short-circuit current where the equipment is being installed in the system.
- E. Failure to provide equipment with adequate SCCR will not be accepted. Further, panels furnished with inadequate SCCR ratings shall be changed or upgraded by the contractor at no cost to the owner.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. For each control panel on the project, include the withstand rating of said control panel.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Panel numbering scheme.
- D. Panel Schedules: For each system to include in maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Coordinate features of all control panels, installed units, and accessory devices. Assure these to be compatible with the following:
  - 1. Electrical Contractor final short circuit analysis regarding available fault current to each control panel furnished under this section.
  - 2. Furnish control panels with adequate withstand rating based on item 1 above
  - 3. Each control panel shall be labeled to identify the rated SCCR
  - 4. Each control panel shall be labeled to identify the NEMA rating
  - 5. All control panels shall comply with the latest edition of the National Electric Code
  - 6. Ratings and characteristics of supply circuit and required control sequence.
  - 7. Ambient and environmental conditions of installation location.

#### 2.2 NEMA RATINGS FOR ENCLOSURES

- A. Unless specified in other Division 22 sections, NEMA ratings for enclosures shall be as follows:

GENERAL PANEL NEMA RATINGS		
<b>Service:</b>	Division 22 Equipment	<b>Material:</b> Per section
Location	NEMA Rating	Other
Outdoors	4X	Stainless Steel
Indoors	2	Per vendor - notes 1 and 2
Outdoor locations subject to flood	6	Stainless Steel
Mechanical equipment rooms	12	Carbon Steel - note 3
Penthouse mechanical areas	12	Carbon Steel - note 3
Localized areas exposed to washdown	4X	Stainless Steel
Parking garages	4	Stainless Steel or Plastic - notes 1 and 2
Kitchens	4X	Stainless Steel
Vivarium Washrooms	4X	Stainless Steel
General Vivarium	4X	Stainless Steel For rooms subject to washdown
pH system rooms	12	Plastic or Stainless Steel - notes 1 and 2
RODI rooms	4	Splash proof
Hazardous locations	Type 7 or type 9 Explosion Proof	Rating for condition
<b>NOTES:</b> 1. Comply with owner standards 2. Plastic enclosures only allowed with owner approval 3. Factory Powder coated, or primed and painted with epoxy paint		

## 2.3 PANEL SCCR RATING

- A. Short Circuit Current Ratings are listed below. The Division 22 spec sections may otherwise stipulate a SCCR rating in each specific equipment section.
  1. Example: Division 22, water packaged booster pumps specifies specific SCCR rating for water booster pump control panels.
    - a. Consequently, the SCCR rating specified in equipment subsections takes precedence over the rating specified in this spec section
- B. At general bid phase of project, the Short Surge Current Rating shall include:
  1. All single-phase control panels greater than 120 VAC for the project are to be a minimum of 14 kA RMS rating
  2. All single-phase control panels less than or equal to 120 VAC for the project are to be a minimum of 10kA RMS rating
  3. All three-phase system control panels not stipulated in Division 22 equipment sections or identified on the drawings shall carry a minimum default rating of 65,000 amperes RMS.

## 2.4 GENERAL CONTROL PANELS DESIGN

- A. The following systems may use General Circuit Control logic or may use Programmable Logic Control, i.e., PLC's may be used at the contractor's discretion
  1. Hot water circulation pumps for general use
  2. Point of use pump stations

3. Point of use single phase equipment

## 2.5 PROGRAMMABLE LOGIC CONTROLLERS (PLC)

- A. The following systems require associated control panels to be PLC

1. Sewage pump stations
2. Hot water circulation pumps in a medical facility
3. All others identified on the drawings and not listed above
4. All PLC control panels shall have the ability to communicate common field-bus protocols, (BACnet, Modbus, Profibus, and LON), via optional communication expansion card installed inside controller.
5. All PLC's shall communicate with the Building Management System

## PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION

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CONTROL

PANEL

## **SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Performance requirements
  - 2. Pack-less expansion joints
  - 3. Grooved-joint expansion joints.
  - 4. Alignment guides and anchors.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
  - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
  - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
  - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

#### **1.6 QUALITY ASSURANCE**

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

### 2.2 PACKLESS EXPANSION JOINTS

#### A. Rubber Union Connector Expansion Joints

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal.
  - a. Flex-Hose Co., Inc. <http://www.specagent.com/Lookup?uid=123456974007>
  - b. Flexicraft Industries <http://www.specagent.com/Lookup?uid=123456974008>
  - c. General Rubber Corporation
  - d. Or Approved Equal. <http://www.specagent.com/Lookup?uid=123456974009>
2. Material: Twin reinforced-rubber spheres with external restraining cables.
3. Minimum Pressure Rating: 150 psig at 170 deg F, unless otherwise indicated.
4. End Connections for NPS 2 and Smaller: Threaded.

#### B. Flexible-Hose Packless Expansion Joints

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal.
  - a. Flex Pression Ltd. <http://www.specagent.com/Lookup?uid=123456973953>
  - b. Flex-Hose Co., Inc. <http://www.specagent.com/Lookup?uid=123456973958>
  - c. Flexicraft Industries
  - d. Or Approved Equal. <http://www.specagent.com/Lookup?uid=123456973954>
2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
  - a. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.

5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded flanged or mechanical end connections.
    - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.
  6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
    - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
  7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged welded end connections.
    - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
  8. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with flanged welded end connections.
    - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
  9. Expansion Joints for Steel Piping NPS 14 and Larger: Carbon-steel fittings with flanged welded end connections.
    - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
- C. Metal-Bellows Packless Expansion Joints
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Flex-Hose Co., Inc. <http://www.specagent.com/Lookup?uid=123456973964>
    - b. <http://www.specagent.com/Lookup?uid=123456973965>. Flexicraft Industries
    - c. <http://www.specagent.com/Lookup?uid=123456973966>. Flex-Weld, Inc.
    - d. Or Approved Equal.
  2. Standards: ASTM F 1120 and EJMAs "Standards of the Expansion Joint Manufacturers Association, Inc."
  3. Type: Circular, corrugated bellows with external tie rods.
  4. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
  5. Configuration: Single joint with base and double joint with base class (es), unless otherwise indicated.
  6. Expansion Joints for Copper Tubing: Single- or multi- ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
    - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
    - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded.
    - c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.

7. Expansion Joints for Steel Piping: Single- or multi- ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
  - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
  - b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Welded.
- D. Externally Pressurized Metal-Bellows Packless Expansion Joints
  1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal.
    - a. Flex-Hose Co., Inc.
    - b. Hyspan Precision Products, Inc.  
<http://www.specagent.com/Lookup?uid=123456974015>
    - c. Mason Industries, Inc.
    - d. Or Approved Equal. <http://www.specagent.com/Lookup?uid=123456974016>
  2. Minimum Pressure Rating: 150 psig 200 psig, unless otherwise indicated.
  3. Description
    - a. Totally enclosed, externally pressurized, multi-ply, stainless-steel bellows isolated from fluid flow by an internal pipe sleeve.
    - b. Carbon-steel housing.
    - c. Drain plugs and lifting lug for NPS 3 and larger.
    - d. Bellows shall have operating clearance between the internal pipe sleeves and the external shrouds.
    - e. Joints shall be supplied with a built-in scale to confirm the starting position and operating movement.
    - f. Joint Axial Movement: 6 inches of compression and 1 inch of extension.
  4. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are not acceptable.
  5. End Connection Configuration: Flanged; one raised, fixed and one floating flange.
- E. Rubber Packless Expansion Joints
  1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal.
    - a. Flex-Hose Co., Inc. <http://www.specagent.com/Lookup?uid=123456973991>
    - b. Garlock Seating Technologies <http://www.specagent.com/Lookup?uid=123456973994>
    - c. General Rubber Corporation
    - d. Or Approved Equal. <http://www.specagent.com/Lookup?uid=123456973995>
  2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."



3. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
4. Arch Type: Single or multiple arches with external control rods.
5. Spherical Type: Single or multiple spheres with external control rods.
6. Minimum Pressure Rating for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
7. Minimum Pressure Rating for NPS 5 and NPS 6: 140 psig at 200 deg F.
8. Minimum Pressure Rating for NPS 8 to NPS 12: 140 psig at 180 deg F.
9. Material for Fluids Containing Acids, Alkalis, or Chemicals: Butyl rubber Chlorosulfonyl-polyethylene rubber Ethylene-propylene-diene terpolymer rubber.
10. Material for Fluids Containing Gas, Hydrocarbons, or Oil: Buna-N Chlorosulfonated polyethylene synthetic rubber.
11. Material for Water: Butyl rubber Buna-N Chlorosulfonated polyethylene synthetic rubber Chlorosulfonyl-polyethylene rubber Ethylene-propylene-diene terpolymer rubber Natural rubber.
12. End Connections: Full-faced, integral steel flanges with steel retaining rings.

## 2.3 GROOVED-JOINT EXPANSION JOINTS

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal.
  - a. Anvil International <http://www.specagent.com/Lookup?uid=123456974003>
  - b. Shurjoint Piping Products <http://www.specagent.com/Lookup?uid=123456974004>
  - c. Victaulic Company
  - d. Or Approved Equal. <http://www.specagent.com/Lookup?uid=123456974005>
- B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
- C. Standard: AWWA C606, for grooved joints.
- D. Nipples: Galvanized, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.
- E. Couplings: Flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water ethylene-propylene-diene terpolymer rubber gasket suitable for cold and hot water, and bolts and nuts.

## 2.4 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides
  1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal.
    - a. Flex-Hose Co., Inc. <http://www.specagent.com/Lookup?uid=123456973981>
    - b. Flexicraft Industries <http://www.specagent.com/Lookup?uid=123456973982>

- c. Mason Industries, Inc.
    - d. Or Approved Equal. <http://www.specagent.com/Lookup?uid=123456973989>
  - 2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.
- B. Anchor Materials:
- 1. Steel Shapes and Plates: ASTM A 36/A 36M.
  - 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
  - 3. Washers: ASTM F 844, steel, plain, flat washers.
  - 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, with tension and shear capacities appropriate for application.
    - a. Stud: Threaded, zinc-coated carbon steel.
    - b. Expansion Plug: Zinc-coated steel.
    - c. Washer and Nut: Zinc-coated steel.

### **PART 3 - EXECUTION**

#### **3.1 EXPANSION JOINT INSTALLATION**

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- C. Install rubber packless expansion joints according to FSA-PSJ-703.
- D. Install grooved-joint expansion joints to grooved-end steel piping.

#### **3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION**

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least four pipe fittings, including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

#### **3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION**

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
  - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
  - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
  - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION

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## **SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. Sleeves.
  - 2. Stack-sleeve fittings.
  - 3. Sleeve-seal systems.
  - 4. Sleeve-seal fittings.
  - 5. Grout.
  - 6. Firestopping.

#### **1.3 PENETRATION FIRE STOPPING ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.

#### **1.4 DESCRIPTION OF THE FIRE STOPPING WORK OF THIS SECTION**

- A. Only tested fire stop systems shall be used in specific locations as follows:
  - 1. Fire stop or fire seal plumbing penetrations for the passage of piping, and other equipment through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.
  - 2. Repetitive plumbing penetrations in fire-rated floor assemblies. Penetrations exist for the installation of tubs, showers, aerators and other plumbing fixtures.

#### **1.5 DEFINITIONS**

- A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

## 1.6 REFERENCES

- A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops".
- B. Test Requirements: UL 1479, "Fire Tests of Through-Penetration Fire Stops".
- C. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.
  - 1. UL Fire Resistance Directory
    - a. Fire Stop Devices (XHJI).
    - b. Fire Resistance Ratings (BXRH).
    - c. Through-Penetration Fire Stop Systems (XHEZ).
    - d. Fill, Voids, or Cavity Material (XHHW).
    - e. Forming Materials (XHKU).
- D. International Fire Stop Council Guidelines for Evaluating Fire Stop Systems Engineering Judgments
- E. Inspection Requirements: ASTM E 2174, "Standard Practice for On-site Inspection of Installed Fire Stops".
- F. ASTM E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials".
- G. All major building codes: ICBO, SBCCI, BOCA, and IBC.
- H. NFPA 101 - Life Safety Code.

## 1.7 QUALITY ASSURANCE

- A. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of fire stop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.
- B. Fire stop System installation must meet requirements of ASTM E814 or UL1479 tested assemblies that provide a fire rating equal to that of construction being penetrated.
- C. Proposed fire stop materials and methods shall conform to applicable governing codes having local jurisdiction.
- D. Fire stop Systems do not reestablish the structural integrity of load bearing partitions/assemblies or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.
- E. For those fire stop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Fire Stop Council.

**1.8 SUBMITTALS**

- A. Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of UL fire stop systems to be used and manufacturer's installation instructions.
- B. Manufacturer's engineering judgment identification number and drawing details when no UL system is available for an application. Engineering judgment must include both project name and contractor's name who will install fire stop system as described in drawing.
- C. Submit material safety data sheets provided with product delivered to jobsite.

**1.9 INSTALLER QUALIFICATIONS**

- A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the fire stopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its fire stopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.
- B. Installation Responsibility: Assign installation of through-penetration fire stop systems and fire-resistive joint systems in Project to a single sole source fire stop specialty contractor.
- C. The work is to be installed by a contractor with at least one of the following qualifications:
  - 1. FM 4991 Approved Contractor.
  - 2. UL Approved Contractor.
  - 3. Hilti 3rd, Fire Spec, Accredited Fire Stop Specialty Contractor
- D. Firm with not less than three (3) years' experience with fire stop installation.
- E. Successfully completed not less than three (3) comparable scale projects using similar systems.

**1.10 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.
- B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at jobsite.
- C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.
- D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
- E. Do not use damaged or expired materials.

**1.11 PROJECT CONDITIONS**

- A. Do not use materials that contain flammable solvents.
- B. Scheduling
  - 1. Schedule installation of CAST IN PLACE firestop devices after completion of floor formwork, metal form deck, or composite deck but before placement of concrete.

2. Schedule installation of other fire stopping materials after completion of penetrating item installation but prior to covering or concealing of openings.
- C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
- D. Weather conditions: Do not proceed with installation of fire stop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.
- E. During installation, provide masking and drop cloths to prevent fire stopping materials from contaminating any adjacent surfaces.

## 1.12 REFERENCES

- A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops"
- B. Test Requirements: UL 1479, "Fire Tests of Through-Penetration Fire Stops."
- C. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.
  1. UL Fire Resistance Directory
    - a. Fire Stop Devices (XHJI).
    - b. Fire Resistance Ratings (BXRH).
    - c. Through-Penetration Fire stop Systems (XHEZ)
    - d. Fill, Voids, or Cavity Material (XHHW)
    - e. Forming Materials (XHKU)
- D. International Fire stop Council Guidelines for Evaluating Fire stop Systems Engineering Judgments
- E. Inspection Requirements: ASTM E 2174, "Standard Practice for On-site Inspection of Installed Fire Stops."
- F. ASTM E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials."
- G. All major building codes: ICBO, SBCCI, BOCA, and IBC.
- H. NFPA 101 - Life Safety Code

## PART 2 - PRODUCTS

### 2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239 inch minimum thickness; round tube closed with welded longitudinal joint.

## 2.2 STACK-SLEEVE FITTINGS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal.
  - 1. Smith, Jay R. Mfg. Co.
  - 2. Zurn Industries, LLC
  - 3. OR Approved Equal.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
  - 1. Under deck Clamp: Clamping ring with setscrews.

## 2.3 SLEEVE-SEAL SYSTEMS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or equal:
  - 1. Calpico, Inc.
  - 2. **Link-Seal.**
  - 3. Metraflex Company (The)
  - 4. Or Approved Equal.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
  - 1. Sealing Elements: EPDM-rubber for non-hydrocarbon situations and NBR where hydrocarbons are used. Use interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Polymer Plastic or Stainless steel.
  - 3. Connecting Bolts and Nuts: Carbon Steel with corrosion resistant coating or Stainless steel of length required to secure pressure plates to sealing elements.

## 2.4 SLEEVE-SEAL FITTINGS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by the following or approved equal:
  - 1. HOLDRITE
- B. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping OD.



**2.5 GROUT**

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

**2.6 FIRE STOPPING AND FIRE RATED CONSTRUCTION**

- A. Division 07 of the project specifications shall govern. for materials and architectural drawings for listed penetration details.
- B. Details and further description of fire stopping systems in this section are supplementary to division 7
  - 1. Components: See Division 7 of the general specifications for fire stopping required components. Division 22 supplementary details further clarify requirements.
  - 2. Provide fire stopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the fire stopping under conditions of service and application, as demonstrated by the fire stopping manufacturer based on testing and field experience.
- C. Approved Manufacturers: Subject to compliance with requirements, through-penetration firestop systems that may be incorporated into the work, provide products by one of the following, or approved equal.
  - 1. 3M
  - 2. Hilti
  - 3. Fire-spec.
- D. Basis of Design: Hilti Inc.
  - 1. Approved Products or approved equal:
    - a. Hilti CFS-CID MD Metal Deck Cast-in Device
    - b. Hilti CID-U Cast-in Device
    - c. Hilti CFS-DID Drop-in Device
    - d. Hilti FS ONE Max Firestop Sealant
    - e. Hilti CFP-ES EndoShield Endothermic Mat
- E. Performance Requirements
  - 1. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
    - a. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls and fire partitions.
    - b. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

2. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
    - a. Horizontal assemblies include floors, floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.
    - b. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
    - c. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall. See IBC Chapter 7 to verify when the T-Rating needs to equal the F-Rating
    - d. T-Ratings shall be achieved by utilizing a Low Bio Persistent Endothermic Mat incorporating foil scrim on both sides
    - e. Basis of Design: Hilti CFP-ES Endo-Shield High Temperature Endothermic Mat. LBC Red List Compliance
  3. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.
    - a. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at 0.30-inch wg (74.7 Pa) at both ambient and elevated temperatures.
    - b. Utilize Hilti CFS-MSL (Modular Sleeve) or CP 653 Cable Pathway Device with appropriate system to achieve L-Rating.
  4. Containment floors including penthouses:
    - a. Install a firestop system with a W-Rating or a note stating it impedes the passage of water if requested by the designer or owner.
  5. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- F. Provide components for each fire stopping system that are needed to install fill material. Use only components specified by the fire stopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
- G. Sealants, caulking and devices shall be rated the same as the wall rating in which they are used.
- H. Do not install penetrations through head-of-wall firestop joint systems. This results in the loss of the assembly rating, possibly leading to firestop special inspection failures.
- I. Do not install penetrations through head-of-wall firestop joint systems. This results in the loss of the assembly rating, possibly leading to firestop special inspection failures.

### **PART 3 - EXECUTION**

#### **3.1 SLEEVE INSTALLATION**

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1 inch annular clear space between piping and concrete slabs and walls.
- C. Sleeves are not required for core-drilled holes.
- D. Sleeves are not required for drywall partitions. the contractor may elect to install sleeves, either removable or permanent at their discretion.
  - 1. All penetrations that require fire stopping sealants or UL rated barriers are to comply with division 7 for all requirements.
- E. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  - 1. When sleeves are used, cut sleeves to length for mounting flush with both surfaces.
- F. Containment floor requirements
  - 1. Extend sleeves installed in floors 2 inches above finished floor level in the following areas:
    - a. Mechanical equipment areas
    - b. Mechanical Penthouses
    - c. Vivariums
    - d. Operating rooms
    - e. Biosafety Level 3 or higher laboratories
    - f. Interstitial spaces housing mechanical equipment and piping above any of the above spaces 1-5.
    - g. All laboratory floors
    - h. In the floor slab above all computer rooms
      - 1) In the floor slab above all clean rooms
      - 2) Clean rooms
  - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- G. Install sleeves for pipes passing through interior partitions.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Install sleeves that are large enough to provide 1/4 inch annular clear space between sleeve and pipe or pipe insulation.
  - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07.
- H. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements for fire stopping specified in Division 07.

### 3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4 inch annular clear space between sleeve and pipe or pipe insulation.
  2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07.
  3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
  4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements for fire stopping specified in Division 07.

### 3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### 3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water-stop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

### 3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  1. Exterior Concrete Walls above Grade:
    - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves. Sleeve-seal fittings.
    - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves. Insert material.
  2. Exterior Concrete Walls below Grade:
    - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system sleeve-seal fittings
      - 1) Select sleeve size to allow for 1 inch annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping NPS 6: Galvanized-steel wall sleeves with sleeve-seal system

- 1) Select sleeve size to allow for 1 inch annular clear space between piping and sleeve for installing sleeve-seal system.
  3. Concrete Slabs-on-Grade:
    - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system
      - 1) Select sleeve size to allow for 1 inch annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping NPS 6: Galvanized-steel-wall sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1 inch annular clear space between piping and sleeve for installing sleeve-seal system.
  4. Concrete Slabs above Grade:
    - a. Piping Smaller Than NPS 6 Insert pipe size: Galvanized-steel-pipe sleeves
    - b. Piping NPS 6 Insert pipe size and Larger: Galvanized-steel-pipe sleeves Stack-sleeve fittings
  5. Interior Partitions:
    - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
    - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

### 3.6 FIRE STOPPING INSTALLATION

- A. Division 7 requirements govern
- B. Manufacturer's Field Services: Contractor to ensure a manufacturer's direct representative is on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. Training will be done per manufacturer's written recommendations published in their literature and drawing details.

CONCRETE FLOORS			CONCRETE OR BLOCK WALLS		
TYPE OF PENETRANT	F-RATING (HR)	UL-CLASSIFIED SYSTEM	TYPE OF PENETRANT	F-RATING (HR)	UL-CLASSIFIED SYSTEM
CIRCULAR BLANK OPENINGS	1	FA 0006,CAJ 0055,CAJ 0090	CIRCULAR BLANK OPENINGS	1	CAJ 0055, CAJ 0090
	2	FA 0006,CAJ 0055,CAJ 0090		2	CAJ 0055, CAJ 0090
	3	FA 0006, CAJ 0055, CAJ 0086, FA 0014		3	CAJ 0055, CAJ 0086
SINGLE METAL PIPES OR CONDUIT	1	CAJ 1226, FA 1028	SINGLE METAL PIPES OR CONDUIT	1	CAJ 1226, WJ 1067
	2	CAJ 1155, CAJ 1291, CAJ 1226, FA 1016, FA 1028, FA 1106, FB1010		2	CAJ 1226, CAJ 1155, CAJ 1291, WJ 1067
	3	CAJ 1155, CAJ 1226, FA 1017, FB 1009		3	CAJ 1226, CAJ 1155, WJ 1041, WJ 1068
	4	CBJ 1037, CBJ 1034, FA 1091		4	CBJ 1034, CBJ 1037, WJ 1041, WJ 1042, WJ 1068
SINGLE NON-METALLIC PIPE OR CONDUIT (I.E. PVC, CPVC, ABS, FRP, ENT)	1	FA 2053, FA 2025, CAJ 2109, CAJ 2098, CAJ 2271, CAJ 2167, CBJ 2021, CAJ 2342	SINGLE NON-METALLIC PIPE OR CONDUIT (I.E. PVC, CPVC, ABS, FRP, ENT)	1	CAJ 2109, CAJ 2098, CAJ 2167, CAJ 2371, CAJ 2342
	2	FA 2053, FA 2025, FA 2092, CAJ 2109, CAJ 2098, CAJ 2271, CAJ 2167, CAJ 2218, CAJ 2488, CAJ 2570, CBJ-2021, CAJ 2284, CAJ 2371, CAJ 2342		2	CAJ 2109, CAJ 2098, CAJ 2167, CAJ 2218, CAJ 2488, CAJ 2570, CAJ 2371, CAJ 2342
	3	FA 2054, FA 2071, FA 2213, FB 2048, CAJ 2098, CAJ 2109, CAJ 2168, CAJ 2371, CAJ 2342, CAJ 2420		3	CAJ 2109, CAJ 2098, CAJ 2168, CAJ 2371, CAJ 2342
	4	CBJ 2016, CAJ 2017		4	WJ 2057, WJ 2091
SINGLE OR BUNDLED CABLES	1	FA 3007,CAJ 3095,CAJ 3180	SINGLE OR BUNDLED CABLES	1	WJ 3036, CAJ 3095, CAJ 3180, WJ 3060
	2	FA 3007,CAJ 3095,CAJ 3180		2	WJ 3036, CAJ 3095, CAJ 3180, CAJ 3281, WJ 3060
	3	FA 3007,CAJ 3095,CAJ 3180		3	CAJ 3095, CAJ 3180, CAJ 3285
SINGLE INSULATED PIPES	1	FA 5015, FA 5017, CAJ 5090, CAJ 5091, CAJ 5098		SINGLE INSULATED PIPES	4
	2	FA 5015, FA 5017, CAJ 5090, CAJ 5091, CAJ5090	1		CAJ 5090, CAJ 5091, CAJ 5061, WJ 5042
	3	FA 5016, CAJ 5090, FA 5018	2		CAJ 5090, CAJ 5091, CAJ 5061, WJ 5042
	4	CBJ 5006	3		CAJ 5090, CAJ 5061
MIXED PENETRANTS	1	CAJ 8099, CAJ 8056, CAJ 8143	MIXED PENETRANTS	4	CBJ 5006, WJ 5028
	2	CAJ 8099, CAJ 8056, CAJ 8143		1	CAJ 8099, CAJ 8056, WJ 8007, CAJ 8143
	3	CAJ 8099, CAJ 8056		2	CAJ 8099, CAJ 8056, WJ 8007, CAJ 8143
	4	CAJ 8095		3	CAJ 8041, CAJ 8056, WJ 8007, CAJ 8099
WOOD FLOOR			GYPSUM WALL BOARD ASSEMBLIES		
TYPE OF PENETRANT	F-RATING (HR)	UL-CLASSIFIED SYSTEM	TYPE OF PENETRANT	F-RATING	UL-CLASSIFIED SYSTEM
METAL PIPES OR CONDUIT	1	FC 1009, FC 1059	METAL PIPES OR CONDUIT	1	WL 1054, WL 1058, WL 1164
	2	FC 1009, FC 1059		2	WL 1054, WL 1058, WL 1164
NON-METALLIC PIPE OR CONDUIT	1	FC 2232, FC 2030, FC 2071, FC 2160, FC 2127, FC 2128, FC 2389		4	WL 1110, WL 1111, WL 1165
	2	FC 2029, FC 2030, FC2071, FC 2128, FC 2127, FC 2160	1	WL 2078, WL 2075, WL 2078, WL 2098, WL 2377, WL 2406, WL2341, WL 2128	
			2	WL 2078, WL 2075, WL 2078, WL 2098, WL 2377, WL 2406, WL2341, WL 2128	
SINGLE OR BUNDLED CABLES	1	FC 3012, FC 3044	4	WL 2184, WL 2245	
	2	FC 3012	1	WL 3065, WL 3111, WL 3112	
			2	WL 3065, WL 3111, WL 3112, WL 3334, WL 3335, WL 3384, WL 3395	
INSULATED PIPES	1	FC 5004, FC 5037, FC 5036	CABLE TRAY	4	WL 3139
	2	FC 5004, FC 5037		1	WL 4011, WL 4019
MIXED PENETRANTS	1	FC 8009, FC 8014, FC 8026, FC8025		2	WL 4011, WL 4019
			4	WL 8014	
			INSULATED PIPES	1	WL 5028, WL 5029, WL 5047, WL 5096
				2	WL 5028, WL 5029, WL 5027, WL 5096, WL 5047
				4	WL 5073
			MIXED PENETRANTS	1	WL 1095, WL 8013
2	WL 1095, WL 8013				
4	WL 8014				

\*\*CONTACT HILTI FOR CURRENT UL-CLASSIFIED SYSTEM OR ENGINEER JUDGMENT DRAWING: 800-879-6000

**NOTES:**

1. Jobsite conditions of each through-penetration firestop system must meet ALL details of the UL-Classified System selected.
2. If jobsite conditions do not match any UL-classified systems in the schedules above, contact Hilti for alternative systems or Engineer Judgment Drawings - 800-879-8000
3. Where more than one applicable UL-Classified System is listed in the schedules, choose the UL System which is most economical for each through-penetration firestop system.
4. Coordinate work with other trades to assure that penetration opening sizes are appropriate for penetrant locations, and vice versa.
5. For 3-hour rated gypsum walls, contact Hilti for a UL-classified system or engineer judgment drawing - 800-879-8000.

END OF SECTION

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## **SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. Escutcheons.
  - 2. Floor plates.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.

### **PART 2 - PRODUCTS**

#### **2.1 ESCUTCHEONS**

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

#### **2.2 FLOOR PLATES**

- A. Split Floor Plates: Cast brass with concealed hinge.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    - g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
  - 2. Escutcheons for Existing Piping:
    - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
    - b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
    - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
    - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
    - e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
    - f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. New Piping: One-piece, floor-plate type.
  - 2. Existing Piping: Split-casting, floor-plate type.



3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

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## **SECTION 220519 - METERS AND GAUGES FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. Bimetallic-actuated thermometers.
  - 2. Filled-system thermometers.
  - 3. Liquid-in-glass thermometers.
  - 4. Thermowells.
  - 5. Pressure gauges.
  - 6. Gauge attachments.
  - 7. Test plugs.
  - 8. Test-plug kits.
  - 9. Sight flow indicators.
  - 10. Water meters.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Product Certificates: For each type of meter and gauge, from manufacturer.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following or approved equal.
  - 1. Ashcroft Inc.
  - 2. Marsh Bellofram
  - 3. Watts, a Watts Water Technologies company
  - 4. Or Approved Equal.
- B. Standard: ASME B40.3, Grade A.
- C. Case: 304 stainless steel; hermetically sealed per ASME B40.3; ingress protection IP65; external reset slotted hex head on back of case
- D. Dial: White aluminum, dished, with black markings.
- E. Connector Type(s): Plain, NPT, Union
- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Flat Instrument Glass.
- I. Ring: Stainless steel.
- J. Element: Bimetal helix.
- K. Pointer: black aluminum.
- L. Accuracy: Plus or minus 1.0 percent full scale value per ASME B40.3, Grade 1A
- M. Basis of Design: WIKA Model 55

### 2.2 FILLED-SYSTEM THERMOMETERS

- A. Direct-Mounted, Stainless steel case, Vapor-Actuated Thermometers:
  - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following or approved equal.
    - a. Ashcroft.
    - b. Marsh Bellofram.
    - c. Trerice, HO Co.
    - d. Or Approved Equal.
  - 2. Standard: ASME B40.200.
  - 3. Case: Stainless steel, 4.5 inches.
  - 4. Dial: White coated aluminum with black markings.
  - 5. Pointer: Adjustable, balance, aluminum with matte black finish.

6. Window: Glass or Lexan.
7. Ring: Stainless steel.
8. Connector Type(s): Union, Thermowell, or plain bulb. At system plain or union bulb. Copper or 316 stainless steel
9. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
  - a. Design for Thermowell Installation: Bare stem.
10. Accuracy: Plus or minus 1 percent of scale range.
11. Basis of Design: WIKA Instruments T1.V series

B. Remote-Mounted, Stainless steel, Vapor-Actuated Thermometers:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal
  - a. Ashcroft.
  - b. Marsh Bellofram.
  - c. Terice, HO Co.
  - d. Or Approved Equal.
2. Standard: ASME B40.200.
3. Case: Stainless steel, 4.5.
4. Dial: White coated aluminum with black markings.
5. Pointer: Adjustable, balance, aluminum with matte black finish
6. Window: Glass or Lexan
7. Ring: Stainless steel.
8. Connector Type(s): Plain, union, or thermowell.
9. Thermal System: Plain or Union. Copper or 316 stainless steel
  - a. Design for Thermowell Installation: Bare stem.
10. Accuracy: Plus or minus 1 percent of scale range.
11. Basis of Design: WIKA Instruments T1. V Series

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Stainless -Case, Compact-Style, Liquid-in-Glass Thermometers:

1. **Manufacturers:** Subject to compliance with requirements, provide products by the following or approved equal:
  - a. Ashcroft.
  - b. Marsh Bellofram.
  - c. Terice, HO Co.

- d. Or Approved Equal.
  2. Standard: ASME B40.200.
  3. Case: Plastic; 6 inch nominal size.
  4. Case Form: Back angle straight unless otherwise indicated.
  5. Tube: Glass with magnifying lens and blue organic liquid.
  6. Tube Background: Non-reflective with permanently etched scale markings graduated in deg F and deg C.
  7. Window: Glass or plastic.
  8. Stem: brass: length to suit installation.
    - a. Design for Thermowell Installation: Bare stem.
  9. Connector: 3/4 inch, with ASME B1.1 screw threads.
  10. Accuracy: Plus or minus 1.0 percent of span.
  11. Basis of Design: WIKA Instruments 213 series
- B. Stainless Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, products by one of the following, or approved equal
    - a. Marsh Bellofram.
    - b. Watts.
    - c. Weiss.
    - d. Or Approved Equal.
  2. Standard: ASME B40.200.
  3. Case: Plastic: 7 inch or 9 inch nominal size unless otherwise indicated.
  4. Case Form: Adjustable angle unless otherwise indicated.
  5. Tube: Glass with magnifying lens and blue or red organic liquid.
  6. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in deg F and deg C.
  7. Window: Glass.
  8. Stem: Brass. 3.5 inches, 6.0 inches, 9.0 inches, or 12.0 inches
    - a. Design for Thermowell Installation: Bare stem.
  9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
  10. Accuracy: Plus or minus 1.0 percent for scale range.

## 2.4 THERMOWELLS

### A. General

1. Standard: ASME B40.200.

2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2 inch, 3/4 inch, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required matching thermometer bulb or stemming.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowells internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.5 PRESSURE GAUGES

A. Direct-Mounted, Stainless-Case, Dial-Type Pressure gauges:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal.
  - a. AMETEK, Inc.
  - b. Ashcroft Inc.
  - c. Watts, a Watts Water Technologies company
  - d. Or Approved Equal.
2. Standard: ASME B40.100.
3. Case: Stainless steel, 4.5 inches.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: White aluminum with stop pin and black lettering.
8. Pointer: Black aluminum.
9. Window: Snap-in poly carbonate
10. Accuracy: Plus or minus 1.0 percent of span (ASME B40.100, grade 1A)
11. Basis of Design: WIKA Instruments series 111.25 CT

B. Remote-Mounted, Stainless-Case, Dial-Type Pressure gauges:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal.

- a. AMETEK, Inc.
  - b. Ashcroft Inc.
  - c. Watts; a Watts Water Technologies company
  - d. Or Approved Equal.
2. Standard: ASME B40.100.
  3. Case: Stainless steel, 4.5 inches.
  4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
  5. Pressure Connection: Brass, with NPS 1/4 NPS 1/4 or NPS 1/2 NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
  6. Movement: Mechanical, with link to pressure element and connection to pointer.
  7. Dial: White aluminum with stop pin and black lettering.
  8. Pointer: Black aluminum
  9. Window: Snap-in polycarbonate
  10. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

## 2.6 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 NPS 1/4 or NPS 1/2 NPS 1/2, ASME B1.20.1 pipe threads and piston porous-metal-type surge-dampening device. Include extension for use on insulated piping.
  1. Basis of Design: WIKA Instrument model 910.12.X00
- B. Valves: Brass ball Brass or stainless-steel needle, with NPS 1/4 NPS 1/4 or NPS 1/2 NPS 1/2, ASME B1.20.1 pipe threads.

## 2.7 TEST PLUGS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal.
  1. National Meter, Inc.
  2. Watts, a Watts Water Technologies company
  3. Weiss Instruments, Inc.
  4. Or Approved Equal.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

## 2.8 TEST-PLUG KITS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal.
  - 1. National Meter, Inc.
  - 2. Terrice, H. O. Co.
  - 3. Weiss Instruments, Inc.
  - 4. **Or Approved Equal.**
- B. Furnish two test-plug kit(s) containing two thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
- D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- E. Pressure gauge: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- F. Carrying Case: Metal or plastic, with formed instrument padding.

## 2.9 SIGHT FLOW INDICATORS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work. Provide products by one of the following, or approved equal
  - 1. Dwyer Instruments, Inc.
  - 2. Emerson Process Management Rosemount Division
  - 3. Ernst Flow Industries
  - 4. **Or Approved Equal.**
- B. Description: Piping inline-installation device for visual verification of flow.
- C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: 125 psig.
- E. Minimum Temperature Rating: 200 deg F.
- F. End Connections for NPS 2 and Smaller: Threaded.
- G. End Connections for NPS 2-1/2 and Larger: Flanged.

## 2.10 WATER METERS

- A. General



1. Contractor to verify the exact model and size with the utility company prior to the purchase of any water meter. Furnish the meter that complies with utility standards for the area.
2. Refer to the Plumbing Drawings, Water Meter Schedule sheet for meter types and locations. Note, schedule sheet takes priority.
3. Coordinate all remote reading devices with the utility company.
4. Verify type of water meter required by the utility company and authorities having jurisdiction. Comply with the utility company priority meter manufacturer.
5. Control Connections: Connect control wiring in accordance with Division 26 for control-voltage electrical power cables.
6. Electrical Connections: Connect wiring in accordance with Division 26 low-voltage electrical power conductors and cables.
7. Ground equipment in accordance with Division 26 for grounding and bonding for electrical systems.
8. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

**B. Communication Devices**

1. For each municipal water meter provided, or where the municipal water is sub metered for irrigation, coordinate with the service provider: furnish and install the following:
  - a. Remote Registration System Encoder Type: Comply with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly. Comply with utility company requirements for municipal installations.
  - b. Data System to be capable of transmitting data using AMR/AMI technology.
2. For each building submeter for "water consumption measurement" requirements, which may require installation of water meters for submetering, with service provider: furnish and install the following:
  - a. Remote Registration System Encoder Type: Comply with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly. Comply with utility company requirements for municipal installations.
  - b. Data System to be capable of transmitting data using AMR/AMI technology.
3. For each building submeter for "water consumption measurement" requirements, which may require installation of water meters for submetering for the building owner or for the tenant, furnish and install the following:
  - a. For sub-metering applications, provide pulse, 4-20, or compatible protocol such that remote reading devices report to the BMS (building management system)
  - b. Each submeter shall have a local readout in addition to BMS protocol.

**C. Available Manufacturers: Subject to compliance with water service provider requirements, and specification requirements, manufacturers offering product that may be incorporated into the Work include, products by one of the following, or approved equal**

1. ABB

2. Badger
3. Neptune
4. Or Approved Equal.

A. Displacement-Type Water Meters

Displacement-Type Water Meters				
Service:	Water		Material:	Bronze
Service Limits	Primary ANSI Class:	150		
Description	Type	Positive Displacement.		
	Capacity and Flows	See schedule sheet		
	Pressure Limit	150 psig Maximum Operating Pressure		
	Temperature Limit	Up to 120 °F		
	Standard	AWWA C700. NSF 61 listed		
	Body Design	Nutating disc; totalization meter.		
	Registration	In gallons or cubic feet or as required by utility company.		
	Isolation valves	Gate, Ball or Butterfly per pipe class. Conform to local plumbing code for valve types		
	Connections	Threaded or flanged		
	Mounting	Mount per manufacturer’s standard. Furnish and install on manufacturer’s skid or field floor support brackets		
	Pressure Gauges	Inlet/outlet pressure indicators.		
Electrical	None Provide 110VAC if AMI/AMR system is provided			
Equivalency	Badger Neptune Mueller Co			

B. Turbine-Type Water Meters

Turbine-Type Water Meters				
Service:	Water		Material:	Bronze
Service Limits	Primary ANSI Class:	150		
Description	Type	Turbine.		
	Capacity and Flows	See schedule sheet		
	Pressure Limit	Pressure Rating: 150 psig, for pressure above 150psig furnish class 250 meters.		
	Standard	AWWA C701. NSF 61 listed		
	Body Design	Turbine; totalization meter.		
	Registration	In gallons or cubic feet or as required by utility company.		
	Isolation valves	Gate, Ball or Butterfly per pipe class. Conform to local plumbing code for valve types		
	Connections	Threaded or flanged		
	Mounting	Mount per manufacturer’s standard. Furnish and install on manufacturer’s skid or field floor support brackets		
	Pressure Gauges	Inlet/outlet pressure indicators.		
Electrical	None Provide 110VAC if AMI/AMR system is provided			
Equivalency	Badger Neptune Mueller Co			

C. Compound-Type Water Meters

Compound-Type Water Meters			
Service:	Water	Material:	Bronze
Service Limits	Primary ANSI Class:	150	
Description	Type	Compound.	
	Capacity and Flows	See schedule sheet	

Compound-Type Water Meters			
Service:	Water		Material: Bronze
Service Limits	Primary ANSI Class:	150	
	Pressure Limit	Pressure Rating: 150 psig, for pressure above 150psig furnish class 250 meters.	
	Standard	AWWA C702. NSF 61 listed	
	Body Design	With integral mainline and bypass meters; totalization meter.	
	Registration	In gallons or cubic feet or as required by utility company.	
	Isolation valves	Gate, Ball or Butterfly per pipe class. Conform to local plumbing code for valve types	
	Connections	Flanged	
	Mounting	Mount per manufacturer's standard. Furnish and install on manufacturer's skid or field floor support brackets	
		Pressure Gauges	Inlet/outlet pressure indicators.
Electrical	None Provide 110VAC if AMI/AMR system is provided		
Equivalency	Badger Neptune Mueller Co		

#### D. Ultrasonic-Type Water Meters

Ultra-Sonic-Type Water Meters			
Service: Water		Material:	Bronze, Stainless steel, Engineered polymer. Epoxy-coated ductile iron.
Service Limits	Primary ANSI Class:	150	
Description	Type	Ultrasonic	
	Capacity and Flows	See schedule sheet	
	Pressure Limit	Pressure Rating: 150 psig, for pressure above 150psig furnish class 250 meters.	
	Standard	Ultrasonic open flow tube; totalization meter	
	Body Design	Ultrasonic open flow tube; totalization meter	
	Registration	In gallons or cubic feet or as required by utility company.	
	Isolation valves	Gate, Ball or Butterfly per pipe class. Conform to local plumbing code for valve types	
	Connections	Thread or flanged	
	Mounting	Mount per manufacturer's standard. Furnish and install on manufacturer's skid or field floor support brackets	
	Pressure Gauges	Inlet/outlet pressure indicators.	
Electrical	Provide 110VAC, duplex outlet		
Equivalency	Badger		
	Neptune		
	Mueller Co		

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

- G. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
- H. Install remote-mounted pressure gauges on panel.
- I. Install valve and snubber in piping for each pressure gauge for fluids.
- J. Install test plugs in piping tees.
- K. Install thermometers in the following locations:
  - 1. Inlet and outlet of each water heater.
  - 2. Inlets and outlets of each water heat exchanger.
  - 3. Inlet and outlet of each hot-water storage tank.
  - 4. Inlet and outlet of each remote water chiller.
  - 5. Inlet and outlet of mixing valves.
  - 6. Inlet of hot water recirculation pumps.
  - 7. At each hot water balancing station.
- L. Install pressure gauges in the following locations:
  - 1. Building water service entrance into building.
  - 2. Inlet and outlet of each pressure-reducing valve.
  - 3. Suction and discharge of each water pump.
  - 4. Outlet of each hot water recirculation pump.
  - 5. Top of each water riser.
  - 6. Inlet and outlet of master mixing valves.

### 3.2 WATER METER INSTALLATION

- A. Contact the municipal water department in the jurisdictional area of this project.
- B. Coordinate the type and model water meter accepted by the municipality.
- C. Provide a shop drawing to the Engineer and Architect with approval documentation from the authority of the accepted water meter for the project.
- D. Pay all local fees, procure the water meter from the water department or from an approved vendor, and install the water meter. Carry out commissioning instructions required by the municipal water authority and plumbing inspector.
- E. Follow manufacturer's recommendation for installation and conform to the guidelines provided by the Installation and Operation Manual.
- F. The meter must be installed horizontally with the registration upright.
- G. A strainer should be used if any solids are present in the liquid.
- H. The meter should be installed with the flow arrow marking aligned with the liquid flow.

### 3.3 CONNECTIONS

- A. Install meters and gauges adjacent to machines and equipment to allow service and maintenance of meters, gauges, machines, and equipment.

### 3.4 ADJUSTING

- A. Adjust faces of meters and gauges to proper angle for best visibility.

### 3.5 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each water heaters and heat exchangers shall be one of the following:
  - 1. Liquid-filled, sealed, bimetallic-actuated type.
  - 2. Direct-mounted, plastic-case, vapor-actuated type.
  - 3. Industrial-style, liquid-in-glass type.
  - 4. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.
- B. Thermometers at inlet and outlet of each hot-water storage tank shall be one of the following:
  - 1. Liquid-filled, sealed, bimetallic-actuated type.
  - 2. Direct-mounted, plastic-case, vapor-actuated type.
  - 3. Compact Industrial-style, liquid-in-glass type.
  - 4. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.
- C. Thermometers at inlet and outlet of each remote water chiller shall be one of the following:
  - 1. Liquid-filled, sealed, bimetallic-actuated type.
  - 2. Direct Remote-mounted, plastic-case, vapor-actuated type.
  - 3. Compact Industrial-style, liquid-in-glass type.
  - 4. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.
- D. Thermometers at inlet and outlet of each hot water recirculation pump shall be one of the following:
  - 1. Liquid-filled, sealed, bimetallic-actuated type.
  - 2. Direct remote-mounted, plastic-case, vapor-actuated type.
  - 3. Compact Industrial-style, liquid-in-glass type.
  - 4. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.
- E. Thermometers at inlet and outlet of each hot water Master Mixing Station shall be one of the following:
  - 1. Compact Industrial-style, liquid-in-glass type.
  - 2. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.
- F. Thermometer stems shall be of length to match thermowell insertion length.

3.6 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Cold-Water Piping: 0 to 140 deg F
- B. Scale Range for Hot-Water Piping: 0 to 200 deg F
- C. Scale Range for Cooled-Water Piping: 0 to 100 deg F
- D. Scale Range for Solar-Water Piping: 0 to 250 deg F

3.7 PRESSURE-GAGE SCHEDULE

- A. Pressure gauges at discharge of each water service into building shall be the following:
  - 1. Sealed, direct -mounted, plastic case.
- B. Pressure gauges at inlet and outlet of each water pressure-reducing valve shall be the following:
  - 1. Sealed, direct-mounted, plastic case.
  - 2. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.
- C. Pressure gauges at suction and discharge of each water pump shall be one of the following:
  - 1. Liquid-filled, sealed open-front, pressure-relief solid-front, pressure-relief, direct-mounted, metal case.
  - 2. Sealed, direct-mounted, plastic case.
  - 3. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.

3.8 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Water Service Piping: 0 to 160 psi and 0 to 1100 kPa.
- B. Scale Range for Water Piping: 0 to 100 psi.
- C. Scale Range for Water Piping: 0 to 160 psi.
- D. Scale Range for Water Piping: 0 to 200 psi.

END OF SECTION

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## SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes:
  - 1. Metal pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Fiberglass pipe hangers.
  - 4. Metal framing systems.
  - 5. Fiberglass strut systems.
  - 6. Thermal-hanger shield inserts.
  - 7. Fastener systems.
  - 8. Pipe stands.
  - 9. Pipe positioning systems.
  - 10. Equipment supports.
  - 11. Miscellaneous materials.
  - 12. Acoustical isolation hangers and supports.
  - 13. Pipe and supports for buried cast iron or PVC piping.
  - 14. Bracing and support for cast iron drainage piping.
- B. Related Sections
  - 1. Division 05 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

#### 1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include Product Data for components Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze pipe hangers.
  - 2. Metal framing systems.
  - 3. Fiberglass strut systems.
  - 4. Pipe stands.
  - 5. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Detailed fabrication and assembly of trapeze hangers.
  - 2. Design Calculations: Calculate requirements for designing trapeze hangers.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

#### 1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.



## **PART 2 - PRODUCTS**

### **2.1 METAL PIPE HANGERS AND SUPPORTS**

#### **A. Carbon-Steel Pipe Hangers and Supports**

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

#### **B. Stainless-Steel Pipe Hangers and Supports**

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

#### **C. Copper Pipe Hangers**

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

- D. Note: hanger rods shall not be used in shear or compression applications. Threaded rod for tension use only.

### **2.2 TRAPEZE PIPE HANGERS**

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

### **2.3 FIBERGLASS PIPE HANGERS**

#### **A. Clevis-Type, Fiberglass Pipe Hangers**

1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of fiberglass polyurethane or stainless steel.

#### **B. Strap-Type, Fiberglass Pipe Hangers:**

1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

## 2.4 METAL FRAMING SYSTEMS

### A. MFMA Manufacturer Metal Framing Systems

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Metallic Coating: Electroplated zinc hot-dipped galvanized mill galvanized in-line, hot galvanized mechanically deposited zinc.

### B. Non-MFMA Manufacturer Metal Framing Systems

1. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Coating: Zinc.

## 2.5 FIBERGLASS STRUT SYSTEMS

### A. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.

1. Channels: Continuous slotted fiberglass or other plastic channel with inturned lips.
2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of fiberglass or stainless steel.

## 2.6 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.7 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless- steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Internally Threaded Anchor for Installation into Metal Deck: Concrete anchor shall be carbon steel, cast-in type with single internal thread and a zinc/yellow chromate plating. The anchor shall have a protective sleeve, steel flange with pre-drilled additional fastening holes and placement spring for attachment to metal deck, anchor is to be secured by clamping the deck between the steel flange and the protective plastic sleeve. The anchor shall bear the diameter and the manufacturer name on the hexagonal head.
- C. Internally Threaded Anchor for Installation into Wood Deck: Concrete anchor shall be carbon steel, cast-in type with single internal thread and a zinc/yellow chromate plating and contained by a plastic flange. The anchor shall have break-off nails for attachment to the surface of wood forms. Anchor will bear the diameter and manufacturer name on hexagonal head.

## 2.8 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand
  - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
  - 2. Base: Stainless steel.
  - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
  - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand
  - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
  - 2. Bases: One or more; plastic.
  - 3. Vertical Members: Two or more protective-coated-steel channels.
  - 4. Horizontal Member: Protective-coated-steel channel.
  - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

## 2.9 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

## 2.10 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## 2.11 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Non-staining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## 2.12 ACOUSTICAL ISOLATION HANGERS AND SUPPORTS

- A. All devices, hangers, and supports shall be manufactured components and not field devised methods.
- B. Acceptable Manufacturers:
  - 1. HOLDRITE, Silencer System
  - 2. LSP Products Group, Acousto-Plumb
- C. Closure Clamp: Sound rated variable closure clamp compatible with copper, PEX, and CPVC pipe, for either side or top mounting. Nylon material with TPR pads with UL94V-2 fire rating. Equal to HOLDRITE #250, #255, #280 and #285.
- D. Shower Head/Tub Spout Attachment Clamp: Acoustical clamp for attachment to in-wall framing system that will accept a drop eared 90-degree elbow. Shell shall be polypropylene with UL94V-2 fire rating with santoprene isolator material. Equal to HOLDRITE #265.
- E. Through Stud Isolator/Suspension Clamp: sound rated suspension hanger or through-hole isolator in wood or metal framing for copper, PEX, and CPVC piping. Shell shall be polypropylene with UL94V-2 fire rating with TPE isolator material. Equal to HOLDRITE #261, #262, #263, and #264.
- F. Acoustical Insulation Hanger Liner: TPE sound insulation lining to minimize occurrence of frictional noise caused by thermal expansion. Attaches to in-wall framing systems or around pipes to provide isolation from structure. Equal to HOLDRITE #270 and #271.
- G. Isolation Felt: Felt used for providing sound insulation between piping and hangers, made from polyester felt, with one side being pressure-sensitive adhesive. Equal to HOLDRITE #272-2 and 272-4.

- H. Vibration Isolation Pad: Engineered sound and neoprene vibration riser pad with 10-gauge steel bearing plate for use with riser clamps and equipment isolation, minimum of 3/4 inch thick. Parallel to HOLDRITE #275.

## 2.13 PIPE SUPPORT SYSTEMS FOR PLASTIC PIPING

- A. Hangers and supports shall be designed for PLASTIC PIPING SYSTEM tubing containing no sharp edges or surfaces.
- B. Drop ear bend supports or pre-manufactured wall supports/pipe positioning systems shall be utilized to provide a rigid installation between the vertical piping in the wall to the fixture supply.
- C. Bend supports shall be used at all locations where the tubing is making a 90-degree bend. This includes both within the ceiling and in the wall cavity.
- D. All thermoplastic pressure piping  $\leq 3$  inches and smaller shall be continuously supported by metallic CTS support channels or metallic V channels
  - 1. V Bottom channel comparable to B-line B3106V plastic pipe support channel, galvanized finish
  - 2. V channels support: V Bottom clevis hanger like B-line B3106 hanger, galvanized finish

## 2.14 HANGERS AND SUPPORTS FOR BURIED CAST IRON OR PVC PIPING

- A. General
  - 1. Underground piping where encountered by soil conditions unfit to support the pipe shall be supported from the structural slab.
  - 2. Pipe support materials are described in this section.
  - 3. Soil conditions shall be identified by the Geotechnical Engineer. Soil forces on the pipe shall be determined by the structural engineer.
  - 4. Refer to plumbing detail sheets for specifics regarding support of underslab piping.
  - 5. Underground Piping that requires support systems shall be shown on the drawings and/or described below:
    - a. All of the buried piping in this contract
    - b. The piping indicated on drawings.
    - c. Piping on the lowest level in areas shaded or crosshatched on the underground piping drawings.
- B. Description
  - 1. Piping is installed by trenching into the fill, and then putting hangers with support rods on the pipes as they are installed.
  - 2. Extend hanger rods upward. Anchor the top of the rod in the concrete slab per details indicated on the drawings.
  - 3. The hangers to be used shall be clamp-on type such that the pipe does not move within the hanger and shall be installed as the work progresses.
  - 4. Always keep hangers in a vertical position.

5. Install pipes as close as possible on the underside of the slab. It shall be carried at this elevation out to and through the exterior grade-beam (foundation wall) before dropping to meet the sewer elevation.
6. Hangers and rods shall be placed at two or four-foot centers maximum - based on verification with the Geotechnical Engineer.
7. Install a hanger at each fitting and change of direction.

**C. Backfill and Support**

1. The loading on the buried pipe shall be limited by one of the following two methods.
  - a. In all cases, place Pea Gravel 6 inches below the pipe and lay pipe solid with its hangers in place
  - b. Method 1
    - 1) Place Pea Gravel or Clean Sand Fill around and above the pipeline all the way up to the slab grade. The same fill shall be provided for 12 in. or more on both sides of the pipeline.
  - c. Method 2
    - 1) Foam Insulation Shear Plane—Sheets of 1 in. thick foam insulation shall be placed on both sides of the rods along the entire length of the pipework. Extend the foam down to and over the pipe to the centerline. Fasten the two sheets together at each hanger with wire ties.
    - 2) Backfill shall be placed on both sides of the insulation so that the rods and insulation remain vertical.
  - d. Just before the slab is poured, all the hanger rods must be present at the proper elevation and in alignment.

**D. Materials**

1. All material used to support the underground piping including rods, hangers, fasteners, clips, retainers and sundries shall be made of series 300 stainless steel.
2. Hanger Rods
  - a. Present pipe load data to the manufacturer to determine exact rod sizes.
  - b. Minimum rod sizes for 2- and 3-inch pipe shall be 1/2 inch.
  - c. Minimum rod sizes for 4- to 6-inch pipe shall be 5/8 inch.
  - d. Minimum rod sizes 8 inch and larger pipe shall be 3/4 inch.
  - e. All rods must be at least 304 stainless steel and fit with stainless steel rod to plate or rod to hanger U-bolt attachments.
3. Hangers: 304 stainless steel heavy duty and standard duty double bolt pipe clamps.
4. Rod attachment Concrete Plates: 304 stainless steel placed within rebar assembly for the concrete slab. See drawing details.

## 2.15 AREAS WHERE CORROSION RESISTANT PIPE SUPPORT SYSTEMS ARE REQUIRED

### A. General:

1. Unless required or documented elsewhere in the drawings or specifications, provide corrosion resistant support systems in schedule B chart below.
2. Support Systems: Use 316 stainless-steel and fiberglass pipe hangers and related support systems including rods, braces, shoes, racks, sleeves, anchors or guides, and miscellaneous connection hardware to structures.
3. Racked Piping: Use fiberglass or stainless-steel strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications.
4. The use of plastic-coated carbon steel or other metallic materials apart from stainless steel is prohibited except as noted.

### B. Schedule

Room Or Area	Limits	Pipe Type	Size	Material
Reclaim Water Equipment Rooms	All Piping Note 3	Thermoplastic Metallic	Greater than 2 inches	316 Stainless Steel
			Equal or less than 2 inches	316 Stainless Steel Fiberglass
Exposed Piping on Roofs	All Piping	Thermoplastic Metallic	Entire piping systems **LINK** note 7	316 Stainless Steel
Exterior Rack Piping	All Piping	Thermoplastic Metallic	Entire piping systems	316 Stainless Steel
Exterior or Open Parking Garages	All Piping	Thermoplastic Metallic	Entire piping systems	Pre galvanized Coated Steel, or Fiberglass supports **LINK** **LINK**
Pool Natatoriums	All Piping	Thermoplastic Metallic	1/2 to 8 inch including all utility services piped through the room	316 Stainless Steel Fiberglass
Pool Equipment Rooms	All Piping	Thermoplastic Metallic	1/2 to 8 inch including all utility services piped through the room	316 Stainless Steel Fiberglass
Clean Rooms	all Piping Note 5	Thermoplastic Metallic	1/2 to 8 inch including all utility services piped through the room	316 Stainless Steel 316 Stainless Steel
Kitchens Prep areas, Dish Washing and Scullery Rooms	All Piping Note 5	Thermoplastic Metallic	Greater than 2 inches	316 Stainless Steel
			Equal or less than 2 inches	316 Stainless Steel Fiberglass
Oceanfront Piers and Wharfs	All Piping exposed to open air Notes 1,2	Thermoplastic Metallic	Entire piping systems	316 Stainless Steel
Oceanfront/ Proximity Buildings Within 1 mile	All Piping Note 1, 2	Thermoplastic Metallic	Greater than 2 inches	316 Stainless Steel
			Equal or less than 2 inches	316 Stainless Steel Fiberglass
<div><div>1.</div><div>All piping exposed to outdoors shall have stainless steel attachments including roof blocks. Roof blocks similar to MAPA **LINK** or MIFAB supports with stainless trim</div></div> <div><div>2.</div><div>All piping in open Penthouses, Open or Louver Ventilated Mechanical Rooms in addition to piping in this chart</div></div> <div><div>3.</div><div>Only where hypochlorite’s are used in the process all exposed Indoor piping to have 316 stainless , thermoplastic, fiberglass **LINK** , Thermoplastic **LINK** , supports</div></div> <div><div>4.</div><div>For all noted above, use Stainless Steel threaded rod links. **LINK**</div></div> <div><div>5.</div><div>Exposed piping in the room. pipework above the room ceiling is exempt.</div></div> <div><div>6.</div><div>Pool Natatoriums and Pool equipment rooms</div></div> <div><div>7.</div><div>For areas designate in this chart, use 316 stainless steel for areas where seismic braces or restraints are installed,</div></div>				

## 2.16 BRACING AND SUPPORT FOR CAST IRON DRAINAGE PIPING

### A. General

1. Cast Iron piping with hub joints or no-hub pipe and fitting coupling joints that are exposed to thrust pressures greater than those recommended by the pipe and fitting manufacturer shall receive auxiliary support by means of appropriate bracing materials, as referred to in CISPI Designation 310-04, CIPSI Designation 301-09 and the CISPI Cast Iron Soil Pipe and Fittings Handbook. Auxiliary restraint products used shall be manufactured assemblies with thrust pressure rating adequate for the specific installation and shall be installed onto horizontal joints NPS 4 diameter and larger in size. Field devised methods and materials shall not be used to accomplish this application solution.

### B. Base Riser Supports, All Pipe Sizes

1. For above floor base of riser stacks supports exiting through wall: Support all base or riser stacks from floor at the lowest point of the sanitary or storm riser. Use an approved floor stanchion or base stand with approved saddle clamp.
2. For underslab base of riser stack supports: Place thrust block at base of long sweep or use pipe restraints to lock underground hubs at inlet and outlet of long sweep.
3. For horizontal to vertical base of riser supports at ceiling – base of riser stack: Support all base or riser stacks using mechanical strap supports across the long sweep or lateral fitting using restraints similar to HOLDRITE #117 series restraints **\*\*LINK\*\***
4. For all change all of direction support
  - a. No-Hub pip and/or Bell and Spigot pipe sizes greater than 4 inch, provide restraints for all drainpipes at all changes in direction and at changes in diameter greater than two pipe sizes per coupling manufacturer reference. HOLDRITE #117 series restraints **\*\*LINK\*\***

### C. All Stormwater piping:

1. Pipe sizes greater than or equal to 3 inch, provide restraints for all drainpipes at all changes in direction and at changes in diameter greater than two pipe sizes per coupling manufacturer reference. HOLDRITE #117 series restraints **\*\*LINK\*\***
2. Base of riser for storm lines > 4 inches in diameter: in addition to item B above, secure the horizontal and vertical portions of the 90 degree log sweep or 90 degree wye and 1/8<sup>th</sup> bend with a joint restraint clamps similar to Anvil figure 595 **\*\*LINK\*\***

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89 and local codes. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.



1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field-fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation
  1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to the manufacturer's written instructions.
- H. Pipe Stand Installation
  1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount them on smooth roof surface. Do not penetrate roof membrane.
  2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 for curbs.
- I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- J. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- M. Install lateral bracing with pipe hangers and supports to prevent swaying.
- N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- Q. Insulated Piping
  1. Attach clamps and spacers to piping.

- a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
  - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
  - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  - b. NPS 4: 12 inches long and 0.06 inch thick.
  - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
  - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
  - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
7. Support of pipe, tubing and equipment shall be accomplished by means of engineered products, specific to each application. Makeshift, field devised methods are not allowed.
8. Comply with CISPI Designation 310-04, CISPI Designation 301-09 and the CISPI Cast Iron Soil Pipe Handbook, regarding auxiliary support for ho-hub cast iron pipe and fitting joints subjected to excessive thrust forces. Use manufactured assemblies with appropriate thrust pressure ratings, rather than field assembled miscellaneous materials.

### 3.2 PEX PIPING SUPPORTS

- A. Follow all recommendations in the PEX design manual for support of PEX piping systems  
\*\*[LINK](#)\*\*
- B. Hangers and supports shall be designed for PEX tubing containing no sharp edges or surfaces.
- C. Drop ear bend supports or pre-manufactured wall supports/pipe positioning systems shall be utilized to provide a rigid installation between the vertical piping in the wall to the fixture supply.
- D. Bend supports shall be used at all locations where the tubing is making a 90-degree bend. This includes both in the ceiling and in the wall cavity.

- E. Provide steel plate protectors in any location where there is possible damage from drywall, concrete board, or paneling screws or nails.
- F. If PEX tubing passes through hollow masonry walls or metal studs, always protect with suitable sleeves or grommets.
- G. Install hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. Method 1: 3 inches and smaller: 32 inches utilizing 3/8 inch rod.
  - 2. Method 2: 3 inches and smaller: Continuously supported by metallic CTS support channels or metallic V channels that:
    - a. Are supported every 6 feet for NPS 1 inch and smaller.
    - b. Are supported every 8 feet for NPS 1-1/4 inches and larger.
    - c. Have a maximum cantilever, measured from the support to the end of the support channel of 1.5 feet.
- H. Vertical Risers
  - 1. Install supports and mid-story guides on vertical PEX risers per the manufacturer's guidelines. At a minimum, install:
    - a. Riser clamp at the base of each floor for both cold and hot water risers.
    - b. Riser clamp at the top of every fourth floor for cold water risers.
    - c. Riser clamp at the top of every other floor for hot water risers.
    - d. Mid-story guide on every floor for both cold and hot water risers to guide expansion. Install iron pipe size (IPS) clamps as mid-story guides so as not to restrain the piping.
- I. Expansion and Contraction
  - 1. As a generally accepted practice, an expansion-controlling device with fixed anchor points or a continuous run of PEX-a Pipe.
  - 2. Support with fixed anchor points is installed every 65 ft. of straight-length piping in a domestic hot-water system.
  - 3. Always install the device at the mid-point of two fixed points.
  - 4. See PEX piping systems manual **\*\*LINK\*\***, expansion compensation section.

### 3.3 ACOUSTICAL HANGERS AND SUPPORT ISOLATION INSTALLATION

- A. Install all items per the manufacturer's recommendations.
- B. Use any and all of the specified components to provide for a complete vibration and acoustical isolated system installation on all water, sanitary and storm, and vent piping systems. Use the appropriate isolator type at each location.
- C. Install acoustical hangers and support isolators to prevent all direct, rigid contact between piping and surrounding structures and hangers. No metal-to-metal contact is permissible.
- D. Provide isolation of all riser clamps. The neoprene pads shall not be more than 25 percent compressed when retaining bolts are tightened. Size supports as required.

- E. Pipes must not directly contact gypsum board, framing, conduit, or other structural elements. Use adequate clearance and approved felt pads to prevent direct contact between pipes and the structure. Holes and cutouts must be adequately oversized to allow clearance all around the piping.

### 3.4 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing for equipment supports to prevent swaying.

### 3.5 BURIED CAST IRON OR PVC PIPING - HANGERS AND SUPPORT INSTALLATION

- A. Piping shall be installed at the prescribed elevation as the fill is being placed within the grade beam area or the piping shall be installed in trenches cut into the fill.
- B. Clamping pipe hangers with rods extending upward shall be installed as the work progresses. The clamping hangers shall be fastened securely to the pipe or fitting and shall hold the rod vertical.
- C. Assure that support plates are structurally tied and supported by the slab rebar as the concrete slab is placed.
- D. Furnish a support hanger at all cleanouts and floor drains. Place concrete at base of cleanouts and floor drains such that the hanger is embedded in the concrete.

### 3.6 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.7 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.8 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 for painting.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.9 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and fiberglass pipe hangers and fiberglass strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
  - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
  7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
  8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
  9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
  10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
  11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
  12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
  17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
  19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
  21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
  6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
  7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary, to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.



3.10 SPACING

- A. Refer to individual piping sections for spacing requirements.
- B. Where no requirement is specified elsewhere, pipe hangers and supports shall be per MSS SP-90.
- C. Space pipe hangers and supports in accordance with following tables, with exceptions as indicated herein.
- D. The vertical spacing shall be at each floor level, with spacing not to exceed that shown in the table below. Provide mid story guides on PEX, PVC, PP, and CPVC piping per local code requirements.

Table 1 – Maximum Horizontal Pipe Hanger and Support Spacing

		1		2		3		4		5	6	7	8	9	10	11	12	13
NOMINAL PIPE OR TUBE SIZE		STD WT STEEL PIPE				COPPER TUBE				CSST	DUCTILE IRON PIPE	CAST IRON SOIL	PEX	PLASTIC PVC	PLASTIC CPVC 1 inch AND SMALLER	PLASTIC CPVC 1- 1/4 inch AND LARGER	PLASTIC PP 1 inch AND SMALLER	PLASTIC PP 1-1/4 inch AND LARGER
		WATER SERVICE		VAPOR SERVICE		WATER SERVICE		VAPOR SERVICE										
in.	mm	ft.	m	ft.	m	ft.	mm	ft.	m									
1/4	(6)					5	1.5	4	1.2	FOLLOW REQUIREMENTS OF THE PIPING MANUFACTURER.	10 FT. (3.0m) MAX SPACING.	5 FT. (3.0m) MAX SPACING EXCEPT MAY INCREASE TO 10 FT. WHERE 10 FOOT LENGTHS ARE INSTALLED. MIN OF ONE (1) HANGER PER PIPE SECTION CLOSE TO JOINT ON THE BARREL. ALSO AT CHANGE OF DIRECTION AND BRANCH CONNECTIONS.	32 IN. (813mm) MAX. SPACING.	4 FT. (1.22m) MAX SPACING.	3 FT. (.91m) MAX. SPACING.	4 FT. (1.22m) MAX. SPACING.	32 IN. (813mm) MAX. SPACING.	4 FT. (1.22m) MAXIMUM SPACING.
3/8	(10)	7	2.1	6	1.8	5	1.5	4	1.2									
1/2	(15)	7	2.1	6	1.8	5	1.5	4	1.2									
3/4	(20)	7	2.1	8	2.4	5	1.5	6	1.8									
1	(25)	7	2.1	8	2.4	6	1.8	8	2.4									
1- 1/4	(32)	7	2.1	10	3.0	6	2.1	8	2.4									
1- 1/2	(40)	9	2.7	10	3.0	8	2.4	8	2.4									
2	(50)	10	3.0	10	3.0	8	2.4	8	2.4									
2- 1/2	(65)	11	3.4	10	3.0	9	2.7	8	2.4									
3	(80)	12	3.7	10	3.0	10	3.0	8	2.4									
3- 1/2	(90)	12	3.7	10	3.0	10	3.0	8	2.4									
4	(100)	12	3.7	10	3.0	10	3.0	8	2.4									
5	(125)	12	3.7	10	3.0	10	30	8	2.4									
6	(150)	12	3.7	10	3.0	10	3.0	8	2.4									
8	(200)	12	3.7	10	3.0	10	3.0	8	2.4									
10	(250)	12	3.7	10	3.0	10	3.0	8	2.4									
12	(300)	12	3.7	10	3.0	10	3.0	8	2.4									
14	(350)	12	3.7	10	3.0													
16	(400)	12	3.7	10	3.0													
18	(450)	12	3.7	10	3.0													
20	(500)	12	3.7	10	3.0													
24	(600)	12	3.7	10	3.0													
30	(750)	12	3.7	10	3.0													

Vertical Spacing	15	4.5	15	4.5	10	3.0	10	3.0	Per manufacturer	15' (4.5m)	15' (4.5m)	10' (3.0m)	10' (3.0m)	10' (3.0m)	10' (3.0m)	10' (3.0m)	10' (3.0m)
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Table 1 – Maximum Horizontal Pipe Hanger and Support Spacing

		1		2		3		4		5	6	7	8	9	10	11	12	13
NOMINAL PIPE OR TUBE SIZE		STD WT STEEL PIPE				COPPER TUBE				CSST	DUCTILE IRON PIPE	CAST IRON SOIL	PEX	PLASTIC PVC	PLASTIC CPVC 1 inch AND SMALLER	PLASTIC CPVC 1- 1/4 inch AND LARGER	PLASTIC PP 1 inch AND SMALLER	PLASTIC PP 1-1/4 inch AND LARGER
		WATER SERVICE		VAPOR SERVICE		WATER SERVICE		VAPOR SERVICE										
in.	mm	ft.	m	ft.	m	ft.	mm	ft.	m									
1/4	(6)					5	1.5	5	1.5	FOLLOW REQUIREMENTS OF THE PIPING MANUFACTURER.	10 FT. (3.0m) MAX SPACING.	WITH LEAD AND OAKUM 5 FT. MAX SPACING EXCEPT MAY INCREASE TO 10 FT. WHERE 10 FOOT LENGTHS ARE INSTALLED. WITH COMPRESSION GASKETS AND NO-HUB, SUPPORT AT EVERY OTHER JOINT UNLESS OVER 4 FEET THEN SUPPORT AT EVERY JOINT. MIN OF ONE (1) HANGER PER PIPE SECTION CLOSE TO JOINT ON THE BARREL. ALSO AT CHANGE OF DIRECTION AND BRANCH CONNECTIONS.	32 IN. (813mm) MAX. SPACING.	4 FT. (1.22m) MAX. SPACING.	3 FT. (.91m) MAX. SPACING.	4 FT. (1.22m) MAX. SPACING.	32 IN. (813mm) MAX. SPACING.	4 FT. (1.22m) MAXIMUM SPACING.
3/8	(10)	7	2.1	6	1.8	5	1.5	6	1.8									
1/2	(15)	7	2.1	6	1.8	5	1.5	6	1.8									
3/4	(20)	7	2.1	8	2.4	5	1.5	6	2.1									
1	(25)	7	2.1	8	2.4	6	1.8	6	2.4									
1- 1/4	(32)	7	2.1	10	3.0	6	2.1	6	2.7									
1- 1/2	(40)	9	2.7	10	3.0	6	2.1	6	3.0									
2	(50)	10	3.0	10	3.0	8	2.4	10	3.4									
2- 1/2	(65)	11	3.4	10	3.0	9	2.7	10	4.0									
3	(80)	12	3.7	10	3.0	10	3.0	10	4.3									
3- 1/2	(90)	12	3.7	10	3.0	10	3.0	10	4.6									
4	(100)	12	3.7	10	3.0	10	3.0	10	4.9									
5	(125)	12	3.7	10	3.0	10	3.0	10	4.9									
6	(150)	12	3.7	10	3.0	10	3.0	10	4.9									
8	(200)	12	3.7	10	3.0	10	3.0	10	4.9									
10	(250)	12	3.7	10	3.0	10	3.0	10	4.9									
12	(300)	12	3.7	10	3.0	10	3.0	10	4.9									
14	(350)	12	3.7	10	3.0													
16	(400)	12	3.7	10	3.0													

18	(450)	12	3.7	10	3.0												
20	(500)	12	3.7	10	3.0												
24	(600)	12	3.7	10	3.0												
30	(750)	12	3.7	10	3.0												
Vertical Spacing		25	7.6	Per Code		10	3.0	Per Code		Per Manufacturer	15' (4.5m)	15' (4.5m)	Each floor	Each floor	Each floor	Each floor	Each floor

		COLUMNS <sup>(3)</sup> 1, 2, 6, 7		COLUMNS <sup>(3)</sup> 3, 4, 9, 10, 11, 12, 13	
NOMINAL PIPE OR TUBING SIZE		NOMINAL ROD DIA.		NOMINAL ROD DIA.	
in	mm	in	mm	in	mm
1/4	(6)			3/8	M10
3/8	(10)	3/8	M10	3/8	M10
1/2	(15)	3/8	M10	3/8	M10
3/4	(20)	3/8	M10	3/8	M10
1	(25)	3/8	M10	3/8	M10
1-1/4	(32)	3/8	M10	3/8	M10
1-1/2	(40)	3/8	M10	3/8	M10
2	(50)	3/8	M10	3/8	M10
2-1/2	(65)	1/2	M12	1/2	M12
3	(80)	1/2	M12	1/2	M12
3-1/2	(90)	1/2	M12	1/2	M12
4	(100)	5/8	M16	1/2	M12
5	(125)	5/8	M16	1/2	M12
6	(150)	3/4	M20	5/8	M16
8	(200)	3/4	M20	3/4	M20
10	(250)	7/8	M20	3/4	M20
12	(300)	7/8	M20	3/4	M20
14	(350)	1	M24		
16	(400)	1	M24		
18	(450)	1	M24		
20	(500)	1-1/4	M30		
24	(600)	1-1/4	M30		
30	(750)	1-1/4	M30		
NOTE: (1) For calculated loads, rod diameters may be sized in accordance with MSS SP-58, Table 3 provided Table 1 and Section 7.3 of MSS SP-58 are satisfied. (2) Rods may be reduced one size for double rod hangers. Minimum rod diameter shall be 3/8 in. (M10). (3) Columns noted refer to Table 1, maximum horizontal pipe hanger and support spacing.					

END OF SECTION

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## **SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

##### **A. Section Includes**

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Restrained-spring isolators.
6. Pipe-riser resilient supports.
7. Resilient pipe guides.
8. Elastomeric hangers.
9. Spring hangers.
10. Vibration isolation equipment bases.
11. Thrust restraints.
12. Snubbers.
13. Restraint channel bracings.
14. Restraint cables.
15. Restraint accessories.
16. Mechanical anchor bolts.
17. Adhesive anchor bolts.

##### **B. Related Requirements**

1. Division 21 for vibration isolation and seismic devices for fire-suppression equipment and systems.
2. Division 23 for vibration isolation and seismic devices for HVAC equipment and systems.

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
  - 3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of and seismic-restraint component required.
    - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
    - b. Annotate to indicate application of each product submitted and compliance with requirements.
  - 4. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
  - 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
  - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal:
  - 1. For each vibration isolation device.
    - a. Include design calculations and details for selecting vibration isolators and vibration isolation bases.
    - b. Design Calculations: Calculate static and dynamic loading due to equipment weight and required to select vibration isolators and for designing vibration isolation bases.
      - 1) Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
    - c. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.
  - 2. For each seismic-restraint device.
    - a. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

- b. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic forces required to select vibration isolators and seismic restraints and for designing vibration isolation bases.
    - 1) Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
  - c. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
3. Wind-Restraint Details:
- a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
  - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during design wind speed. Indicate association with vibration isolation devices.
  - c. Comply with requirements in other Sections for equipment mounted outdoors.
4. Seismic-Restraint Details:
- a. Design Analysis: To support selection and arrangement of seismic and restraints. Include calculations of combined tensile and shear loads.
  - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
  - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
  - d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

#### 1.4 INFORMATIONAL SUBMITTALS

##### A. Coordination Drawings:

- 1. Show coordination of vibration isolation device installation for PLUMBING piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- 2. Show coordination of seismic bracing for PLUMBING piping and equipment with vibration isolation, other systems and equipment in the vicinity, including other supports and restraints, if any.



- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the applicable building code unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval by agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are required. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
  - 1. Basic Wind Speed: Verify with Structural Engineer.
  - 2. Building Classification Category: Verify with Structural Engineer.
  - 3. Minimum 10 lb/sq. ft. multiplied by maximum area of plumbing component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.

### 2.2 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. [Ace Mountings Co., Inc.](#)
    - b. [California Dynamics Corporation.](#)
    - c. [Isolation Technology, Inc.](#)
    - d. Or Approved Equal.
  - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.

3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Smooth, Ribbed or Waffle pattern.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.
  - a. Surface Pattern: Smooth, Ribbed or Waffle pattern.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

### A. Double-Deflection, Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. [Ace Mountings Co., Inc.](#)
  - b. [California Dynamics Corporation.](#)
  - c. [Isolation Technology, Inc.](#)
  - d. Or Approved Equal.
2. Mounting Plates:
  - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
  - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

### A. Restrained Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. [Ace Mountings Co., Inc.](#)
  - b. [California Dynamics Corporation.](#)
  - c. [Isolation Technology, Inc.](#)
  - d. Or Approved Equal.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - a. Housing: Cast-ductile iron or welded steel.

- b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.5 OPEN-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. [Ace Mountings Co., Inc.](#)
  - b. [California Dynamics Corporation.](#)
  - c. [Isolation Technology, Inc.](#)
  - d. Or Approved Equal.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

## 2.6 RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. [Ace Mountings Co., Inc.](#)
  - b. [California Dynamics Corporation.](#)
  - c. [Isolation Technology, Inc.](#)
  - d. Or Approved Equal.
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
  - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
  - b. Top plate with threaded mounting holes and elastomeric pad.
  - c. Internal leveling bolt that acts as blocking during installation.
3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.

4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.7 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2 inch- thick neoprene.
  1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
  2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

## 2.8 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2 inch- thick neoprene.
  1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.9 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. [Ace Mountings Co., Inc.](#)
    - b. [California Dynamics Corporation.](#)
    - c. [Isolation Technology, Inc.](#)
    - d. Or Approved Equal.
  2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
  3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

## 2.10 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. Ace Mountings Co., Inc.
  - b. California Dynamics Corporation.
  - c. Kinetics Noise Control, Inc.
  - d. Or Approved Equal.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

#### 2.11 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
  1. California Dynamics Corporation.
  2. Kinetics Noise Control.
  3. Mason Industries, Inc.
  4. Or Approved Equal.
- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
  1. Design Requirements: Lowest possible mounting height with not less than 1 inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1 inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- D. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Design Requirements: Lowest possible mounting height with not less than 1 inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
  4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

## 2.12 THRUST RESTRAINTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
1. [Ace Mountings Co., Inc.](#)
  2. [California Dynamics Corporation.](#)
  3. [Kinetics Noise Control.](#)
  4. Or Approved Equal
- B. Description: Spring element combined with steel angles, backup plates, threaded rod, washers and nuts to produce a pair of devices capable of limiting movement of air handling equipment to 0.25 inch.
- C. Restraint shall be convertible in the field from compression type to tension type.
- D. Unit shall be pre-compressed.

## 2.13 SNUBBERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
1. [Kinetics Noise Control, Inc.](#)

2. Mason Industries, Inc.
  3. Vibration Mountings & Controls, Inc.
  4. Or Approved Equal.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
  2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
  3. Maximum 1/4 inch air gap, and minimum 1/4 inch- thick resilient cushion.

#### 2.14 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
1. Cooper B-Line, Inc.
  2. Hilti, Inc.
  3. Unistrut.
  4. Or Approved Equal.
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

#### 2.15 RESTRAINT CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
1. Kinetics Noise Control, Inc.
  2. Loos & Co., Inc.
  3. Vibration Mountings & Controls, Inc.
  4. Or Approved Equal.
- B. Restraint Cables: ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

#### 2.16 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
1. Cooper B-Line, Inc.
  2. Kinetics Noise Control, Inc.
  3. Mason Industries, Inc.

4. Or Approved Equal.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

## 2.17 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
  1. Cooper B-Line, Inc.
  2. Hilti, Inc.
  3. Kinetics Noise Control, Inc.
  4. Or Approved Equal.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## 2.18 ADHESIVE ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
  1. Hilti, Inc.
  2. Kinetics Noise Control, Inc.
  3. Mason Industries, Inc.
  4. Or Approved Equal.
- B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.



## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and equipment to receive vibration isolation- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Examine areas and equipment to receive seismic restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

### **3.2 APPLICATIONS**

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength is adequate to carry present and future static and seismic loads within loading limits.

### **3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION**

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Comply with requirements in Division 07 for installation of roof curbs, equipment supports, and roof penetrations.
- D. Equipment Restraints:
  - 1. Install seismic snubbers on Plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
  - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- E. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
  - 2. Space lateral supports a maximum of 40 feet OC, and longitudinal supports a maximum of 80 feet OC.

3. Brace a change of direction longer than 12 feet.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- I. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- K. Drilled-in Anchors:
  1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
  2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
  5. Set anchors to manufacturer's recommended torque, using a torque wrench.
  6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 for piping flexible connections.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
  1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
  3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  5. Test to 90 percent of rated proof load of device.
  6. Measure isolator restraint clearance.
  7. Measure isolator deflection.
  8. Verify snubber minimum clearances.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

### 3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

### 3.7 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03.

### 3.8 VIBRATION ISOLATION SCHEDULES

- A. Provide vibration isolators and equipment bases for all rotating, piston driven or vibrating equipment in accordance with the following schedules. Selection of equipment isolators shall be based on approved equipment shop drawings.

Base & Isolator Types			
Base Types		Isolator Types	
A	No base, isolators attached directly to equipment.	1	Elastomeric pad.
B	Structural steel rails or base.	2	Elastomeric floor mount or hanger. Use restrained elastomeric mount where seismic restraint is required.
C	Concrete inertia base.	3	Spring floor isolator or hanger.
D	Curb-mounted base.	4	Restrained spring isolator.
		5	Thrust restraint.

Vibration Isolation -RODI Skids and Vacuum Pumps															
r Type	Horsepower and Other	RPM	Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			Table Notes
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
RODI Filter Skids	All	All	A	2	0.25	A	4	0.75	A	4	1.5	A	4	2.5	1
RODI RO Skids	All	All	A	1	0.25	A	4	0.75	A	4	1.5	A	4	1.5	1,2
RODI Storage Tanks	All	All	A	1	0.25	A	4	0.75	A	4	1.5	A	4	1.5	1,2
Vacuum Pumps	All	All	A	1	0.25	A	4	0.75	A	4	1.5	A	4	1.5	
Notes:															
1. Increase isolator deflection so isolator stiffness is less than one-tenth the stiffness of the supporting structure, as defined by the deflection due to load at the equipment support. 2. Where equipment manufacturer indicates component cannot be installed directly on individual isolators (type A), provide equipment manufacturer recommended supplemental support (base type).															

Vibration Isolation - Air Compressors															
Compressor Type	Horsepower and Other	RPM	Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			Table Notes
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Tank-mounted horizontal	≤10	All	A	3	0.75	A	3	0.75	A	3	1.5	A	3	1.5	1
	≥15	All	C	3	0.75	C	3	0.75	C	3	1.5	C	3	1.5	1
Tank-mounted vertical	All	All	C	3	0.75	C	3	0.75	C	3	1.5	C	3	1.5	1
Base-Mounted	All	All	C	3	0.75	C	3	0.75	C	3	1.5	C	3	1.5	1
Large Reciprocating	All	All	C	3	0.75	C	3	0.75	C	3	1.5	C	3	1.5	1
Notes:															
1. Compressors: Install base-mounted compressors through 5 hp and horizontal tank-type air compressors through 10 hp directly on spring isolators (type 3) with structural bases (type B), and compressors 15 to 100 hp on spring isolators (type 3) with inertia bases (type C) weighing 1 to 2 times the compressor weight.															

Vibration Isolation - Pumps															
Pump Type	Horsepower and Other	RPM	Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			Table Notes
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Close Coupled	≤7.5	All	B	2	0.25	C	3	0.75	C	3	0.75	C	3	0.75	1
	≥10	All	C	3	0.75	C	3	0.75	C	3	1.5	C	3	1.5	1
Large Inline	5 to 25	All	A	3	0.75	A	3	1.5	A	3	1.5	A	2	1.5	
	≥30	All	A	3	1.5	A	3	1.5	A	3	1.5	A	3	2.5	
End suction and split case	≤40	All	C	3	0.75	C	3	0.75	C	3	1.5	C	3	1.5	1
	50 to 125	All	C	3	0.75	C	3	0.75	C	3	1.5	C	3	2.5	1
	≥150	All	C	3	0.75	C	3	0.75	C	3	2.5	C	3	3.5	1
Notes: 1. Pumps: Type C bases strength and shape shall accommodate base elbow supports. Concrete bases (type C) shall be designed for a thickness of one-tenth the longest dimension with minimum thickness as follows: (1) for up to 30 hp, 6 in.; (2) for 40 to 75 hp, 8 in.; and (3) for 100 hp and up, 12 in. Pumps over 75 hp and multistage pumps shall be provided with supplemental restraining devices.															

Vibration Isolation - Water Heaters Generators															
Type	Horsepower and Other	RPM	Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			Table Notes
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Gas Fired	All	All	A	1	0.25	B	4	0.75	B	4	1.5	B	4	2.5	1
Electric	All	All	A	1	0.25	B	4	0.75	B	4	1.5	B	4	2.5	1
Steam Fired	All	All	A	1	0.25	B	4	0.75	B	4	1.5	B	4	2.5	1
Notes: 1. Where equipment manufacturer indicates component cannot be installed directly on individual isolators (type A) provide equipment manufacturer recommended supplemental support (base type).															

### 3.9 SCHEDULE FOR VIBRATION ISOLATION WATER STORAGE TANKS UP TO 2000 GALLON

A. Furnish and install vibration isolation and seismic restraint for all water storage tanks. Submit to the engineer a delegated design submission compliant with tank structure for seismic restraint. At a minimum submit the following:

1. Furnish and Install at minimum one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact
2. Furnish female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the ICBO Evaluation Service, Inc. verifying to its allowable loads.
3. Furnish and install housekeeping pad anchors consisting of a ductile iron casting that is tapered and hexagonal, smaller at its base than at its top. The upper portion shall have holes for rebar to pass through. The anchor shall be continuously threaded from top to bottom for the attachment of soleplates. Housekeeping pad anchors shall be attached to the structural slab using a stud wedge anchor.

**3.10 VIBRATION ISOLATION SOLAR PANELS**

- A. Provide with each solar panel, manufacturers vibration isolation and seismic control system. Design Calculations: Calculate static and dynamic loading due to equipment weight and required to select vibration isolators and for designing vibration isolation bases.
  - 1. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

**3.11 PIPING SYSTEM VIBRATION ISOLATION**

- A. Vibration isolators for suspended piping:
  - 1. Provide spring hangers for all piping in equipment rooms and up to 50 ft from vibration-isolated equipment and PRV stations. The first three hangers from the equipment shall be provided with the same deflection as the equipment isolators, with a maximum limitation of 2 in. deflection. Remaining hangers shall be spring or combination spring and elastomeric with 0.75 in. deflection. The first two hangers adjacent to the equipment shall be the positioning or pre-compressed type. Provide positioning hangers for all isolated piping 8 in. and larger. Piping over 2 inches in diameter suspended below or within 50 ft of conference rooms, classrooms and auditorium areas shall be hung with isolation hangers.
- B. Vibration isolators for floor-supported piping:
  - 1. Provide vibration isolators for floor supports for piping in equipment rooms to isolate equipment. Isolators shall be selected according to the guidelines for hangers. The first two adjacent floor supports shall be the restrained spring type, with a restraint/blocking feature to prevent load transfer to equipment flanges as the piping is filled or drained. Provide a slide plate where pipe is subjected to large thermal movement (PTFE, graphite, or steel) and shall be installed on top of the isolator. Provide a thermal barrier when rubber products are installed directly beneath steam or hot-water lines.
- C. Vibration isolation for piping riser supports:
  - 1. Provide resilient pipe riser support near to midpoint of riser and provide spring hangers at each floor or structural level to support riser and allow thermal expansion risers.
  - 2. Provide spring hangers for first three hangers connected to branch piping at each level.

**3.12 SCHEDULE FOR GAS PIPING AND MEDICAL GAS PIPING**

- A. Furnish and install complete seismic restraining system for all natural gas piping and medical gas piping system installed in this contract.
  - 1. Use seismic cable restraints (paragraph 2.3.L) if isolated. Seismic cable restraints or seismic solid braces restraints may be used on un-isolated piping.
  - 2. Seismically restrain all piping as follows:
    - a. Gas piping, medical gas piping, and medical compressed air and medical vacuum piping that is 1 inch ID or larger.
  - 3. Transverse piping restraints shall be at 40 feet maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.

4. Longitudinal restraints shall be at 80 feet maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
5. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24 inches of the elbow or tee or combined stresses are within allowable limits at longer distances.
7. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
8. Branch lines may not be used to restrain main lines.

END OF SECTION

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## SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Valve tags.
  - 5. Warning tags.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to be included in maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
  - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following or approved equal:
    - a. Brady Corporation
    - b. Marketing Services, Inc.



- c. Seton Identification Products
    - d. Or Approved Equal.
  - 2. Material and Thickness:
    - a. Brass, 0.032-inch
    - b. Stainless steel, 0.025-inch
    - c. Aluminum, 0.032-inch or anodized aluminum, 0.032-inch
    - d. Above are minimum thickness, and all having predrilled or stamped holes for attachment hardware.
  - 3. Letter Color: Black.
  - 4. Background Color: White.
  - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 6. Minimum Letter Size: 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
  - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
  - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
- 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following or approved equal:
    - a. Brady Corporation
    - b. Marking Services, Inc.
    - c. Seton Identification Products
    - d. Or Approved Equal.
  - 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
  - 3. Letter Color: Black.
  - 4. Background Color: White.
  - 5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
  - 6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
  - 8. Fasteners: Stainless-steel rivets or self-tapping screws.
  - 9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following or approved equal:
  - 1. Brady Corporation
  - 2. Marking Services Inc.
  - 3. Seton Identification Products
  - 4. Or Approved Equal.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: White.
- D. Background Color: Red.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following or approved equal:
  - 1. Brady Corporation
  - 2. Marking Services Inc.
  - 3. Seton Identification Products

4. Or Approved Equal.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Pipe Label Contents: Include identification of piping service using designations listed in part 3.1 ; also include an arrow indicating flow direction.
  1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  2. Lettering Size: Size letters according to ASME A13.1 for piping At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

## 2.4 VALVE TAGS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following or approved equal:
  1. Brady Corporation
  2. Marking Services, Inc.
  3. Seton Identification Products
  4. Or Approved Equal.
- B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  1. Tag Material: Brass, 0.032-inch or stainless steel, 0.025-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
  2. Fasteners: Brass wire-link chain or beaded chain or S-hook.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  1. Valve-tag schedule shall be included in operation and maintenance data.
- D. When an isolation or other functioning valve controls a specific remote operation that is separated by a partition or wall, include in the valve tag the valve's function. At the remote connection point, place signage stipulating where the control valve is located.

## 2.5 WARNING TAGS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following or approved equal:
  1. Brady Corporation
  2. Marking Services Inc.

3. Seton Identification Products
  4. Or Approved Equal.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches.
  2. Fasteners: Reinforced grommet and wire or string.
  3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  4. Color: Safety yellow background with black lettering.

### PART 3 - EXECUTION

#### 3.1 PIPE IDENTIFICATION SCHEDULE

##### A. General

1. Provide color-coded pipe identification markers on piping installed under this Section. Pipe markers shall be Snap-On laminated plastic protected by clear acrylic coating. Pipe markers shall be applied after Architectural painting where such is required.
2. Provide an arrow marker with each pipe content marker to indicate direction of flow. If flow can be in either direction, use double-headed arrow marker.
3. Color banding shall meet ASME, ANSI latest and OSHA requirements.
4. Markers are to be applied to all piping, regardless of under jacket colors per the tables that follow:
5. Apply labels to all piping routed throughout any areas including those above drop ceilings, under floor, and those exposed to view when access doors or access panels are opened.
6. Apply labels to piping in concealed areas. Concealed areas, for purposes of this identification section, are those areas that cannot be seen except by demolition of the building elements.
7. In addition to pipe markers, arrow markers shall be used to indicate the direction of flow.
8. Where the same service is distributed at different pressures, include in the marker the pressure of the service.
  - a. Example: Natural gas - Gas 2 psig, or Gas 10 inches WC
  - b. Example: Compressed air - Lab Compressed Air 25 psig or Lab compressed air 110 psig
9. As a minimum, locate pipe markers as follows:
  - a. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one (1) header, it is necessary to mark only the header.
  - b. At each branch or riser take off on piping systems, excluding short takeoffs for fixtures and terminal units.

- c. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where the pipe penetrates a wall, floor, service column or enclosure.
- d. At access doors, manholes and similar access points that permit view of concealed piping.
- e. Near major equipment items and other points of origination and termination

B. The charts below indicate the following:

- a. Marker/Legend: label text printed on the pipe label
- b. Label Color: back round base color
- c. Text Color: self-explanatory

<b>CHART 1</b> <b>Basic Plumbing Services</b>				
SERVICE	DRAWING	MARKER LEGEND (printed label)	LABEL COLOR	TEXT COLOR
Domestic Cold Water	CW	Domestic Cold Water	Green	White
Domestic Hot Water	HW	Domestic Hot Water	Green	White
Domestic Hot Water Return	HWR	Domestic Hot Water Return	Green	White
Domestic Hot Water 140° F	HW(140)	Domestic Hot Water 140 deg F	Green	White
Domestic Hot Water Return 140° F	HWR(140)	Domestic Hot Water Return 140 deg F	Green	White
Main Water Service to Facility	W	Municipal Water	Green	White
Non-Potable Water	NPW	Caution: Non-Potable Water. Do Not Drink	White	Green
Trap Primer	TP	Trap Primer Supply	Green	Black
Flushing Water	FL	Flushing Water	Purple	White
Reclaimed Water	REW	Reclaimed Water	Purple	White
Solar Hot Water Supply	SW(S)	Solar Hot Water Supply	Orange	Black
Solar Hot Water Supply	SW(R)	Solar Hot Water Return	Orange	Black
Natural Gas - Low pressure	G	Natural Gas	Yellow	Black
Natural Gas - High pressure	G (x psi)	Natural Gas xx psig (note 1)	Yellow	Black
Natural Gas Vent	GAS(V)	Gas Vent	Yellow	Black
Propane	LP	Propane Gas	Yellow	Black
Indirect Waste	IW	Per Service	White	Black
HVAC Condensate	CWW	Cold Condensate	Green	White
Condensate Vent	CWW(V)	Clear Waste Vent	Green	White
Rainwater	RW	Rainwater Drain	Green	Black
Rainwater Vent	RW(V)	Rainwater Vent	Green	Black
Secondary Rainwater	RW(O)	Rainwater Drain Overflow	Green	Black
Sanitary Waste	SW	Sanitary, Waste, (note 2)	Orange	Black
Sanitary Vent	SV	Sanitary, Vent (note 2)	Orange	Black
Kitchen Waste	KW	Kitchen Waste	Orange	Black
Kitchen Vent	KV	Kitchen Vent	Orange	Black
Garage Waste	GW	Garage Waste	Orange	Black
Garage Vent	GV	Garage Vent	Orange	Black
Sanitary Force Main	SAN(FM)	Sanitary Force Main	Orange	Black
Rainwater Force Main	RW(FM)	Storm Force Main	Green	Black
Notes:  1. Indicates line pressure in label. 2. Specify service, i.e., sanitary waste, sanitary vent etc.				

CHART 2 Basic Laboratory Plumbing Services				
SERVICE	CODE	MARKER LEGEND	LABEL COLOR	TEXT COLOR
Lab 140 deg F Hot Water	LHW(140)	140 deg F Laboratory Hot Water Supply	Green	White
Lab 140 deg F Hot Water Return	LHWR(140)	140 deg F Laboratory Hot Water Return	Green	White
Lab Cold Water	LCW	Lab Cold Water	Green	White
Lab Hot Water	LHW(120)	Lab Hot Water	Green	White
Lab Hot Water Return	LHWR(120)	Lab Hot Water Return	Green	White
Emergency Tempered Water Supply	TWS	Tepid Water Supply	Green	White
Emergency Tempered Water Return	TWR	Tepid Water Return	Green	White
Compressed Air Intake	CAI	Compressed Air Intake	Blue	White
Compressed Air	CA(XXX)	Compressed Air xxx psig (note 1)	Blue	White
Shop or Plant air	SA(XXX)	Shop Air xxx psig (note1)	Blue	White
Laboratory Vacuum	VAC	Lab Vacuum	White/black checkerboard	Black Boxed
Laboratory Vacuum Exhaust	VE	Vacuum Exhaust	White/black checkerboard	Black Boxed
Carbon Dioxide	CO2(XX)	Carbon Dioxide xx psig (note 1)	Grey	White
Nitrogen	N2(XXX)	Nitrogen xxx psig (note 1)	White	Black
Helium	HE(XXX)	Helium xxx psig (note 1)	White	Black
Argon	AR(XXX)	Argon xxx psig (note 1)	White	Black
Inert Gas Vent	IGV	Inert Gas Vent	White	Black
Oxygen	O2(XXX)	Oxygen xxx psig (note 1)	Green	White
Oxygen Gas Vent	OGV	Oxygen Gas Vent	Green	White
Hydrogen	H2(XXX)	Hydrogen,	Yellow	Black
Flammable Gas Vent	FGV	Flammable Gas Vent	Brown	White
High Purity Gas	HPxxx(XXX)	HP Name of Gas xxx psig (note 1)	White	Black
Ultra High Purity Gas	UHPxxx(XXX)	UHP Name of Gas xxx psig (note 1)	White	Black
Lab Waste(Force Main)	LW(FM)	Lab Waste Force Main	Orange	Black
Lab Vent	LV	Lab Vent	Orange	Black
Lab Waste	LW	Lab Waste	Orange	Black
Process Waste	PW	Process Waste	Orange	Black
Reverse Osmosis Pretreatment Water	PTW	RO Pretreatment Water	Green	White
Purified Water Supply	PWS	ASTM type 1, 2, or 3, Supply (note 3)	White	Green
Purified Water Return	PWR	ASTM type 1, 2, or 3, Return (note 3)	White	Green
Purified Water for Humidification	PW(H)	RO Humidification Make-up	Yellow	Black
RO Reject Water	ROR	RO Reject Water	Purple	White
Notes: 1. Indicates line pressure in label. 2. Specify service, i.e., sanitary waste, sanitary vent etc. 3. Label pure water systems by type, i.e., ASTM 1, ASTM 2, CAPI, USP cold, USP hot, WFI etc. Submit label legend to owner for verification and approval				

THE CONTENTS IN CHART 3 ARE EXTENDED LAB SERVICES. REMOVE IF THE PROJECT DOES NOT HAVE EXTENDED LABORATORY SERVICES OR EDIT TO SUIT

CHART 3 Extended Laboratory Plumbing Services				
SERVICE	CODE	MARKER LEGEND	LABEL COLOR	TEXT COLOR
BSL3 Lab Cold Water	LCW(BSL3)	Level 3 Biosafety Lab Cold Water	Orange	Black
BSL3 Lab Hot Water	LHW(120-BSL3)	Level 3 Level 3 Biosafety Lab Hot Water	Orange	Black
BSL3 Lab Hot Water Return	LHWR(120-BSL3)	Level 3 Biosafety Lab Hot Water Return	Orange	Black
Special Waste Stream	SW1	that cannot go to ph system and may be routed to a tank or containment area Per Service	Orange	Black
BSL3 Lab Waste	LW(BSL3)	Biosafety Level 3 Wastewater	Orange	Black
BSL3 Lab Vent	LV(BSL3)	Biosafety Level 3 Vent	Orange	Black
BSL3 Lab Gas (Inert)	XXX(xxx-BSL3)	Per the gas service (note 1)	Black	White
BSL3 Lab Gas (Flammable)	XXX(xxx-BSL3)	Per the gas service (note 3)	Brown	White
BSL3 Inert Gas Vent	IGV(BSL3)	BSL3 Inert Gas Vent	Yellow	Black
BSL3 Oxygen Gas Vent	OGV(BSL3)	BSL3 Oxygen Gas Vent	Yellow	Black
BSL3 Flammable Gas Vent	FGV(BSL3)	BSL3 Flammable Gas Vent	Yellow	Black
BSL3 Vacuum	VAC (BSL3)	BSL3 Vacuum service (note 5)	White/black checkerboard	Black Boxed
USP	USP	Reagent Grade Cold Water	Yellow	Black
E Grade Purified Water	E GRADE	GRADE E RODI	Yellow	Black
Decontamination System Waste Piping	DW	HAZARDOUS WASTE - do not breach	Orange	Black
Decontamination System Vent Piping	DV	HAZARDOUS WASTE VENT - do not breach	Orange	Black
Notes 1. For example: Cylinder Carbon Dioxide, Cylinder Argon, Cylinder Oxygen, Cylinder Nitrogen, etc. 2. For example: Cylinder Argon-Methane, etc. 3. For example: Hydrogen, Methane, etc. 4. Stipulate E-grade level on the label 5. BSL vacuum must be contained in the lab barrier spaces, this includes pumps, piping outlets, exhausts 6. Designate Supply or Return in the label. Eg. "RODI -1 Lab Water Supply"				

<b>CHART 4</b>				
<b>Medical Gas Services</b>				
SERVICE	CODE	MARKER LEGEND	LABEL COLOR	TEXT COLOR
Medical Oxygen	MO	Medical Oxygen	Green	White
Medical Vacuum	MVAC	Medical Vacuum	White	Black
Waste Anesthetic Gas Disposal	WAGD	Waste Anesthetic Gas Disposal	Purple	White
Medical Nitrous Oxide	MN2O	Medical Nitrous Oxide	Blue	White
Medical Nitrogen	MN(XXX)	Medical Nitrogen	Black	White
Medical Air	MA	Medical Air	Yellow	Black
Medical Helium	MHE	Medical Helium	Brown	White
Medical Carbon Dioxide	MCO2	Medical Carbon Dioxide	Grey	White
Inert Gas Vent	IGV	Inert Gas Vent	Match colors of medical gas	
Oxygen Gas Vent	OGV	Oxygen Gas Vent	Green	White
Flammable Gas Vent	FGV	Flammable Gas Vent	Orange	Black
Instrument Air for Tools	IA(XXX)	Instrument Air for Tools	Red	White
Oral Evacuation	HVE	Oral Evacuation	White	Black
Dental Vacuum	DV	Dental Vacuum	White	Black
Renal Dialysis RO Water Supply	RO-RD	Dialysis RO	White	Green
Specialty Gas Mixture	Gas A%/Gas B%	Per Gas Mixture		

<b>CHART 5</b>				
<b>Vivarium Service Piping</b>				
SERVICE	CODE	MARKER LEGEND	LABEL COLOR	TEXT COLOR
Vivarium Cold Water	VCW	Vivarium Cold Water	Green	White
Vivarium Hot Water Supply	VHW	Vivarium Hot Water	Green	White
Vivarium Hot Water Return	VHWR	Vivarium Hot Water Return	Green	White
ABSL Vivarium Cold Water	VCW(ABSL)	Animal Biosafety Lab Cold Water	Orange	Black
ABSL Vivarium Hot Water Supply	VHW(ABSL)	Animal Biosafety Lab Hot Water	Orange	Black
ABSL Vivarium Hot Water Return	VHWR(ABSL)	Animal Biosafety Lab Hot Water Return	Orange	Black
Vivarium Compressed Air	VCA(XXX)	Vivarium Compressed Air xxx psig	Blue	White
Vivarium Vacuum	VVAC	Vivarium Vacuum	White	Black
Vivarium Oxygen	VO2(XX)	Vivarium Oxygen xx psig	Green	White
Vivarium Oxygen Gas Vent	OGV	Vivarium Oxygen Gas Vent	Green	White
Vivarium Carbon Dioxide	VCO2(XX)	Vivarium Carbon Dioxide xx psig	Grey	White
Inert Gas Vent	IGV	Vivarium Inert Gas Vent	Match colors of gas service	
ABSL Lab Gas (Inert)	XXX(ABSL)	ABSL Per the gas service	Yellow	Black
ABSL Lab Gas (Oxidizer))	XXX(ABSL)	ABSL Per the gas service	Yellow	Black
ABSL Lab Gas (Flammable)	XXX(ABSL)	ABSL Per the gas service	Yellow	Black
ABSL Inert Gas Vent	IGV(ABSL)	ABSL Inert Gas Vent	Match colors of gas service	
ABSL Oxidizer Gas Vent	OGV(ABSL)	ABSL Oxidizer Gas Vent	Yellow	Black
ABSL Flammable Gas Vent	FGV(ABSL)	ABSL Flammable Gas Vent	Yellow	Black
Animal Watering System	AWS	Animal Watering System	Green	Black
Lab Waste from ABSL Labs	LW(ABSL)	ABSL Wastewater	Orange	Black
Lab Vent from ABSL Labs	LV(ABSL)	ABSL Vent	Orange	Black
Decontamination System Waste Piping	DW	ABSL BIOWASTE - do not breach	Orange	Black
Decontamination System Vent Piping	DV	ABSL BIOWASTE VENT - do not breach	Orange	Black



### 3.2 CONTINUOUS PROTECTIVE PLASTIC JACKETS AND COLORS

- A. The following areas shall require all insulated piping to be protected along the entire pipe length with White PVC jacket covers (Ceel-Co or Zeston plastic jacket). See Division 22 for plumbing pipe insulation for jacket specifics:
- a. Penthouse Mechanical Rooms - Piping 10 feet and lower
  - b. Plumbing Equipment Rooms - Piping 10 feet and lower
  - c. Mechanical Rooms - Piping 10 feet and lower
  - d. All Rainwater Leaders (horizontal) in areas without ceilings
  - e. Shipping Docks where piping is exposed or below ceilings - Piping 10 feet and lower
  - f. Vivarium MEP Walkways or Accessible Interstitial Spaces - All Piping
  - g. Vivarium (general) - Exposed Piping
  - h. Vivarium Washrooms (both clean and dirty side) - All Piping
  - i. Kitchens - Exposed Piping Below Ceiling
  - j. Pilot Plants - All Piping
  - k. Food Plants - All Piping
2. This plastic jacket shall include fitting covers and piping covers.
  3. Piping to be covered with this plastic jacket shall be insulated and finished as herein specified and then the plastic jacket shall be applied.

### 3.3 LABELING OF GAS PIPING

- A. Furnish and install one coat of primer and two coats of finish paint to all interior gas piping installed as part of this contract.
1. See Division 09 for paint types for interior piping.
  2. Painting shall begin at plumbing side of contract downstream of the utility company gas meter - see exterior painting below for piping exposed to weather.
  3. All gas piping shall be painted "Safety Yellow" per ANSI/ASME identification code 13.1.
  4. Painting shall include all gas vents from vent origin to termination.
  5. Include necessary paint finish touch-up where welding or jointing process has interfered with paint finish
  6. Install labels after paint has cured for a minimum of 5 days.
- B. Gas Piping Exposed to Weather or on Roof
1. Furnish and install OSHA Safety Yellow to exterior and roof mounted gas piping commencing at a starting point one (1) foot below roof to gas pipe termination point on roof in the following manner:
    - a. Primer: Epoxy primer/sealer applied at a spreading rate recommended by the manufacturer (2 coats)

- 1) Moore M36-00/M37 Polyamide Epoxy Clear Sealer Finish
    - 2) PPG 97-14XX Series Pitt Guard DTR Polyamide Epoxy Clear Sealer Finish
    - 3) S-W Heavy Duty Epoxy B67W300 Series
  - b. Intermediate Coat: Epoxy applied at a spreading rate recommended by the manufacturer of 3.0 to 8.0 mils
    - 1) DuPont 25P High Solids Epoxy Mastic
    - 2) S-W Heavy Duty Epoxy B67W300 Series
    - 3) Tnemec Series 66 Hi-Build Epoxoline Polyamidoamine Epoxy
  - c. Topcoat: Semi-gloss aliphatic polyurethane enamel applied at a spreading rate recommended by the manufacturer to achieve a dry film thickness of 2.0 - 4.0 mils.
    - 1) Moore M73/M75 Aliphatic Acrylic Urethane Semi-Gloss
    - 2) PPG 97-8XXX Series Pitthane High Build Acrylic Aliphatic Urethane
    - 3) S-W Corothane II Low VOC Satin Finish B65W200 Series
2. All finish gas piping shall be painted "Safety Yellow" per ANSI/ASME identification code 13.1.
3. Include necessary paint finish touch-up where welding or jointing process has interfered with paint finish
4. Install labels after paint has cured for a minimum of five (5) days.
5. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces or conditions detrimental to formation of a durable paint film. Provide finish coats that are compatible with primers used.

### 3.4 PREPARATION

- A. Clean piping and equipment surface of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.5 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

### 3.6 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.7 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Division 09.
- B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
  - 8. Mains shall be labeled at points of entrance and exit from mechanical room, adjacent to each valve, on each riser, at each tee fitting, at points of entrance and exit from building, at least once in each room, and at intervals no longer than 20 feet.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

### 3.8 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Tags, Valves, Equipment, and Instruments
    - a. Upon completion of work, attach engraved laminated plastic tags to all valves, and instrumentation. Equipment shall bear a stamped stainless tag. Tags shall have black characters on white face, consecutively numbered and prefixed with letter P for general valves. Tags shall bear the number used in the P&IDs for those items so marked.
    - b. Embossed or engraved aluminum or brass tags may be substituted if desired.
    - c. Tags shall be at least 1 inch diameter with numerals at least 3/8 inch high and attached by S hooks and chains.
    - d. Nameplates, catalog numbers and rating identifications shall be securely attached to electrical and mechanical equipment with screws or rivets. Adhesives or cements will not be permitted.

- e. Non-potable water outlets shall be identified with permanently attached yellow color code or 4 inches high triangle tag reading, "water unsafe."
  - f. Coordinate numbering system with existing piping tags as not to duplicate numbers.
- 2. Valve-Tag Size and Shape: All Plumbing and Piping Services that are part of this contract 1-1/2 inches round.
  - 3. Valve-Tag Colors: Comply with the same colors as indicated for Pipe Labels
  - 4. Letter Colors: manufacturers standard.

### 3.9 WARNING-TAG INSTALLATION

- A. Write the required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

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AND EQUIPMENT.DOC

## SECTION 220716 - PLUMBING EQUIPMENT INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes insulating the following plumbing equipment:

- 1. Insulation materials
- 2. Insulating cements
- 3. Adhesives
- 4. Mastics
- 5. Sealants
- 6. Factory-applied jackets
- 7. Field-applied cloths
- 8. Field-applied jackets
- 9. Tapes
- 10. Securements
- 11. Corner angles

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).
- B. LEED Submittals:
  - 1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
  - 2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  2. Detail attachment and covering of heat tracing inside insulation.
  3. Detail removable insulation at equipment connections and access panels.
  4. Detail application of field-applied jackets.
  5. Detail application at linkages of control devices.
  6. Detail field application for each equipment type.
- D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
1. Sheet Form Insulation Materials: 12 inches square.
  2. Sheet Jacket Materials: 12 inches square.
  3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
  1. Equipment Mockups: One tank or vessel, pump.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

#### 1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22.
- B. Coordinate clearance requirements with equipment Installer for equipment insulation application.
- C. Coordinate installation and testing of heat tracing.

#### 1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

### PART 2 - PRODUCTS

#### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Water Boiler Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Calcium Silicate:
  - 1. **Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal:**
    - a. **Industrial Insulation Group, LLC (IIG-LLC)**
    - b. **Or Approved Equal.**
  - 2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
- G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. **Johns Mansville.**
    - b. **Owens Corning.**
    - c. **Pittsburgh Corning Corporation**
    - d. **Or Approved Equal.**
  - 2. Block Insulation: ASTM C 552, Type I.
  - 3. Special-Shaped Insulation: ASTM C 552, Type III.
  - 4. Board Insulation: ASTM C 552, Type IV.
  - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
  - 6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
  - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
  - 1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. **Aeroflex USA, Inc.**
    - b. **Armacell LLC**
    - c. **K-Flex USA**
    - d. **Or Approved Equal.**



- I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. **Certain Teed Corporation**
    - b. **Johns Manville; a Berkshire Hathaway company**
    - c. **Knauf Insulation**
    - d. **Or Approved Equal.**
- J. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
  - 1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. **Industrial Insulation Group, LLC (IIG-LLC)**
    - b. **Johns Manville; a Berkshire Hathaway company**
    - c. **Knauf Insulation**
    - d. **Or Approved Equal.**
- K. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. **CertainTeed Corporation**
    - b. **Johns Manville, a Berkshire Hathaway company**
    - c. **Knauf Insulation**
    - d. **Or Approved Equal.**
- L. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
  - 1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. **Industrial Insulation Group, LLC (IIG-LLC)**
    - b. **Knauf Insulation**
    - c. **Rock Wool**

d. **Or Approved Equal.**

M. Mineral-Fiber, Preformed Pipe Insulation:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:
  - a. **Johns Manville; a Berkshire Hathaway company.**
  - b. **Knauf Insulation.**
  - c. **Manson Insulation Inc.**
  - d. **Or Approved Equal.**
2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

N. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi rigid board material with factory applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:
  - a. **CertainTeed Corporation.**
  - b. **Johns Manville; a Berkshire Hathaway company.**
  - c. **Knauf Insulation.**
  - d. **Or Approved Equal.**

O. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:
  - a. **Armacell LLC.**
  - b. **Nomaco Insulation.**
  - c. **Or Approved Equal.**

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. **Manufacturers:** Subject to compliance with requirements, provide products by the following or approved equal:

- a. Ramco Insulation, Inc.
  - b. Or Approved Equal.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
  - 1. **Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal:**
    - a. Ramco Insulation, Inc.
    - b. Or Approved Equal.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
  - 1. **Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal:**
    - a. Ramco Insulation, Inc.
    - b. Or Approved Equal.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated unless otherwise indicated.
- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
  - 1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Or Approved Equal.
  - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
  - 1. **Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal:**
    - a. Foster Brand; H. B. Fuller Construction Products.
    - b. Or Approved Equal.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Or Approved Equal.
  2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Or Approved Equal.
  2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.

- c. Foster Brand; H. B. Fuller Construction Products.
    - d. Or Approved Equal.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- G. PVC Jacket Adhesive: Compatible with PVC jacket.
- 1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Dow Corning Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. PIC Plastics, Inc.
    - d. Or Approved Equal.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
- 1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Foster Brand; H. B. Fuller Construction Products.
    - b. Knauf Insulation.
    - c. Vimasco Corporation.
    - d. Or Approved Equal.
  - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Knauf Insulation.
    - e. Or Approved Equal.
  2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F.
  4. Solids Content: 60 percent by volume and 66 percent by weight.
  5. Color: White.

## 2.5 SEALANTS

- A. Joint Sealants:
1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Or Approved Equal.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Permanently flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 100 to plus 300 deg F.
  5. Color: White or gray.
  6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. FSK and Metal Jacket Flashing Sealants:

1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Or Approved Equal.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Fire- and water-resistant, flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 40 to plus 250 deg F.
  5. Color: Aluminum.
  6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. **Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal:**
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Or Approved Equal.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Fire- and water-resistant, flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 40 to plus 250 deg F.
  5. Color: White.
  6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.



2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC bi-axially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
  - a. **Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal:**
    - 1) Dow Chemical Company (The).
    - 2) Or Approved Equal.
5. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC bi-axially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
  - a. **Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal:**
    - 1) Dow Chemical Company (The).
    - 2) Or Approved Equal.
6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
  - a. **Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal:**
    - 1) Dow Chemical Company (The).
    - 2) Or Approved Equal.

## 2.7 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd..
  1. **Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal:**
    - a. Alpha Associates, Inc.
    - b. Or Approved Equal.

## 2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.



- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. PIC Plastics, Inc.
    - c. Proto Corporation.
    - d. Or Approved Equal.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: White or color-code jackets based on system. Color as selected by Architect.
  4. Factory-fabricated tank heads and tank side panels.
- C. Metal Jacket:
1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. ITW Insulation Systems; Illinois Tool Works, Inc.
    - c. RPR Products, Inc.
    - d. Or Approved Equal.
  2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    - a. Finish and thickness are indicated in field-applied jacket schedules.
    - b. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
    - c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
  3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
    - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
    - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
    - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
    - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper or 2.5-mil- thick polysurlyn.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
    - d. Or Approved Equal.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
    - d. Or Approved Equal.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Compac Corporation.
    - b. Ideal Tape Co., Inc., an American Biltrite Company.
    - c. Venture Tape.
    - d. Or Approved Equal.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
    - d. Or Approved Equal.
  2. Width: 2 inches.
  3. Thickness: 3.7 mils.
  4. Adhesion: 100 ounces force/inch in width.
  5. Elongation: 5 percent.
  6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
1. **Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal:**
    - a. Dow Chemical Company (The).
    - b. Or Approved Equal.
  2. Width: 3 inches.
  3. Film Thickness: 4 mils.
  4. Adhesive Thickness: 1.5 mils.
  5. Elongation at Break: 145 percent.
  6. Tensile Strength: 55 lbf/inch in width.

## 2.10 SECUREMENTS

### A. Bands:

1. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
  - a. ITW Insulation Systems; Illinois Tool Works, Inc.
  - b. RPR Products, Inc.
  - c. Or Approved Equal.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

### B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.
  - a. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Midwest Fasteners, Inc.
    - 4) Or Approved Equal.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  - a. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - 1) AGM Industries, Inc.
    - 2) CL WARD & Family Inc.
    - 3) Gemco.
    - 4) Or Approved Equal.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
  - a. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Midwest Fasteners, Inc.
    - 4) Or Approved Equal.
  - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
  - a. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - 1) Gemco.
    - 2) Midwest Fasteners, Inc.
    - 3) Or Approved Equal.
  - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
  - c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
  - a. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - 1) AGM Industries, Inc.

- 2) Gemco.
    - 3) Midwest Fasteners, Inc.
    - 4) Or Approved Equal.
  - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
  - a. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Midwest Fasteners, Inc.
    - 4) Or Approved Equal.
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
  - a. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by the following or approved equal:**
    - 1) Gemco.
    - 2) Midwest Fasteners, Inc.
    - 3) Or Approved Equal.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.
  1. **Manufacturers: Subject to compliance with requirements, provide products by the following or approved equal:**
    - a. C & F Wire.
    - b. Or Approved Equal.

## 2.11 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item as specified in insulation system schedules.

- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches OC.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches OC.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.



- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Manholes.
  - 5. Handholes.
  - 6. Cleanouts.

### 3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

- A. Mineral-Fiber, Pipe, and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
  - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
  - 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
  - 3. Protect exposed corners with secured corner angles.
  - 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
    - a. Do not weld anchor pins to ASME-labeled pressure vessels.
    - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches OC. in both directions.
    - d. Do not over compress insulation during installation.
    - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    - f. Impale insulation over anchor pins and attach speed washers.
    - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  - 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
  - 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut

with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches OC. Install a wire ring around each end and around outer periphery of center openings and stretch pre-stressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches OC. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches.
  8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
  9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
  10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
  2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
  2. Fabricate boxes from stainless steel, at least 0.040 inch thick.
  3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

### 3.5 INSTALLATION OF CALCIUM SILICATE INSULATION

- A. Insulation Installation on Water Boiler Breechings:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
  2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
  3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

### 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
  - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  - 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
  - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
  - 1. Draw jacket material smooth and tight.
  - 2. Install lap or joint strips with same material as jacket.
  - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
  - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
  - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches OC. and at end joints.
- E. Where PVDC jackets are indicated, install as follows:
  - 1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fish mouthing," and use PVDC tape along lap seal to secure joint.
  - 2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

### 3.8 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
  - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.10 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment that is not factory insulated.
- C. Heat-exchanger (water-to-water for water heating service) insulation shall be one of the following:
  1. Calcium Silicate: 3 inches thick.
  2. Cellular Glass: 3 inches thick.
  3. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
  4. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
  5. Mineral-Fiber Pipe and Tank: 2 inches thick.
  6. Mineral-Fiber Preformed Pipe Insulation, Type I: 2 inches thick.
- D. Steam-to-hot-water converter insulation shall be one of the following:
  1. Calcium Silicate: 3 inches thick.
  2. Cellular Glass: 3 inches thick.
  3. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.

4. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
  5. Mineral-Fiber Pipe and Tank: 2 inches thick.
  6. Mineral-Fiber Preformed Pipe Insulation, Type I: 2 inches thick.
- E. Hot-water pump insulation shall be one of the following:
1. Cellular Glass: 2 inches thick.
  2. Mineral-Fiber Blanket: 1 inch thick and 3-lb/cu. ft. nominal density.
  3. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
- F. Hot-water storage tank insulation shall be one of the following, of thickness to provide an R-value of 12.5:
1. Cellular glass.
  2. Mineral-Fiber Blanket: 3-lb/cu. ft. nominal density.
  3. Mineral-Fiber Board: 3-lb/cu. ft. nominal density.
  4. Mineral-fiber pipe and tank.
- G. Water storage tank insulation shall be one of the following:
1. Cellular Glass: thick.
  2. Flexible Elastomeric: 1 inch thick.
  3. Mineral-Fiber Blanket: 1 inch thick and 3-lb/cu. ft. nominal density.
  4. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
  5. Mineral-Fiber Pipe and Tank: 1 inch thick.
  6. Polyolefin: 1 inch thick.

### 3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Concealed:
1. None.
  2. PVC: 30 mils thick.
  3. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish Corrugated Stucco Embossed: 0.016 inch 0.024 inch thick.
- D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
1. None.
  2. PVC: 30 mils thick.
  3. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish Corrugated Stucco Embossed: 0.024 inch thick.

- E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
  - 1. Stainless Steel, Type 304 or Type 316, Smooth Stucco Embossed, with 1-1/4-Inch- Deep Corrugations 2-1/2-Inch- Deep Corrugations 4-by-1-Inch Box Ribs: thick.

**3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE**

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Concealed:
  - 1. None.
  - 2. PVC: 30 mils thick.
  - 3. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish Corrugated Stucco Embossed: 0.024 inch thick.
- D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
  - 1. Stainless Steel, Type 316, Smooth 2B Finish Corrugated Stucco Embossed with Z-Shaped Locking Seam: 0.024 inch thick.
- E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
  - 1. Stainless Steel, Type 316, Smooth Stucco Embossed, with 1-1/4-Inch- Deep Corrugations 2-1/2-Inch- Deep Corrugations 4-by-1-Inch Box Ribs: 0.024 inch thick.

**END OF SECTION**

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## SECTION 220719 - PLUMBING PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
  - 1. Insulation materials
  - 2. Accessory materials
  - 3. Insulated couplings for rack piping systems
  - 4. Insulated cast iron or steel piping systems supported on clevis or band hangers
  - 5. Factory applied jackets
  - 6. Tapes
  - 7. Securements

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- B. LEED Submittals:
  - 1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
  - 2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail attachment and covering of heat tracing inside insulation.
  - 3. Detail insulation application at pipe expansion joints for each type of insulation.
  - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
- D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
  1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
  2. Jacket Materials for Pipe: 12 inches long by NPS 2.
  3. Sheet Jacket Materials: 12 inches square.
  4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  1. Supply and Drain Protective Shielding Guards: ICC A117.1.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.



1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22.
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Type A: Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Certain-Teed.
    - b. Johns Manville.
    - c. Owens Corning.
    - d. Or Approved Equal.

2. Molded Fibrous Glass Pipe Insulation: Comply with ASTM C 547, Type 1, Grade A, and ASTM C 585, for sizes required and of a type suitable for installation on piping systems as required. One (1) of the following types shall be used:
  3. For indoor systems operating at temperatures from 0 deg F (-18 deg C) to +850 deg F (454 deg C):
    - a. Owens Corning™ Fiberglas™ Insulation with SSL II® Positive Closure System.
  4. For pipe fittings where pressed jointing systems are used
    - a. Option 1 - field fit pre-molded fitting cover above
    - b. Option 2 - use PVC fitting cover field fit with included applied insulation.
  5. For systems operating below ambient (32 deg F (0 deg C) to +65 deg F (18 deg C)) temperature:
    - a. Owens Corning™ VaporWick® Pipe Insulation. (see Plumbing Pipe Insulation – VaporWick® Pipe Insulation)
  6. Block Insulation: ASTM C 552, Type I.
  7. Special-Shaped Insulation: ASTM C 552, Type III.
  8. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
  9. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Type B: Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. K-Flex USA.
    - d. Or Approved Equal.
  2. Flexible elastomeric in tubular foam. AC/Accoflex, AP/Armaflex, AP/Armaflex SS. This product meets the requirements as defined in ASTM C 534, Grade 1, Type I, "Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
  3. Materials shall have a flame spread index of less than 25 and a smoke developed index of less than 50 when tested in accordance with ASTM E 84, latest revision.
  4. Materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft<sup>2</sup>- deg F at a 75 deg F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
  5. Materials shall have a maximum water vapor transmission of 0.08 perm inches when tested in accordance with ASTM E 96, Procedure A, latest revision.
  6. Adhesive shall be the insulation manufacturer's recommended contact adhesive: Armaflex 520, Armaflex 520 BLV. B.

7. Insulation finish shall be the insulation manufacturer's recommended finish: WB Armaflex Finish. C.
  8. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings as specified above.
- H. Type C: Mineral-Fiber, Preformed Pipe Insulation:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. Knauf Insulation.
    - c. Manson Insulation Inc.
    - d. Or Approved Equal.
  2. Perpendicular oriented Mineral Fiber Insulation: ASTM C1393, Type IIIB, Category 2:
    - a. For piping equal to or larger than 10 in (250 mm) diameter operating at temperatures up to +850 deg F (454 deg C):
    - b. Owens Corning™ Fiberglas™ FLEXWRAP® Insulation.
  3. Perpendicular oriented Mineral Fiber Insulation: ASTM C1393, Type II, Category 1:
    - a. For piping equal to or larger than 10 in (250 mm) diameter operating at temperatures up to +650 deg F (343 deg C):
    - b. Owens Corning™ Fiberglas™ Pipe and Tank Insulation.
  4. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. Type D: Hydrous Calcium Silicate
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Johns Manville.
    - b. Industrial Insulation Group (IIG); Thermo-12 Gold.
    - c. Or Approved Equal.
  2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
  3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
  4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in pre-forming insulation to cover valves, elbows, tees, and flanges.

5. Preformed pipe insulation of rigid, ANSI/ASTM C533; rigid white; asbestos free; "k" value of 0.44 at 300 deg F. Trade name "Cal-Sil" for piping up to 1200 deg F. Johns Manville or equal.
  6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- J. Type E: Phenolic
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Kingspan Solar
    - b. Resolco International
    - c. Or Approved Equal.
  2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
  3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
  4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
  5. Factory-Applied Jacket: ASJ. Requirements are specified in "Factory-Applied Jackets" Article.
- K. Type F: Underground Elastomeric
1. For Underground Installation basis of design is Armaflex Tuffcoat **\*\*LINK\*\***
  2. Used only for underslab trap primer piping where copper tube is used as pipe material.
- L. Type G: Protective Shielding Pipe Covers
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Engineered Brass Company.
    - b. Truebro.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- M. Type H: Exterior Underground Pre-Engineered Insulated
1. Application: Hot or cold water from building-to-building buried underground
  2. Service limits: 40 deg F (5 deg C) to 250 deg F (120 deg C) at 150 psig (1000 KPa)
  3. Completely factory-fabricated, insulated, and jacketed copper piping system for the underground distribution. Pipe to be Type "K" copper tube insulated with rigid, foamed-in-place, polyurethane foam that is encased and sealed in a rugged PVC jacket.

4. Insulation: Foamed-in-place closed-cell polyurethane foam that fills the annular space between the pipe and outer jacket
    - a. Thermal conductivity. 90 percent closed cell structure provides high resistance to water absorption. Nominal density is 2 LB/FT<sup>3</sup>, thermal conductivity ("K" factor) is 0.14 BTU in./ (HR) (sf) (deg F) at 73 deg F.
  5. PVC Outer Jacket: Type 1, Grade 1 Polyvinyl Chloride flexible vapor barrier to protect both the insulation and pipe. C-resistant and strong enough so the system can withstand H-20 loading with 2 feet of cover with 90 percent backfill compaction.
  6. Coupling: Machined coupling containing two O-ring seals. When two lengths are joined in the coupling the O-rings are compressed to form a watertight connection and also provide separation of pipe ends for expansion and contraction. Expansion loops or expansion joints are not required whereas each coupling acts as an expansion joint, evenly distributing free expansion and contraction along the entire line.
  7. End Seal: A latex coating is factory applied to both ends of the pipe insulation to ensure moisture protection at all couplings.
  8. Basis of Design: Perma-Pipe/Ricwil Copper-Gard
- N. Type J: Protection of non-rated plenum piping
1. Flexible, non-combustible enclosure for cables and pipes in return air plenums
  2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Basis of Design: 3M Fire Wrap.
    - b. Morgan Plenum Wrap
    - c. Unifraxs FyreWrap® 0.5 Plenum Insulation
    - d. **Or Approved Equal.**
  3. Flexible fire-resistant wrap consisting of an inorganic fiber blanket encapsulated with a scrim-reinforced foil.
  4. Installation shall be in strict accordance with manufacturer's written instructions C).
  5. Flame Spread Index and Smoke Developed Index of the foil encapsulated blanket shall be less than 25 / less than 50.
- O. Type K: Underground Insulation and Jackets for Grease Waste Piping
1. Manufacturers:
    - a. Basis-of-Design Product: Subject to compliance with requirements, provide underground pipe insulation for the exterior kitchen heat traced wastewater indicated as BOD below or provide products by one of the following, or approved equal.
      - 1) Basis of Design: PITTPWRAP FOAMGLAS ® Insulation on Underground Direct-Buried Piping System by Pittsburg Corning
      - 2) Knauf Industries
      - 3) Owens Corning Corporation

- 4) Or Approved Equal.
2. General Applications
  - a. All insulation materials shall be stored in an area protected from the weather and kept dry before and during applications.
  - b. All piping shall be cleaned of foreign substances and free of surface moisture prior to and during the application of insulation.
  - c. Make certain that all weld beads are ground smooth with the surface of the pipe prior to application of the insulation.
3. Products
  - a. FOAMGLAS® insulation, ASTM C 552, "Spec. for Cellular Glass Thermal Insulation 2 inches thick, by Pittsburgh Corning Corporation.
  - b. Jacketing
    - 1) PITTWRAP® jacketing (FI-209), supplied by Pittsburgh Corning Corporation.
    - 2) Reinforcing Fabric PC® Fabric 79, Pittsburgh Corning Corporation (product data sheet FI-159).
    - 3) Strapping Tape Glass fiber-reinforced, 1 inch (25 mm) wide, Scotch brand #880 by 3M, or equal.
    - 4) Bore Coating Hydrocal® B-11, by U.S. Gypsum, or equal.
    - 5) High-Temperature Sealant PC® RTV 450 Silicone Adhesive—FI-244 (maximum temperature limit 400 deg F
4. Factory-Jacketed
  - a. FOAMGLAS® insulation which has been pre-jacketed with PITTWRAP® jacketing shall be applied joint-to-joint with all joints tightly butted. Strapping tape may be used over the jacketing to temporarily secure the insulation until longitudinal laps are sealed and butt strips applied.
    - 1) See PITTWRAP appropriate data sheet for details for sealing PITTWRAP® jacketing laps and butt strip application.
5. Pre-Insulation of Pipe Where conditions permit, FOAMGLAS® insulation and jacketing may be applied outside of the trench to sections of piping.
  - a. Pipe lengths should be insulated in segments. Length of insulation segment should not exceed 10 ft (3 m).
  - b. Leave uninsulated spaces between segments to allow for placement of slings by which the pipe can be lowered into the trench.
  - c. The use of a spreader bar with two (2) slings or more is recommended. The quantity and location of sling placement shall be determined by the design professional to avoid excessive deflection and facilitate proper control of the pipe length during transfer.
  - d. After the sections of pipe are in place in the trench, and ends of the sections secured, insulation and jacketing shall be applied to the joint areas and uninsulated spaces that were not completed above ground.

- e. Adequate working space should be maintained for installation personnel.

## 2.2 ACCESSORY MATERIALS

- A. Accessories: Provide accessories per insulating system manufacturer's recommendations, including the following:
  - 1. Closure Materials: Butt strips, bands, wires, staples, mastics, adhesives, and pressure-sensitive tapes.
    - a. Mold resistant mastics are recommended for cold ( $\leq 60$  deg F) water applications.
  - 2. Field-Applied Jacketing Materials: Sheet metal, plastic, canvas, fiberglass cloth, insulating cement, PVC fitting covers.
  - 3. Support Materials: Hanger straps, hanger rods, saddles, support rings, and high-density inserts.
- B. Adhesives for Indoor Applications: VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.3 INSULATED COUPLINGS FOR RACK PIPING SYSTEMS

- A. The insulation and vapor barrier must be contiguous through the rack support clips with the support materials: cited above in A.3
- B. Alternatively, products designed to replace insulation shields for racked utility piping located on strut bars and routed throughout buildings may be used. The replacement must substitute a thermo-plastic Olefin (TPO) or manufacturers standard insulating coupling and support, with insulation placed on each side of the strut clip and butted against the clip.
- C. Design Basis: Hydra-Zorb products Klo-shure 9 series for insulated pipe and tube fastened on strut bars.
  - 1. The insulation must be adhered and taped to the TPO couplers.
  - 2. Use only for services less than 180 deg F.
  - 3. Do not use for steam.
  - 4. Do not use for piping systems that are subject to steam or hot water sanitation.

## 2.4 INSULATED CAST IRON OR STEEL PIPING SYSTEMS SUPPORTED ON CLEVIS OR BAND HANGERS

- A. Section: Hangers and Supports
  - 1. Thermal hanger shields shall be used on cast iron horizontal insulated pipe systems at each point of support. Manufactured units shall comply with MSS SP-58 standards and be tested per MSS guidelines. Each assembly shall fit the various pipe diameters and match the outside diameter of the adjoining pipe insulation.
  - 2. Thermal hanger inserts shall be calcium silicate with a minimum compressive strength of 100 PSI. The insert shall be jacketed with industry standard, non-reactive, all service meeting ASTM E 96A (maximum 0.02 perm). 'Water-resistant coatings', which do not provide a sealable vapor barrier, shall not be allowed. A mastic of a contrasting color may be used (i.e. Childers CP-30 or MEI 5510 or equal), providing the longitudinal seam is field-sealed during installation.

3. A rolled shield of G-90 galvanized steel shall be an integral part of the unit and shall be of a gauge and length appropriate for the compressive strength of the insert material and type of hanger.
4. Insulation and jacket shall extend a minimum of 1 inch beyond each end of the galvanized steel shield to provide a complete, neat and vapor-tight seal with the adjoining insulation.

**B. Basis of Design: VEP Insulated Pipe Supports**

1. Hanger type and span between hangers shall govern the type of thermal hanger shield used and shall be as follows:
  - a. Band-type hangers to 10-foot maximums (clevis, teardrop) — Value Engineered Products' (VEP) Pro-shield, Quik-Shield or equal.
  - b. Roller-type hangers, regardless of hanger spans - VEP's MaxSpan R.H. or equal.
  - c. Band-type hangers with spans greater than 10 feet - VEP's MaxSpan units or equal.
  - d. Trapeze style and other clamping-type supports to 10 foot maximums - VEP's Pro-Shield or
  - e. Trapeze style and other clamping-type supports exceeding 10 feet\* - VEP's MaxSpan units
2. Product must be tested to ASTM E84
3. Safety Ratio shall be a minimum of 3.5:1 - (support capabilities to anticipated pipe load).
4. Independent test results documenting the compliance of 'or equal' products shall be available upon request of the Architect, Engineer, or Owner.

**2.5 FACTORY-APPLIED JACKETS**

- A. Coordinate types of factory-applied jacket insulation materials selected, and types of factory-applied jackets indicated in insulation system schedules.
- B. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
  1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
  2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
  3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.
- C. Jacket Types



TYPE	STYLE	MATERIALS
Type 1	All Service Jacket	Vapor Barrier Jackets: Kraft reinforced foil vapor barrier with self-sealing adhesive joints. Jacket shall be heavy-duty fire-retardant material with glass fiber reinforcing and self-sealing lap. Jacket will be factory applied to the insulation. Jacket shall have neat, white Kraft finish or white vinyl suitable for painting, with bead puncture resistance of 50 units minimum. Vapor barrier shall be .001 inch aluminum foil adhered to the inner surface of the jacket. Permeance shall not exceed 0.02 perms. Jacket shall be Owens-Corning Fiberglass "ASJ-SSL" or Manville flamesafe "AP-T".
Type 2	PVC Jackets:	Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.  One piece, pre-molded type equal to Johns Manville Zeston 2000/300 Series PVC 20 or 30 mil jacketing and PVC fitting covers. All jackets shall follow manufacturers to comply with temperature of service piping.  Jackets shall meet USDA compliance standard for all food handling
Type 4	Aluminum Jacket:	Aluminum roll stock ready for shop or field cutting. Comply with ASTM B 209/M 3003 alloy, H-14 temper.  0.016 inch thick smooth aluminum jacket with longitudinal ZEE style closures. Jacket shall be secured at both joints with 2 inch wide aluminum straps centered over butt joint of jacket. Provide 1/2 inch wide aluminum bands on 12 inch centers. Fitting covers shall be manufactured for purpose intended and shall be of same material. Acceptable for outdoor installation.
Type 5	Stainless Steel Jackets:	Weatherproof stainless steel jacketing, manufactured from T-304 smooth in .010 thickness. All jacketing shall have an internally bonded moisture retarder over the surface in contact with the insulation.
Type 6	Stainless Steel Jackets:	Weatherproof stainless steel jacketing, manufactured from T-316 smooth in .016 thickness. All jacketing shall have an internally bonded moisture retarder over the surface in contact with the insulation.
Type 7	Protective Shielding Piping Enclosures for barrier free trap and water piping under fixture	Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal. <ul style="list-style-type: none"> <li>▪ Truebro.</li> <li>▪ Zurn Industries, LLC.</li> </ul> Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.  Furnish protective shielding to all Emergency Eyewash units where water waste and trap are exposed and are exclusively selected for Barrier Free Use.
Type 8	For underground grease waste pipes	PITTWRAF® jacketing (FI-209), supplied by Pittsburgh Corning Corporation. Comparable manufacturers products specific to the manufactured insulating materials is acceptable

## 2.6 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.

4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Compac Corporation.
    - b. Ideal Tape Co., Inc., an American Biltrite Company.
    - c. Venture Tape.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.

- c. Ideal Tape Co., Inc., an American Biltrite Company.
- 2. Width: 2 inches.
- 3. Thickness: 3.7 mils.
- 4. Adhesion: 100 ounces force/inch in width.
- 5. Elongation: 5 percent.
- 6. Tensile Strength: 34 lbf/inch in width.

## 2.7 SECUREMENTS

### A. Bands

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. ITW Insulation Systems; Illinois Tool Works, Inc.
  - b. RPR Products, Inc.
- 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
- 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

### B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

### C. Wire: 0.062-inch soft-annealed, stainless steel.

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. C & F Wire.

## PART 3 - EXECUTION

### 3.1 PIPING INSULATION SCHEDULE

#### A. General Summary Table - Referred Products

- 1. Insulating Material

Type	Product	Common Reference Additional
A	Glass Fiber	Fiberglas
B	Flexible Elastomeric Insulation	Armaflex black or white closed cell
C	Mineral Fiber Pre-Formed	Preformed Minwool
D	Hydrous Calcium Silicate	Cal-Sil
E	Phenolic Foam	Solar
F	Buried copper trap primer piping	Armaflex Tuffcoat
G	Package	for Handicap Fixtures waste and water
H	Closed-Cell Polyurethane Foam	Package pre-insulated pipe and insulation - Ricwil
J	Plenum wrap for piping	Fire Wrapping for non-rated piping in return air plenums
K	Cellular Glass	FoamGlas

## 2. Jacket Material

Type	Product	Common Reference Additional
1	All Service Jacket	General White ASJ
2	Protective PVC Jacket	General White PVC
4	Aluminum Jacket	General outdoor
5	Stainless Steel Jacket	Clean rooms
6	Stainless Steel Jacket	Pharma
7	Plastic Preformed Barrier Free	For Handicap Fixtures
8	Manufacturers Wrapping	Pittwrap or comparable

PIPING SYSTEM	TYPE	THICKNESS INCHES	JACKET	NOTES
Water Service Cold, Up To Meter - Water Supply	A C	1 1	Type 2	
All Cold-Water Supply, potable and non-potable	A C	1/2	Type 1	Note 4 Note 5
All Hot Water Supply and Return less than 1-1/2 inches, potable and non-potable	A C	1 1	Type 1	Note 4 Note 5
All Hot Water Supply and Return greater than 1-1/2 inches, potable and non-potable	A C	1-1/2 1-1/2	Type 1	Note 4 Note 5
Cold Water Supply in Kitchens	B	1/2	Type 2	Below Ceilings
Cold Water Supply in Kitchens	B	1/2	Type 1	Above Ceilings
Hot Water Supply and Return in Kitchens less than 1-1/2 inches	B	1	Type 2	Below Ceilings
Hot Water Supply and Return in Kitchens less than 1-1/2 inches	B	1	Type 1	Above Ceilings
Hot Water Supply and Return in Kitchens greater than 1-1/2 inches	B	1-1/2	Type 2	Below Ceilings
Hot Water Supply and Return in Kitchens greater than 1-1/2 inches	B	1-1/2	Type	Above Ceilings
Emergency or Tempered Water System less than 1-1/2 inches	A C	1	Type 1	Type 2 When Routed Through Food Service Area Note 5
Emergency or Tempered Water System greater than 1-1/4 inches	A C	1	Type 1	Type 2 When Routed Through Food Service Area Note 5
All Cold-Water Piping Passing Through and in Clean Rooms	B	1	Type 2	Above Ceilings Note 4
All Cold-Water Piping Passing Through and in Clean Rooms	B	1	Type 3	Below Ceilings Note 4
All Hot Water Piping Passing Through and in Clean Rooms	B	1-1/2	Type 2	Above Ceilings Note 4

PIPING SYSTEM	TYPE	THICKNESS INCHES	JACKET	NOTES
All Hot Water Piping Passing Through and in Clean Rooms	B	1-1/2	Type 3	Below Ceilings Note 4
All Insulated Piping in Mechanical Rooms, and in Corridors Without Ceilings,	Per This Table	Per This Table	Type 2	Note 5
Roof Drains and Horizontal Rainwater	A C	1/2	Type 1	Note 3 Include Drain Bodies Note 5 if exposed to view
Horizontal Overflow Roof Drainage System	A, B or C	1/2	Type 1	Note 3
Storm water Force Main Piping	A, B or C	1/2	Type 1	From pump station to gravity trunk line connection
Plumbing piping receiving condensate from HVAC or general equipment	A or C	3/4	Type 1 and 2	Clearly labeled Includes horizontal and vertical piping See note 4
Hot Service Drains and Vents	A C	1-1/2 1	Type 1	Note 3 Note 5
Piping Exposed to Freezing (Water) less than 2 inch	A C	2	Type 5	
Piping Exposed to Freezing (Water) greater than 2 inch	A C	3	Type 5	See note 2
Piping Exposed to Freezing (Sanitary)	A C	2	Type 5	See note 2
Piping Exposed in enclosed Parking Garages	A C	2	Type 2 Type 4	See note 2
Piping Exposed in open Parking Garages	A C	2	Type 2 Type 5	See note 2
Solar Supply and Return. Interior	B	2	Type 3	
Solar Supply and Return. Exterior	E	2	Type 5	
Reclaim Water Systems metallic piping	A, B or C	1/2	Type 1	Note 4 Note 5 For metallic pipe insulated either purple paint ASJ along its entire length or cover with PVC purple covering
Reclaim Water Systems thermoplastic piping	none			
Buried Hot or Cold Water Piping Building to Building	H	Factory	Factory	Pre-Insulated Sizes 1/2 to 4 inch
Trap Primer Piping Buried Underslab	F	1/2	none	Armocell Tuffcoat Spec for Interior only
Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities	G	1/2	Type 7	Package System Only  Includes EW&S Where Designated for Barrier Free Use.
All Kitchen Heat Traced Grease Waste. All Heat Traced Sanitary	A	2	Type 2	Note 5
Underground Kitchen Heat Traced Grease Waste. Underground Heat Traced Sanitary	K	2	Type 8	Note 5
Stainless Piping: Hot Stainless Steel Piping Systems, 140 deg F to 200 deg F less than 3 inch	D	2½	Type 6	Up To 185 deg F Note 5
Plastic piping systems in return air plenums that do not meet ASTM E-84 standard	J	0.5	Foil	Pipe label tags attached around foil to identify piping use full bands and lagging
Supplemental Notes Note 1: Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated Note 2: This contractor will furnish and install heat trace tape, prior to insulation installation. Raychem self-regulating Winter Guard Plus 8 watts per foot with failure alarm. In instances where temperature may drop below 10 deg F, use 12 watts				

PIPING SYSTEM	TYPE	THICKNESS INCHES	JACKET	NOTES
<p>per foot.</p> <p>Note 3: Insulation shall include drain sump body and all horizontal piping to and including the elbow down to vertical.</p> <p>Note 4: Unless noted otherwise this section pertains to ALL piping in a specified system, including in-chase or in-shaft piping.</p> <p>Note 5: see spec section 220553 subsection 3.5 H for requirements of plastic jacketing.</p> <p>a. all insulated piping to be protected along the entire pipe length where indicated in 220553, 3.5H with white PVC jacketed covers similar to (<b>Knauf</b>, Ceel-Co o<b>Zeston plastic jacket</b>),</p> <p>b. this applies to exposed piping.</p>				

### 3.2 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.
- D. Mix insulating cement with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use de-mineralized water.

### 3.4 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.

- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with the least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches OC.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches OC.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.

2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

### 3.5 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
  1. Pipe: Install insulation continuously through floor penetrations.
  2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.

### 3.6 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.



**B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:**

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

**C. Insulate instrument connections for thermometers, pressure gauges, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.**

**D. Install removable insulation covers at locations indicated. Installation shall conform to the following:**

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.7 INSTALLATION OF CELLULAR-GLASS INSULATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches OC.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

#### B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

**D. Insulation Installation on Valves and Pipe Specialties:**

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

**3.8 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION**

**A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.**

**B. Insulation Installation on Pipe Flanges:**

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

**C. Insulation Installation on Pipe Fittings and Elbows:**

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

**D. Insulation Installation on Valves and Pipe Specialties:**

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

**3.9 INSTALLATION OF MINERAL-FIBER INSULATION**

**A. Insulation Installation on Straight Pipes and Tubes:**

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches OC.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

**B. Insulation Installation on Pipe Flanges:**

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

**C. Insulation Installation on Pipe Fittings and Elbows:**

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

**D. Insulation Installation on Valves and Pipe Specialties:**

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

**3.10 INSTALLATION OF POLYOLEFIN INSULATION**

**A. Insulation Installation on Straight Pipes and Tubes:**

1. Seal split-tube longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

**B. Insulation Installation on Pipe Flanges:**

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
  4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of polyolefin pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
  2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  3. Install insulation to flanges as specified for flange insulation application.
  4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- 3.11 FIELD-APPLIED JACKET INSTALLATION
- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturers recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches OC. and at end joints.

### 3.12 INSTALLATION OF FOAMGLAS INSULATION ON UNDERGROUND PIPING

#### A. Preparation

1. After the nominal system diameter is determined (pipe diameter plus insulation thickness), the trench shall be excavated to allow 6 inches (15 cm) minimum clearance in all directions around the final O.D. of the system.
2. The bottom of the trench shall be graded to the design slope of the piping and to provide uniform bearing along its entire length.
3. Where wet or unstable soils are encountered, such soil shall be removed to a sufficient depth and the trench backfilled with coarse sand or loose granular earth. This backfill shall be compacted to a density equal to that of the acceptable portions of the trench.
4. Where excavation of rock is required, the rock shall be excavated to an over depth of 6 inches (15 cm) minimum below the specified trench depth. Over depths in rock shall be backfilled with loose granular earth or coarse sand and thoroughly tamped.
5. In areas of high-water table, adequate drainage shall be provided by a gravel bed and a perforated drainpipe covered with synthetic drainage fabric to prevent clogging.
  - a. The pipe shall lead to a sump provided with means to remove water from the trench area. Such conditions shall be determined and provided for by the engineer or design professional.
6. All insulated piping shall rest in a 6 inches (15 cm) layer of compacted sand. Excavation shall be kept free of standing water during insulation and jacketing application.
7. Note: Where excessive or cyclical movement is anticipated, the bore of FOAMGLAS® insulation shall be coated with a thin application of bore coating and allowed to dry before insulation is applied to the pipe.

#### B. Insulation Application FOAMGLAS® insulation and PITWRAP® jacketing shall be applied to piping in 10' segments (maximum length). After completion, the segments are rotated 180 degrees and the bottom of the jacketing and butt strips are inspected for proper application and sealing. If any defects are visible, they must be corrected. Major defects may require removal of jacketing. Assuming proper jacketing and sealing, the segments are rotated back into position and the connecting butt strips are applied.

1. Field jacketed insulation-staggered joints: the last section of FOAMGLAS® pipe covering the 10 ft segment is cut even to form a through joint between completed segments.
2. Large diameter piping: shorter segments can be insulated and jacketed if more practical.
3. Abrasion: insulation sections for large diameter piping will have to be bore coated.
4. Special considerations-anchors, guides, expansion loops, elbows, etc.: the completed insulated segment is rotated and inspected before installing the connecting section of insulation at the anchors, guides, expansion loops, elbows, etc.
5. These procedures are not to be used on oversized insulation.

#### C. Field-Jacketed

1. Field-jacketed FOAMGLAS® insulation shall be applied to the piping with butt joints staggered and tightly butted. Longitudinal and butt joints shall be left dry. All joints shall be tightly fitted to eliminate voids by refitting or replacing sections of insulation.

2. Each section of insulation shall be held in place by two wraps of strapping tape with a 50 percent overlap per wrap.
3. For double-layer applications, the second layer of FOAMGLAS® insulation shall be applied in a manner similar to the first, with all joints staggered between layers.

**D. Jacketing**

1. Application Apply the specified jacketing in strict accordance with the appropriate product data sheet. Request Technical Data Letter #244 from Pittsburg Corning for quality control installation methods.
2. Seal all overlaps and butt strips as noted in the product data sheet to ensure that ground water cannot penetrate the jacket system.
3. Note: In tunnels, manholes and pre-cast trenches where high ambient temperatures may exist, metal bands should be installed 12 inches on center of the jacketing exterior to control slippage of the overlap seal.

**E. Irregular Surfaces**

1. At all irregular surfaces such as elbows, tees, fitting covers, etc., the PITTWRAF® jacketing shall be precut to fit the contour of the surface to which it is to be applied. Precut sections shall allow for 2 inch (5 cm) overlap. All laps shall be sealed. In addition to sealing the PITTWRAF® jacketing on these irregular surfaces, a glove coat of the PITTCOTE® 300 coating shall be applied over the jacketing. First, carefully burn away the exterior plastic film on the PITTWRAF® jacketing. Then apply a glove coat of PITTCOTE® 300 coating. While still tacky, embed a layer of reinforcing fabric in the coating. After one hour, apply a second coat of PITTCOTE® 300 coating over the first coat. Total wet film thickness of the two coats should be 1/8 inch (3 mm) minimum. As an alternative to the cutting and fitting of PITTWRAF® jacketing on fittings, a five-layer application of PITTCOTE® 300 coating may be used.
2. The coating shall be applied in accordance with the procedures found in product Pittsburg Corning data sheet FI-120, in alternating layers of mastic, reinforcing fabric, mastic, mastic fabric and mastic, totaling five layers. Total wet film thickness shall be 1/4 inch (6 mm) minimum. If backfilling takes place less than 24 hours after PITTCOTE® 300 coating is applied, roofing felt shall be placed over the coating before backfilling.
3. Ends and bore of insulation left exposed at day's end shall be sealed between the insulation and the pipe with PITTCOTE® 300 coating to prevent bulk water entry. All completed work shall be backfilled as soon as possible to prevent damage to the insulation system.

**F. Anchors/Guides**

1. Size of concrete anchors and guide blocks and locations of each shall be determined by the engineer or design professional. Anchors shall be continuously welded to the carrier pipe.
2. When sizing anchors, coefficient of friction for FOAMGLAS® insulation is an average of 0.6. It is common engineering practice to locate line guides on both sides of an expansion loop, zee, or expansion joint. The line guide ensures that the thermal expansion is properly directed into the expansion mechanism. Butt ends of insulation in contact with anchor and/or guide plates shall be sealed continuously to plates with high-temperature sealant. Diameter of pipe sleeve guides shall be a maximum of 1/4 inch (6 mm) greater in diameter than the diameter of the pipe.

**G. Wall Penetrations**

1. The piping system should be designed so that no movement occurs at the penetrations except for manholes containing expansion couplings. All other movement should be accommodated by expansion loops or at changes of direction. Prime all concrete surfaces at penetrations before applying asphalt coating.

**H. Expansion Provisions**

1. Expansion loops, ells, tees and lead-off lines shall be insulated with oversize insulation. Inside diameter of the oversize insulation shall be the same as the exterior diameter of the straight run piping insulation. If the calculated pipe movement is greater than this allowance, contact Pittsburgh Corning Corporation.
2. Oversize insulation shall be the same thickness as the straight run piping insulation, but not less than 2 inches (5 cm) thick.
  - a. Oversize insulation shall overlap straight run insulation at least 9 inches (23 cm). All oversize insulation which provides for expansion shall be encased in concrete, a minimum of 3 inches (8 cm) thick around the insulation.
  - b. Concrete pad supports molded to fit inside the oversize insulation to center the pipe and to allow free movement shall be provided. Concrete support pads may be fabricated in the field or prefabricated.
  - c. These supports should be cured a minimum of seven days prior to use in steam piping applications. Alternatively, expansion joints may be used to accommodate expansion and are to be insulated. Expansion joints are common on pipes larger than 12 inches (30 cm) NPS.
  - d. A sheet metal insulation support shall be provided to support the oversize insulation. If pipe insulation is not of sufficient thickness to allow sheet metal support to clear expansion joints, provide insulation collars of sufficient thickness and minimum 9 inches (23 cm) width to provide clearance.

**I. Field Quality Control**

1. After application of the jacketing system to all straight and irregular sections of insulation, visually inspect all laps, seams, butt strips and glove-coated areas to ensure that these areas are sealed from water entry in accordance with the specifications and appropriate product data sheet.

**J. Backfilling**

1. The trench shall be carefully backfilled using the excavated earth approved for backfilling, consisting of sand, clay, earth, loam, or other approved materials. Sand backfill shall be placed within 6 inches (15 cm) of the insulated pipe and shall be free of rocks, debris, or stones greater than 1/4 inch (6 mm) diameter. Care shall be taken not to damage the PITTWRAP® jacketing during backfilling. Backfill shall be applied in 6 inches (15 cm) lifts, tamping each lift until a depth of 12 inches (30 cm) over the insulated pipe is reached. The remainder of the trench shall be backfilled in 12 inches (30 cm) lifts, with each lift tamped to the desired compaction.

**3.13 FINISHES**

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09.



1. Flat Acrylic Finish: Two (2) finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
  - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### 3.14 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  1. Submit test report to Engineer as part of the closeout documents.
- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.15 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  1. Drainage piping located in crawl spaces.
  2. Underground piping.
  3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  1. None.
  2. PVC, Color-Coded by System: 30 mils thick.
  3. Stainless Steel, Type 304 Smooth 2B Finish: 0.016 inch thick.
- D. Piping, Exposed:
  1. PVC: 30 mils thick.
  2. Stainless Steel, Type 304, Smooth 2B Finish with Z-Shaped Locking Seam: 0.020 inch thick.

3.17 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

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## SECTION 220800 - COMMISSIONING OF PLUMBING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This section includes
  - 1. Test equipment.
- B. Related Sections:
  - 1. Division 01 for general commissioning process requirements.

#### 1.3 DESCRIPTION

- A. Refer to Division 01 for the description of commissioning.

#### 1.4 DEFINITIONS

- A. Refer to Division 01 Section "General Commissioning Requirements" for definitions.

#### 1.5 SUBMITTALS

- A. Refer to Division 01 for CxA's role.
- B. Refer to Division 01 for specific requirements. In addition, provide the following:
  - 1. Certificates of readiness
  - 2. Certificates of completion of installation, prestart, and startup activities.
  - 3. O&M manuals
  - 4. Test reports

#### 1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

## 1.7 COORDINATION

- A. Refer to Division 01 for requirements pertaining to coordination during the commissioning process.

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the contractor for the equipment being tested. For example, the plumbing contractor of Division 22 shall ultimately be responsible for all standard testing equipment for the plumbing system in Division 22, except for equipment specific to and used by TAB in their commissioning responsibilities. A sufficient quantity of two-way radios shall be provided by each subcontractor.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. Data logging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.
- E. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 deg F and a resolution of + or - 0.1 deg F. Pressure sensors shall have an accuracy of + or - 2.0 percent of the value range being measured (not full range of meter) and have been calibrated within the last year.

## PART 3 - EXECUTION

### 3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems
- B. Red-lined Drawings:
  - 1. The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.
  - 2. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
  - 3. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings.
  - 4. The contracted party, as defined in the Contract Documents will create the as-built drawings.

**C. Operation and Maintenance Data:**

1. Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.
2. The CxA will review the O&M literature once for conformance to project requirements.
3. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the contractor.

**D. Demonstration and Training:**

1. Contractor will provide demonstration and training as required by the specifications.
2. A complete training plan and schedule must be submitted by the contractor to the CxA four weeks (4) prior to any training.
3. A training agenda for each training session must be submitted to the CxA one (1) week prior the training session.
4. The CxA shall be notified at least 72 hours in advance of scheduled tests so that testing may be observed by the CxA and Owner's representative. A copy of the test record shall be provided to the CxA, Owner, and Architect.
5. Engage a Factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specific equipment.
6. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, trouble shooting, servicing, and maintaining equipment.
7. Review data in O&M Manuals.

**E. Systems manual requirements**

1. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
2. The GC shall include final approved versions of the following information for the Systems Manual:
  - a. As-Built System Schematics
  - b. Verified Record Drawings
  - c. Test Results (not otherwise included in Cx Record)
  - d. Periodic Maintenance Information for computer maintenance management system
  - e. Recommendations for recalibration frequency of sensors and actuators
  - f. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information.
  - g. Training Records, Information on training provided, attendees list, and any on-going training.
3. This information shall be organized and arranged by building system, such as fire alarm, chilled water, heating hot water, etc.

4. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.

## 1.8 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meetings.
- C. Attend domestic water balancing review and coordination meetings.
- D. Participate in Plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- G. Prepare preliminary schedule for Plumbing system orientations and inspections, operation and maintenance manual submissions, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, testing and balancing and task completion for owner. Distribute preliminary schedule to commissioning team members.
- H. Update schedule as required throughout the construction period.
- I. During the startup and initial checkout process, execute the related portions of the prefunctional checklists for all commissioned equipment.
- J. Assist the CxA in all verification and functional performance tests.
- K. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- L. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA (45) days after submittal acceptance.
- M. Coordinate with the CxA to provide (48) hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
- N. Notify the CxA a minimum of two (2) weeks in advance of the time for start of the balancing work. Attend the initial balancing meeting for review of the balancing procedures.
- O. Participate in, and schedule vendors and contractors to participate in the training sessions.
- P. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
  1. Plumbing equipment including domestic water heaters, pumps, plumbing fixtures, and all other equipment furnished under this Division.
  2. Gas piping, sanitary waste and vent piping, storm drainage piping, sump pumps and automatic sprinkler system.
  3. Fire stopping in fire rated construction, including caulking, gasketing and sealing of smoke barriers.
  4. Air compressors

5. Fuel delivery systems
- Q. The equipment supplier shall document the performance of his equipment.
- R. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.
- S. Balance Contractor
  1. Attend initial commissioning coordination meeting scheduled by the CxA.
  2. Submit the site specific balancing plan to the CxA and Design Professional for review and acceptance.
  3. Attend the balancing review meeting scheduled by the CxA. Be prepared to discuss the procedures that shall be followed in balancing the Plumbing system.
  4. At the completion of the balancing work, and the submittal of the final balancing report, notify the Plumbing contractor and the CM/GC.
  5. At the completion of balancing work, and the submittal of the final balancing report, notify the Plumbing Contractor and the CM/GC.
  6. Participate in verification of the balancing report, which will consist of repeating measurements contained in the balancing reports. Assist in diagnostic purposes when directed.
- T. Provide training of the Owner's operating staff using expert qualified personnel, as specified.
- U. Equipment Suppliers
  1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
  2. Assist in equipment testing per agreements with contractors.
  3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
- V. Refer to Division 01 for additional contractor responsibilities.
- 1.9 OWNER'S RESPONSIBILITIES
  - A. Refer to Division 01 for Owner's Responsibilities.
- 1.10 DESIGN PROFESSIONAL'S RESPONSIBILITIES
  - A. Refer to Division 01 for Design Professional's Responsibilities.
- 1.11 CXA'S RESPONSIBILITIES
  - A. Refer to Division 01 for CxA's Responsibilities.
- 1.12 TESTING PREPARATION
  - A. Certify in writing to the CxA that Plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

- B. Certify in writing to the CxA that Plumbing instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

#### 1.13 DOMESTIC WATER BALANCING VERIFICATION

- A. Prior to performance of Domestic Water Balancing work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least ten (10) days in advance of testing and balancing Work, and provide access for the CxA to witness balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of Plumbing systems at the direction of the CxA.
  - 1. The CxA will notify testing and balancing subcontractor ten (10) days in advance of the date of field verification. Notice will not include data points to be verified.
  - 2. The balancing subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
  - 3. Failure of an item includes a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final balancing report.
  - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

#### 1.14 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Plumbing testing shall include entire Plumbing installation. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the Plumbing contractor, balancing subcontractor shall prepare detailed testing plans, procedures, and checklists for Plumbing systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.



- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

#### **1.15 PLUMBING SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES**

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 22 sections. Provide submittals, test data, inspector record, and certifications to the CxA.
- B. Plumbing Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 for HVAC Controls." Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests and chemical treatment: Test requirements are specified in Division 22 piping sections. Plumbing Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
  - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
  - 2. Description of equipment for flushing operations.
  - 3. Minimum flushing water velocity.
  - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- D. Plumbing Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, fuel gas, sanitary waste and vent piping, storm drainage piping, sprinkler and domestic water distribution systems.
- E. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.
- F. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

1. All Water Systems including hot and cold water systems and their related components and heaters.
  2. All Compressed Air Systems
  3. All Water Heaters and Heat Exchangers
  4. All Condensing Equipment
  5. All Vacuum Systems
  6. Emergency Eyewash and Shower Equipment
  7. All Backflow Devices
  8. Fuel Gas System
  9. Gas System – Carbon Dioxide
  10. Gas System – Central Cylinder
  11. Gas System – Hydrogen
  12. Gas System – Natural Gas
  13. Gas System – Nitrogen
  14. Hot Water Circulating Pumps
  15. Hot Water Tempering Stations
  16. Plumbing Fixtures
  17. Rainwater Collection System
  18. RODI Purified Water Systems
  19. Sanitary Waste and Venting System
  20. pH Neutralization Systems
  21. Chemical Waste Handling, Storage and Process Systems
  22. Special Waste Systems
  23. Wastewater Pumping Systems
  24. Lab Waste Pumping Systems
  25. Storm Drainage System
  26. Trap Primer
  27. Water Booster Systems
  28. Water Storage Systems
- 1.16 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT
- A. Refer to Division 01 for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

1.17 APPROVAL

- A. Refer to Division 01 for approval procedures.

1.18 DEFERRED TESTING

- A. Refer to Division 01 for requirements pertaining to deferred testing.

1.19 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
- B. Refer to Division 01 for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

1.20 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 for requirements pertaining to training.
- B. Plumbing Contractor. The mechanical contractor shall have the following training responsibilities:
  - 1. Provide the CxA with a training plan two weeks before the planned training.
  - 2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of Plumbing equipment.
  - 3. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  - 4. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
  - 5. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
  - 6. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
  - 7. The plumbing contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls.
  - 8. Training shall occur after functional testing is complete, unless approved otherwise by the Owner.

END OF SECTION

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## **SECTION 221110 - COMMON PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Piping materials
  - 2. Under-building-slab and aboveground pipes, tubes, and fittings inside buildings.
  - 3. Stainless steel water piping
  - 4. Encasement for piping.
  - 5. Dielectric fittings

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For transition fittings and dielectric fittings.
- B. All Pipe, Fittings, Valves and Sundries contained in this specification section. All piping systems shall be submitted as a single piping submittal package with labels tagged consistent with the pipe index found in Part 2 of this spec.
- C. LEED Submittals:
  - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
  - 2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. All Product shop drawings and submittal sheets for all pipe, fittings, valves, equipment, appurtenances, and systems included in this section.
- B. System purging and disinfecting activities report and hot water balancing reports.
  - 1. Completion Documentation. Submit HW balancing report to Engineer. Submit testing report(s) including system tested, date, test method, witnesses and participants, and

statement that any deficiencies discovered during testing have been satisfactorily corrected.

2. Provide documentation and certifications as required by authorities for building occupancy. Prior to occupancy, submit to Engineer and AHJ
  - a. Certification that the potable water systems have been balanced and sterilized,
  - b. Laboratory certifications on test samples of the water.
- C. Field quality-control reports.
- D. Potable/non-potable cross connection test report and survey sheets

#### 1.5 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
  1. Number of days in advance of proposed interruption of water service.
  2. Do not interrupt the water service without Architect's, Construction Manager's, and Owner's written permission.

### PART 2 - PRODUCTS

#### 2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule Index and Pipe Tables." Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

#### 2.2 BUILDING PLUMBING SYSTEM PIPING

- A. Building-underground and aboveground pipes, tubes, and fittings inside buildings
- B. Where building and plumbing codes allow, the contractor, at their option may substitute stainless steel piping for potable and non-potable water services.
- C. Water piping and components shall comply with NSF 61 Annex G.

#### 2.3 STAINLESS-STEEL WATER PIPING

- A. Appurtenances for Grooved-End, Stainless-Steel Pipe:
  1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. **Grinnell Mechanical Products.**
    - b. **Shurjoint Piping Products.**

- c. Victaulic Company.
  - d. Or Approved Equal.
- 2. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.
- 3. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:
- 4. AWWA C606 for stainless-steel-pipe dimensions.
- 5. Stainless-steel housing sections.
- 6. Stainless-steel bolts and nuts.
- 7. EPDM-rubber gaskets suitable for hot and cold water.
- 8. Minimum Pressure Rating:
  - a. NPS 8 and Smaller: 600 psig.
  - b. NPS 10 and NPS 12: 400 psig.
  - c. NPS 14 to NPS 24: 250 psig.

#### 2.4 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Form: Sheet or tube.
- C. Color: Black or natural.

#### 2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. A. Y. McDonald Mfg. Co.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  - 2. Standard: ASSE 1079.
  - 3. Pressure Rating: 125 psig minimum at 180 deg F for low pressure piping and 150 psig 250 psig for high systems where the operating pressure exceeds 150 psig.
  - 4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Watts; a Watts Water Technologies company.
    - b. Wilkins.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASSE 1079.
  3. Factory-fabricated, bolted, companion-flange assembly.
  4. Pressure Rating: 125 psig minimum at 180 deg F 150 psig 175 psig 300 psig match system working pressure.
  5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Central Plastics Company.
    - d. Or Approved Equal.
  2. Non-conducting materials for field assembly of companion flanges.
  3. Pressure Rating: 150 psig.
  4. Gasket: Neoprene or phenolic.
  5. Bolt Sleeves: Phenolic or polyethylene.
  6. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Elster Perfection Corporation.
    - b. Precision Plumbing Products.
    - c. Victaulic Company.
    - d. Or Approved Equal.
  2. Standard: IAPMO PS 66.
  3. Electroplated steel nipple complying with ASTM F 1545.
  4. Pressure Rating and Temperature: 300 psig at 225 deg F.



5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

### PART 3 - EXECUTION

#### 3.1 PIPE SCHEDULE INDEX

SERVICE	CODE	MAXIMUM SERVICE OPERATING LIMITS		PIPE CLASS	PIPE MATERIAL
		(psig)	Temp (°F)		
City or Service Water Entrance Piping	CW	100	250	A05	Type K Copper or D1CL
Domestic Cold Water	CW	100	250	A10 A20	Type L Copper
Domestic Hot Water	HW	100	250	A10 A20	Type L Copper
Domestic Hot Water Return	HWR	100	250	A10 A20	Type L Copper
Stainless Steel Class 150 Water Piping	CW HW	150	250	A23	Stainless Steel
Stainless Steel Class 250 Water Piping	CW HW	250	250	A21	Stainless Steel
Non-Potable Water	NPW	100	250	A10 A20	Type L Copper
Tepid Water	TW	100	250	A10 A20	Type L Copper
Tepid Water Return	TWR	100	250	A10 A20	Type L Copper
Trap Primer	TP	100	250	A10 A20	Type L Copper
Indirect Waste (above ground)	IW	Gravity	80	A17 A10	G. Steel Copper
Hot or Cold Potable or non -Potable Water piping for high rise mains	Service labeled	250	180	A21	Stainless Steel with mechanical or weld joints
	FL	100	250	A25	Copper Purple Labeled Pipe
	QW	100	250	A25	Copper Purple Labeled Pipe
Rain Leader	RW	Gravity	80	D10	Cast Iron
Sanitary Waste & Vent	S, W or V	Gravity	120	D10	Cast Iron
Indirect Waste (below ground)	IW	Gravity	80	D10	Cast Iron
Force Main (Sanitary or Storm)	FM	50	120	D11 A10	G. Steel Copper
Groundwater Collection Piping	GC	0	80	D18	Sch 40 PVC Perforated
Sanitary Waste and Vent	S, W or V	0	120	D20	Schedule 40 PVC
Kitchen Grease Waste Piping	KW	Gravity	120	D13	Epoxy Coated Cast Iron
	KW	Gravity	120	D-25	Blucher Stainless Steel
Wastewater from soda fountains See note 9	KW	Gravity	40 - 100	D13 D25	Epoxy Cast Iron or Stainless Steel
Alternative Pipe Material - Water	Wres	150	120	P30	CPVC
Alternative Pipe Material - Water	WRes	80	200	P35	PEX
Reclaim Water	REC	100	73	P45	Charlotte Purple

SERVICE	CODE	MAXIMUM SERVICE OPERATING LIMITS		PIPE CLASS	PIPE MATERIAL
		(psig)	Temp (°F)		
					Pipe
				P47	Niron Purple Pipe
	FL	100	250	P45	Charlotte Purple Pipe
				P47	Niron Purple Pipe
	QW	100	250	P45	Charlotte Purple Pipe
				P47	Niron Purple Pipe

GENERAL PIPE SPEC NOTES:

- Each valve type shall be the product of a single manufacturer. Each system shall be provided with valves as required by code and shown on the drawings and shall be installed to facilitate operation, replacement and repair
- Provide access panels for concealed valves behind non-removable ceilings or walls.
- Provide shut-off valves on supply piping to individual pieces of equipment.
- Provide pipe dope, Teflon tape, wax rings, neoprene gaskets and other jointing compounds as required by best standard practice and only on service as recommended by manufacturer.
- Apply putties and jointing compounds for plumbing fixtures and trim as recommended by manufacturers.
- Valves on insulated piping systems shall be equipped with extended handles to accommodate insulation thickness.
- All piping insulation and materials installed in return air plenums shall be plenum rated. Thermoplastic piping systems are hereby prohibited in return air plenums.
- Piping routed through metal stud or wood stud partitions: provide centering such that piping does not contact metal studs and also protection of piping systems routed horizontally through metal stud or wood stud partitions where the piping crosses a stud. Sleeve type protection shall be used to prevent damage to the lateral piping using screws/nails/fasteners. Provide pre-manufactured products equal to puncture solution, or on-site sleeves.
- In all areas where waste from Soda dispensing equipment enters the waste drainage system, the waste piping that serves the area shall be corrosion resistant from the soda machines to a man sanitary trunk header. The corrosion resistant header may also pick up other users from the commissary area

### 3.2 EARTHWORK

- Comply with requirements in Division 31 for excavating, trenching, and backfilling.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- Piping Installation
  - Install piping approximately as shown on the drawings and as directed during installation by the General Contractor or the Architect.
  - Piping shall be installed as straight and direct as possible forming right angles or parallel lines with building walls, other piping and neatly spaced.
  - The horizontal runs of piping, except when concealed in partitions, shall be installed as high as possible.
- Piping or other apparatus shall not be installed in such a manner that interferes with the full swing of the doors and access to other equipment.
- The arrangement, positions and connections of pipes, fixtures, drains, valves, and the like, indicated on the drawings shall be followed as closely as possible, but the right is reserved by the General Contractor or the Architect to change locations and elevations to accommodate the work, without additional compensation for such change.

- D. It shall be possible to drain the water from all sections of each cold and hot water piping system. Pitch piping back to drain valves.
- E. Screwed piping of brass or chrome plated brass shall be made with special care to avoid marring or damaging pipe and fitting exterior and interior surfaces.
- F. Screwed pipe and copper tubing shall be reamed smooth before installation.
- G. All exposed piping in connection with fixtures and where exposed on finished walls or to view, shall be chrome plated. Where chrome plated piping is installed, cut and thread pipe so that no unplated pipe threads are visible when the work is completed.
- H. Remove and replace with new materials, any copper or brass piping (chrome plated or unplated) and valves showing visible tool marks.
- I. Vertical risers shall be firmly supported by riser clamps, properly installed to relieve all weight from the fittings.
- J. The pipe and fittings shall be manufactured in the United States of America and in accordance with the Commercial Standards, American National Standards Institute and American Society of Testing Materials.

### 3.4 GRAVITY PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Supplementary Bracing: See Division 22 for hangers and supports, Sub-Section 2.5 for specific restraint conditions for cast iron soil pipe.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping free of sags and bends.
- G. Install piping to allow application of insulation.
- H. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- I. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- J. Install steel piping according to applicable plumbing code.
- K. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
- L. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

- M. Install aboveground PVC piping according to ASTM D 2665.
- N. Install Underground PVC piping according to ASTM D 2321.
- O. Be responsible for checking each pipe for alignment, centerline elevation and invert grade for underground installations.
- P. At times when work is not in progress, open ends of pipe and fittings shall be securely closed so that no trench water, earth or other substance will enter the pipe or fittings. Pipe laid through rock excavation shall rest on a six-inch layer of well-compacted sand.
- Q. The Sanitary (waste and vent), and storm drainage piping three inches and smaller in diameter shall pitch a minimum of 1/4 inch per foot and piping four inches and larger in diameter shall pitch a minimum of 1/8 inch per foot.
- R. The vent stacks shall be connected as shown and extended through the roof a minimum of 18 inches. Waste and vent pipes shall be concealed unless otherwise noted.
- S. Every fixture shall be separately trapped, and the traps must be vented unless an approved battery or wet vented system is installed. Floor drains shall be considered as a fixture.
- T. Vents shall be connected to the discharge of each trap in the sanitary system, and then carried individually to a point above the flood level of the fixture before connecting with any other vent pipes. Pitch the branch vents back to the fixtures.
- U. The vents passing through the roof shall be a minimum size of four inches in diameter.
- V. Cleanouts shall be provided in drainage piping at changes in directions, at foot of stacks or other required points so that all portions of the lines will be readily accessible for cleaning or rodding out.
- W. The maximum horizontal distance between cleanouts; in piping four inches in diameter and smaller shall not be more than 50 feet apart; in piping five inches in diameter and larger shall not be more than 100 feet apart.
- X. Traps on sanitary piping not integral with fixtures and in accessible locations shall be provided with a brass trap screw protected by the water seal and will be regarded as a cleanout.
- Y. Test tees with brass cleanout plugs shall be provided at the foot of all vertical waste and storm drainage stacks and at each floor. Wherever cleanouts on vertical lines occur concealed behind finished walls, they shall be extended to back of finished wall and a wall plate shall be provided.

### **3.5 SPECIALTY PIPING INSTALLATION**

- A. Install engineered soil and waste drainage and vent piping systems as follows:
  - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
  - 2. Solvent Drainage System: Comply with ASSE 1043 and solvent fitting manufacturer's written installation instructions.
  - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- B. Anchorage shall be provided to restrain drainage piping from axial movement.
  - 1. For plastic pipe sizes greater than 6 inches, and other pipes sizes greater than 4 inches (102 mm), restraints shall be provided for drainpipes at all changes in direction and at all changes in diameter greater than two pipe sizes. Braces, blocks, rodding, backfill and other methods specified as suitable by the coupling manufacturer shall be utilized.

2. Bases of stacks shall be supported by the building structure, virgin or compacted earth or other material suitable to support the weight of the piping.
  - C. Expansion joint fittings in drainage pipe.
    1. Expansion joint fittings shall be used only where necessary to provide for expansion and contraction of the pipes. The expansion joint fittings shall be of the typical material suitable for use with the type of piping with which such fittings are installed.
  - D. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
    1. In all areas with corrosive soil environments, install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
  - E. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
  - F. Plumbing Specialties:
    1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Division 22.
    2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22.
    3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22.
  - G. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
  - H. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22.
  - I. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22.
  - J. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22.
- 3.6 JOINT CONSTRUCTION (GRAVITY DRAIN STORM AND VENT SYSTEMS)
- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
  - B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
  - C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
  - D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.
- F. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or the pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in a cross pattern.
- I. Plastic, Non-Pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
  3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

### 3.7 PRESSURE PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipes and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube and ductile iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5 when soil is of corrosive nature.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gauge, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gauges in Division 22 and with requirements for drain valves and strainers in this section for water piping specialties.
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. When water pressure exceeds 80 psig, install water-pressure-reducing valves downstream from shutoff valves.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Division 22.

- J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- M. Install piping to permit valve servicing.
- N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- O. Install piping free of sags and bends.
- P. Install fittings for changes in direction and branch connections.
- Q. Install PEX piping with loop at each change of direction of more than 90 degrees.
- R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- S. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Division 22.
- T. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Division 22.
- U. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Division 22.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22.
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22.
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22.

### 3.8 JOINT CONSTRUCTION (PRESSURE PIPING SYSTEMS)

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.

- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
  - F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
  - G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gauge. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
  - H. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tubes and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
  - I. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
  - J. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
  - K. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
  - L. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
    - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    - 3. PVC Piping: Join according to ASTM D 2855.
  - M. Joints for PEX Piping: Join according to ASTM F 1807.
  - N. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.
- 3.9 TRANSITION FITTING INSTALLATION
- A. Install transition couplings at joints of dissimilar piping.
  - B. Transition Fittings in Underground Domestic Water Piping:
    - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
    - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
  - C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: per manufacturers recommendations



**3.10 DIELECTRIC FITTING INSTALLATION**

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings couplings or nipples nipples unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges flange kits nipples.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

**3.11 EXAMINATION OF VALVES**

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace them with new valves.

**3.12 VALVE INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for butterfly and gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install check valves for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
  - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
  - 3. Lift Check Valves: With stem upright and plumb.
- G. Install valve tags. Comply with requirements in Division 22 for valve tags and schedules.

**3.13 FOOD SERVICE EQUIPMENT**

- A. Provide roughing and final connections for water, waste, kitchen waste, vent and gas systems.
- B. Include all necessary appurtenances such as traps, tailpieces, strainers, wheel handle stops, valves, drain cocks, etc. to fixtures and equipment so required.

- C. Each fixture, appliance, or piece of equipment, including work in, under or through tables, cabinets and equipment chases shall be fit with valves and traps.
- D. Provide miscellaneous equipment connections and indirect drains from service units and similar equipment. Unions or flanged means of disconnect shall be installed at kitchen equipment and at all places where disconnect of piping allows for repair or removal of the equipment.
- E. Roughing shall not begin until the Architect has approved equipment and fixture shop drawings and a kitchen template is furnished by the pertinent manufacturer.
- F. Verify all connection requirements with the architect and kitchen consultant. Each location of service connection shall be obtained prior to roughing such that all work may be installed in a neat and professional manner.
- G. Garbage Disposer: Include ball valves, solenoid valve and vacuum breaker on the cold-water service to this equipment
- H. Water Hammer Arrestors: an isolation valve shall be installed beneath each absorber. Absorbers shall be sized in accordance with the Plumbing and Drainage Institute Standard PDI-WH-201. Furnish and install shock absorbers at each piece of equipment with quick closing valves including but not limited to:
  - 1. Dishwashers
  - 2. Booster heaters
  - 3. Cold or hot water fill stations with spring loaded manual valves.
  - 4. At all equipment with solenoid shutoff valves
- I. Provide isolation or stop valves at all fixture and equipment connections. Valves shall be provided at the equipment. Valves shall be 1/4 turn isolation type stop valves.
- J. Provide vacuum breakers on water service lines to booster heaters, garbage disposer, dishwashers, pot washers, as well as all equipment that has means for a hose connection at the outlet faucet.
- K. Provide a backflow device comparable to a Watts SD-3 conforming to ASSE-1022 on the cold-water connection to carbonators, beverage dispensers and coffee machines.
- L. Provide adjustable pressure reducing valves (PRV's) at all hot water connections to glassware washers, dishwashers, pot washers and other automatic kitchenware wash equipment.
- M. Furnish and install approved backflow preventers for all food service equipment including dishwashers, combi-ovens, pot washers, garbage disposers that are not equipped with approved integral backflow devices.

### 3.14 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Division 22.
- B. Comply with requirements for pipe hanger, support products, and installation in Division 22.
  - 1. Vertical Piping: MSS Type 8 or 42, clamps.
  - 2. Individual, Straight, Horizontal Piping Runs:
  - 3. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
  - 4. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.

5. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
  6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  7. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
  2. NPS 3: 60 inches with 1/2-inch rod.
  3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
  4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
  5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
  6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
  2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
  3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
  4. NPS 2-1/2: 108 inches with 1/2-inch rod.
  5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
  6. NPS 6: 10 feet with 5/8-inch rod.
  7. NPS 8: 10 feet with 3/4-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
  2. NPS 1-1/2: 108 inches with 3/8-inch rod.
  3. NPS 2: 10 feet with 3/8-inch rod.
  4. NPS 2-1/2: 11 feet with 1/2-inch rod.
  5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
  6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
  7. NPS 6: 12 feet with 3/4-inch rod.
  8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

- J. Install supports for vertical steel piping every 15 feet.
- K. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
  - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
  - 3. NPS 2: 10 feet with 3/8-inch rod.
  - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
  - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
  - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
  - 7. NPS 6: 12 feet with 3/4-inch rod.
  - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- L. Install supports for vertical stainless-steel piping every 15 feet.
- M. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
  - 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
  - 3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
  - 4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
  - 5. NPS 6: 48 inches with 3/4-inch rod.
  - 6. NPS 8: 48 inches with 7/8-inch rod.
- N. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
- O. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.
- P. Install hangers for vertical PEX piping every 48 inches.
- Q. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
  - 2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
  - 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
  - 4. NPS 6: 48 inches with 3/4-inch rod.
  - 5. NPS 8: 48 inches with 7/8-inch rod.
- R. Install supports for vertical PVC piping every 48 inches.
- S. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

### 3.15 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect water piping to water-service piping with shutoff valve; extend and connect to the following:
  - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
  - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  - 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
  - 4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

### 3.16 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Division 22.
- B. Label pressure piping with system operating pressure.

### 3.17 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Piping Inspections:
    - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
  - 2. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
  - 3. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
  - 4. Piping Tests:

- a. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
  - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
  - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
  - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
  - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
  - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.18 TESTING AND ADJUSTING - GENERAL

- A. Scope
1. Test and adjust plumbing systems as specified and as required by authorities that have jurisdiction. Perform tests recommended by manufacturers of materials and equipment. This requirement may be waived by Architect.
  2. Testing, balancing, and adjusting shall in no way relieve guarantee requirements.
  3. Furnish instruments, equipment, material, and labor necessary to conduct tests.
  4. All systems shall be thoroughly adjusted for perfect intended operation. All mechanical equipment shall be adjusted for flow, temperature, etc. of fluid.
  5. Pumps, relief valves and pressure reducing valves shall be adjusted as specified and as required by the Engineer. Submit in writing to the Engineer upon completion of this work that it is completed and ready for use.
- B. Before date of acceptance, furnish Architect with certificates of testing and inspection indicating approval of authorities having jurisdiction and conformance with requirements of Contract Documents.
- C. General
1. Submit proposed test procedures, recording forms, and test equipment for review before testing.
  2. Notify Architect and authorities involved at least 48 hours before testing and inspection.
  3. Do not paint, cover or conceal work before testing, inspecting and obtaining approval; this includes backfilling and application of insulation.

4. Costs of repairs and restoration of work of other trades and of existing building surfaces or material damaged during cleaning or testing shall be borne by trade performing cleaning or testing.
- D. No tests shall be started until systems have been cleaned as described under "Cleaning." Provide temporary piping and connections for testing, flushing, or draining systems to be tested.
  1. Repair or replace leaks, damage and defects that result from tests to like-new condition. Remove and replace defective materials with acceptable materials.
  2. Piping and joints shall be made tight without caulking. Continue tests until systems operate without adjustments and repair to equipment or piping.
  3. Provide testing instruments, force pumps, gauges, equipment, and labor necessary to conduct tests. Instruments used for testing and balancing shall have been calibrated within six months before balancing. Instrument calibration shall be certified.
  4. Submit six copies of the complete testing and balancing report to Architect for review.
- E. The final test shall be made after vertical and horizontal pipes and roughing-in have been run and before sewer or fixture connection is made.
  1. After soil, waste, and storm lines, etc. have been installed, outlets shall be temporarily plugged up.
  2. Test piping and check for leakage.
  3. Retesting after leaks are repaired shall be at no additional cost.
- F. Pressurized Piping Systems
  1. Leak tests shall be conducted in accordance with ANSI applicable codes and as specified herein.
  2. Test piping of various systems before covered or furred in.
  3. Tests shall be witnessed by the Architect and pronounced satisfactory before pressure is removed or any water drained off.
  4. Equipment shall be valved off or removed during the test if equipment pressure rating is less than test pressure.
  5. Retest systems after leaks are repaired within Contract Price.
- G. Potable Water System Test
  1. Certification of the potable water system integrity shall be required where separate systems of potable and non-potable water are provided to supply plumbing fixtures.
  2. Fill potable water system to capacity with clean clear water. Introduce water at top of piping system (hot and cold). During filling, introduce green food coloring dye into piping system. A floor-by-floor survey shall be conducted. Operate each outlet (hot and cold) connected to potable water system until coloring has been observed. A method of maintaining the level of water and coloring shall be employed in order to make-up the drawn off amounts. A survey sheet shall indicate each floor and the room number sequentially.
  3. This survey is required to be performed after all pressure testing and flushing of the piping system but before sterilization, further it is required that all fixtures connected to the potable water system be installed prior to the test.

- H. Examine Part 2 for supplemental testing requirements.

3.19 TESTING: PIPING SYSTEMS

A. General

1. Piping systems shall be subjected to testing water or air as noted and shall hold tight at the pressure head stated for the time interval required without adding air or water. While any system is being tested, required head or pressure shall be maintained until joints are inspected.
2. Equipment, material, power, and labor necessary for the inspection and test of piping systems shall be furnished. The system shall be complete and able to withstand the test procedures prescribed.
3. Tests shall be witnessed by the Inspector having jurisdiction and the Architect with 48-hour notice given these authorities.
4. Equipment, material, and labor required for testing of various systems or part thereof shall be provided by Plumbing Contractor.

B. Sanitary, Other Waste, Vent and Roof Water Conductor Systems

1. Water test shall be applied to drainage systems either in their entirety or in sections as required, after rough piping has been installed.
2. If applied to the entire system, openings in piping system shall be tightly closed, except the highest opening, and system filled with water to point of overflow.
3. If the system is tested in sections, each opening shall be tightly closed except the highest opening in the section under test, and each section shall be filled with water, but no section shall be tested with less than a 10-foot head of water.
4. In testing successive sections, at least upper 10 feet of next preceding section shall be tested so that no joint of piping in building, except the uppermost 10 feet of the system shall be submitted to a test of less than a 10-foot head of water.
5. Water shall be kept in the system for at least 30 minutes before inspection starts; the system shall then be made tight at all points.
6. Points of drainage systems tested with air instead of water shall be tested by attaching an air compressor testing apparatus to suitable opening and, after closing all other inlets or outlets, forcing air into systems until a uniform gauge pressure of 5 psi or sufficient pressure to balance a column of mercury 10 inches high. Pressure shall be held without introduction of additional air for a period of at least 15 minutes.

C. Water Piping Systems

1. Upon completion of water supply systems or section thereof, as required, the system shall be tested and proved tight under 1.5 times the operating system pressure and a minimum of 150 psi. The gauge shall be located on lowest new floor and pressure shall hold for a period of one hour without introducing additional water. Water used for testing shall be from a potable source of supply.
2. Filtered water piping system shall be tested with filtered or distilled water to a pressure of 100 psi for one hour.

D. Testing Summary



System	Test Medium	Test Pressure	Test Duration
Drainage and Vent (All Systems)	Water	10 feet	30 minutes
Water (All Systems)	Water	1.5 operating pressure and 150 psig minimum	1 hour
Thermoplastic Piping	Water No air	1.5 operating pressure and manufacturers recommendation	1 hour
Ejector Discharge/Pumped Piping System	Water	1.5 times system pressure and 50 psig min	1 hour

- E. Defective Work: If inspection or tests show defects, such defective work or material shall be replaced, and inspection and tests shall be repeated. Repairs to the piping shall be made with new material. No caulking of screwed joints or holes shall be acceptable.
- F. Additional Tests
1. Provide additional tests such as smoke pressure tests as required by regulations or as directed by authorities making the inspection.
  2. Provide for any repeated test as directed by the Architect, to make all systems tight as required.
  3. Visual inspections of joints and valves shall be made as directed by the Architect.

### 3.20 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
  2. Open shutoff valves to fully open position.
  3. Open throttling valves to proper setting.
  4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
  5. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
  6. Adjust calibrated balancing valves to flows indicated.
  7. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
  8. Remove and clean strainer screens. Close drain valves and replace drain plugs.
  9. Remove filter cartridges from housings and verify that cartridges are as specified for application where they are used and are clean and ready for use.
  10. Check plumbing specialties and verify proper settings, adjustments, and operation.

### 3.21 BALANCING OF HOT WATER SYSTEMS

- A. Hot Water Systems shall include all water piping that is heated through equipment arranged for that purpose.

1. Balance all hot or heated water systems.
2. These shall include building potable and non-potable hot water, hot distributed laboratory water, building tempered water systems, building process or industrial hot systems, and building pure water systems.

**B. Building Distribution Systems**

1. The entire hot water circulation systems shall be thoroughly balanced so hot water drawn from fixtures shall be as quickly available as possible.
  - a. Hot water delivery times shall be based on American Society of Plumbing Engineers (ASPE) water heating design manual standards.
  - b. Hot water from all fixtures shall be based on comparable temperatures as stipulated in presiding building codes.
  - c. Tempered water to emergency fixtures shall be available per the latest energy code to all fixtures and shall meet ANSI requirements for temperature and volume.
2. All circuits and sub circuits shall be flow and temperature balanced such that hot water positive flow is achieved in each branch circuit of the building hot water systems.
3. See drawing detail sheets and specification section pipe table A10 for flow and balancing valve spec options. The specified products indicate either integral flow or flow/temperature balancing devices, assure the installed devices meet these specifications.
4. Indicate on a riser diagram the type of balancing device use, method of calibration and proposed flow in each branch circuit of the hot water piping network for each hot water system.

**C. All Building Hot Water Distribution Pumps**

1. Balance flows to the main Thermostatic Hot Water Mixing Valves according to manufacturer's instructions.
2. Provide plastic tags on each circuit indicating the flow and balancing valve position to the Mixing valves and then to the water heaters.

**D. Submissions. For each system noted:**

1. Submit a report indicating the actual flow and temperature in each circuit described in Item C above. The report shall designate the following:
  - a. Time to achieve hot water at the remote hot water faucet in the circuit.
  - b. Hot water temperature achieved.
  - c. Setting on circuit setter.
2. For the circuits at the outlets of hot water circulation pumps, indicate the following:
  - a. The actual flow and temperature into Temperature Mixing Valve
  - b. The actual flow and temperature back to the heaters and/or storage tanks

**3.22 CLEANING**

- A. Purging and disinfection operations shall be based on samples obtained prior to and post disinfection from the site of the potable and non potable water systems.

Cleaning Group #1	All Potable and Non-Potable Water Piping, Including Flushing Water, Reclaim Water Systems and Quench Water Piping Systems.	
Work in Progress	As work progresses throughout construction, remove dirt and debris, and keep clean the interior of all water piping systems	
Purging and disinfection operations	All Division 22, sections of the specifications are subject to procedures outlined in this table for cleaning and disinfection procedures of potable and non-potable water piping system	
Fluid Used	Clean potable water shall be the media for flushing the piping system	
Cleaning	Cleaning accomplished by a flushing process. The flushing rate shall be equal to the design flow rate for lines in the system. If a process pump is in the system, the flushing rate shall be the pumping rate of the pump. If more than one pump is in the system, the highest pumping rate shall be the flushing rate.	
Disinfection	Test Parameters	Purging and disinfection operations, shall be based on samples obtained prior to and post disinfection from the site of the potable and non-potable water systems.
	Samples	Samples shall be gathered by a qualified testing agency.
		Draw a minimum of two samples for each testing procedure.
		Location in the piping system where sample is drawn
		Date samples drawn
		Name of person responsible for taking the samples
	New Piping and/or Parts of Existing Piping That Have Been Altered, Extended, or Repaired	Purge before using
		New or repaired water systems shall be purged of deleterious matter and disinfect prior to utilization
		Use purging and disinfecting procedures prescribed by the health authority or the water purveyor as well as inspectional authorities having jurisdiction
		If methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below
		Flush piping system with clean, potable water until dirty water does not appear at outlets.
	Minimum Concentration	Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours
	Requirement	Water piping systems shall be thoroughly disinfected with the solution containing specified concentration
	Filters	Bypass all building filters
	Chlorinating materials	Shall be either liquid chlorine or sodium hypochlorite solution, shall be introduced into the system and drawn to all points in the system.
	Duration	Disinfection solution shall be allowed to remain in system for 24 hours, during this time, valves and faucets shall be opened and closed several times.
	Post Disinfection	After disinfection, solution shall be flushed from the system with clear water until residual chlorine content is no greater than 0.2 parts per million.
	Hot Water System	Perform chlorination prior to heating the domestic hot water system. Run circulation pumps on the domestic HW system shall be supervised by Owner and performed by approved chemical testing laboratory and results sent to the Architect or Architect's representative for verification.
	Repeat procedures if biological examination shows contamination	
Flushing	Flush the system with clean, potable water until chlorine matches the chlorine content of the incoming potable supply. This, such that water coming from system after the standing time.	
	Repeat procedures if lab testing of samples indicates that required purity is not obtained.	

Cleaning Group #1	All Potable and Non-Potable Water Piping, Including Flushing Water, Reclaim Water Systems and Quench Water Piping Systems.
Flushing Duration	Strainers and/or baskets shall be inspected frequently during the flushing operation and cleaned. Flushing operation shall continue until extraneous material is no longer accumulating in the strainer or basket at the discharge point. After the completion of flushing, the system shall be drained completely and returned to the pre-cleaning condition.
Test Reports and Certification	Identification of system tested
	Testing laboratory shall submit a summary of test procedure for approval prior to any work performed. Work shall be in accordance with Owner's requirements. Subcontractor shall provide valves required to disinfect water supply system in part as required by phasing of construction and to provide isolating valves and draw-off valves for proper containment, phasing and flushing.
	Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

END OF SECTION

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## SECTION 221115 - PLUMBING NATURAL GAS PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Performance requirements
  - 2. Pipe Tables: Gas pipes, tubes, and fittings.
  - 3. Motorized gas valves
  - 4. Piping connector specialties.
  - 5. Dielectric unions.
  - 6. Buried pipe labeling and identification.
  - 7. Earthquake valves
  - 8. Fire safety valves
  - 9. Boiler and water heater gas detection systems

#### 1.3 CODES AND REGULATIONS:

- A. State Plumbing and Gas codes
- B. NFPA 54 gas code
- C. NFPA 70, National Electrical Code.
- D. NFPA 72, National Fire Alarm Code.
- E. Americans with Disabilities Act.
- F. Uniform Building Codes (UBC).
- G. Local and State Building Codes.
- H. All requirements of the local Authority Having Jurisdiction.

#### 1.4 DEFINITIONS

- A. CWP: Cold working pressure.

- B. Division 22 - Plumbing Work. All parts and pieces hereby referred.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. An example includes rooftop locations.
- D. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- F. ASME American Society of Mechanical Engineers
- G. ASCE: American Society of Civil Engineers
- H. CO: Carbon Monoxide
- I. CS Carbon Steel
- J. DN: Diameter Nominal
- K. NBR: Nitrile Butadiene Rubber.
- L. NPS Nominal Pipe Size
- M. NRTL: Nationally Recognized Testing Laboratory
- N. PE: Polyethylene Pipe

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. Manufacturer
  - 2. Model Number
  - 3. Catalogue Data sheet with Photographs
  - 4. Wiring and equipment connection diagrams clearly showing factory equipment and field installed equipment.
- B. Detail fabrication and assembly of seismic restraints.
- C. Shop Drawings
  - 1. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure.
  - 2. Detail the location of anchors, alignment guides, and expansion joints and loops.
  - 3. Include plans, elevations, sections and mounting and attachments details.
  - 4. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
  - 5. Wiring Diagrams
    - a. Detail wiring for signal, power, and control wiring
- D. Operation and Maintenance Data

1. Include Emergency, Operation and Maintenance manuals.
  2. Refer to Division 01 Section "Operation and Maintenance Data"
  3. Manufacturer's recommended detailed installation instructions
- E. Delegated-Design Submittal: For natural-gas piping seismic restraint supports, for both pipe and equipment to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Operation and Maintenance Data: For motorized gas valves pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

#### 1.9 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
  1. Notify Architect and Owner no fewer than five **days** in advance of proposed interruption of natural-gas service.
  2. Do not proceed with interruption of natural-gas service without Owner's written permission.

#### 1.10 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
- Piping and Valves: 100 psig minimum unless otherwise indicated.
  - Service Regulators: 100 psig minimum unless otherwise indicated.
- B. Natural-Gas System Pressure within buildings
- Allowed: 0.5 psig
  - Allowed: More than 0.5 psig, but not more than 2 psig,
  - Allowed: Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig,, and is reduced to secondary pressure of 0.5 psig or less.
- C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

### 2.2 PIPE TABLES: GAS PIPE AND FITTINGS

- A. Piping Systems
- B. Joint Compound and Tape: Suitable for natural gas.
- C. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

#### A11 - NATURAL GAS

Pipe Class: A11			
Service: Natural Gas		Material: Steel	
Service Limits	Primary ANSI Class:	150	
	Coefficient of linear expansion	6.5 x 10 <sup>-6</sup> inches per inch	Corrosion Allowance 0.05 inch

GENERAL		
Approvals for Use	All sizes	Secure approval from the owner and from the Authority Having Jurisdiction for the use of MegaPress or Mueller Streamline® STL-G Carbon Steel fittings and valves for this project. Submit approval to the engineer with the shop drawing submittals.

PIPE AND FITTINGS		
Piping	All sizes	Schedule 40 Carbon Steel ASTM A53-EGrade B, ASTM A106 Grade A, or ASTM A120.
Fittings	1/2 to 2 inches	Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern Note, when pressures exceed 5 psig, then all piping must be welded
	2-1/2 inches and up	Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding



	1/2 to 4 inches	Viega MegaPress G or Mueller Streamline® STL-G Carbon Steel Press fittings 1/2 inch to 4 inch shall conform to ANSI LC4-2012/CSA 6.32-2102 standard. Fittings for use on IPS Schedule 40 pipe shall have a nickel / zinc coating to reduce corrosion. Fittings shall have an HNBR sealing element, 420 stainless steel grip ring and Smart Connect (SC) feature that guarantees detection of an un-pressed fitting during testing. Installation must be in accordance to manufacturer's instruction and all installers shall be trained by manufacturer on proper installation.
	Pressure greater than 5 psig	Note, when pressures exceed 5 psig, all piping, all sizes, must be welded
Unions	1/2 to 2 inch	Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends or Viega MegaPress G or Mueller Streamline® STL-G Carbon Steel Unions 1/2 inch-2 inch meeting requirements above.
Flanges	Type	Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and regulator gaskets of the following material group, end connections, and facings: Viega MegaPress G or Mueller Streamline® STL-G Carbon Steel Flanges meeting ASME B16.5 and ANSI LC4 / CSA 6.32.
	Material Group	1.1
	Connections	Threaded or butt welding to match pipe
	Lapped Face:	Not permitted underground
Gaskets	Gasket Materials	ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral- wound metal gaskets.
	Bolts and Nuts	ASME B18.2.1, carbon steel aboveground and stainless steel underground
	Viega MegaPress	G Flanges meeting ASME B16.5 and ANSI LC4 / CSA 6.32
<b>VALVES</b>		


<b>Pipe Class:</b> A11			
<b>Service:</b> Natural Gas		<b>Material:</b> Steel	
<b>Service Limits</b>	Primary ANSI Class:	150	
	Coefficient of linear expansion	6.5 x 10 <sup>-6</sup> inches per inch	Corrosion Allowance 0.05 inch

Available Manufacturers	Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: Watts Regulator, Apollo, Serd Audco, Resun, Nordstrom, AY McDonald Note: All valves used for gas shall be approved for use by the State Fuel Gas Code and/or the State Plumbing Board		
Plug/Gas Cock Valves	1/2 to 2 inch	Bronze body and plug manually operated low pressure (2 psig or less) natural or propane gas valve for use indoors at ambient temperatures of 32 to 125 degrees Fahrenheit Basis: A.Y.McDonald 10554 to 10558	
	2½ inch and up	Iron Body, Greasable and Lubricated Tapered Plug, rectangular port, regular opening, Flanged End, WOG, 125 psi SWP Valve shall be equal to R&M Energy Systems Inc. Resun 1431-200.	
Ball Valve	1/2 to 2 inch THD or Weld	Bottom loaded pressure stem valve rated at 600 psi WOG. Basis of Design: Watts B-6000-UL-MassApollo 70-100-07 series, Watts FBV-3C	
	1/2 to 2 inch Press Connect Valves	Viega LLC; MegaPress G Ball Valve with Smart Connect Technology to detect unpressed fittings during the testing process. Installers shall be credentialed by the manufacturer within the last two years.	
		Carbon Steel Press-Connect Valves shall conform to CSA 6.32 / ANSI LC-4 or CSA 6.32a / ANSI LC-4a. Carbon Steel Press-Connect Valves ½-inch thru 2-inch for use with schedule 40 ASTM A53 carbon steel pipe.	
		1/2 inch thru 2 inch fittings shall have stainless-steel grip ring with bidirectional teeth, 304 stainless separator ring, and HNBR sealing element at each press connection. Special attention shall be given to the required two step pressure test. Initial test for unpressed fitting detection per manufacturer's installation manual Full pressure test in accordance with code requirements	
	2-1/2 inches and up	Ball valves shall be of the floating-ball design providing bi-directional, tight shutoff in accordance with MSS SP-72. The valves shall be rated at 150# WSP/300# WOG. Bodies shall be ductile iron per ASTM A536, With ANSI Class 150 raised-face flanges. The interior and exterior of the body shall be UL certified polyester powder coated to meet NSF/ANSI 61 and NSF/ANSI 372. The ball shall be PFA infused stainless steel, with a stainless-steel blowout-proof stem. The seats and body seals shall be PTFE. The stem seal shall be PTFE, externally adjustable chevron type. Valves shall be equipped with locking handles as standard. Valves shall be equipped with 2" manual gear operators. Basis of Design American Valve 4000D series : <LINK>	
Check Valve	All available sizes	150# Class, bronze swing check valve	
	Configuration	Aluminum disc, screwed cap, threaded or flanged ends, lifting lug for 3 – 8 inch valves.	
	Design Basis:	1/2 to 1½ inch Eclipse 1000 series <LINK>. 2 to 8 inch - McMaster-Carr 316SS Check <LINK> for pressures 2 psi and above US Valve 1½ to 8 inch gas line low pressure check valve <LINK> Contractor to Consult manufacturers for proper valve configurations per application	
Non-Return Valves	Description	Spring loaded non-return valve to prevent back feeding of gases which could lead to unwanted gas mixtures	
	Material	Brass	
	Sizes	½ to 1 inch	
	O-ring	NPR	
Design Basis		Witt non return valve <LINK>	



**PRESSURE REGULATING DEVICES**

<b>Pipe Class:</b>	<b>A11</b>		
<b>Service:</b>	Natural Gas		<b>Material:</b> Steel
<b>Service Limits</b>	Primary ANSI Class:	150	
	Coefficient of linear expansion	6.5 x 10 <sup>-6</sup> inches per inch	Corrosion Allowance 0.05 inch

Available Manufacturers	<p>Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, the following:</p> <ul style="list-style-type: none"> <li>• American Meter Company</li> <li>• Belgas</li> <li>• Eclipse Combustion, Inc.</li> <li>• Fisher Control Valves and Regulators</li> <li>• Itron Valve</li> <li>• Sensus</li> <li>• Maxitrol Company</li> <li>• Pietro Fiorentini Company</li> </ul> <p>Note: All valves used for gas shall be approved for use by the State Fuel Gas Code and/or the State Plumbing Board.</p> <p>Note: A tee fitting with one capped opening shall be installed on the upstream side between regulator and its shutoff valve and on the downstream side not less than 10 pipe diameters from regulator outlet. Fittings shall accommodate field pressure measuring instruments. Provide 1/4 turn isolation valves on each tee fitting plus cap. When installing regulators for condensing gas boilers or water heaters, strictly observe manufacturer's installation guidelines. Assure the regulator manufacturer sizes the device such that lockup or droop does not occur when condensing units start and/or quickly stop. Assure the regulator position is per the equipment (boilers, water heaters, AHU) manufacturers and the regulator manufacturer standards for all circumstances. Install all pilot lines in strict conformance with manufacturer requirements.</p>		
Main Gas Service Regulator	<p>Coordinate with the Utility for gas service regulators. The service regulator is to be furnished and installed by <b>the gas utility</b>.</p> <p>Basis of Design: Piero Fiorentini <a href="#">Norval</a> Dival series regulator selection program link</p>		
<p>Line Pressure Regulator – (5 psig to low pressure)</p> 	Type	Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff	
	Body	Body and Diaphragm Case: Ductile iron or die-cast aluminum.	
	Standard	Comply with ANSI Z21.80.	
	Springs	Manufacturer standard	
	Plate	Manufacturer standard	
	Seat Disc	Manufacturer standard	
	Orifice	Aluminum; interchangeable	
	Seal Plug	Manufacturer standard	
	Overpressure:	Protection Device Factory mounted on pressure regulator.	
	Inlet Filter	Yes	
	Vent	Atmospheric: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping	
	Pressure	Maximum Inlet Pressure: 5 psig (13.8 kPa)	
	Rooftop Installations	Install a vent from the regulator to above the snow line – see venting below.	
	Design Basis	Maximum Inlet Pressure: 5 psig, (34.5kPa) Over Pressure Device: 4 port dual model device Pietro Fiorentini Governor Overprotection Device (ODP) Operator/Monitor model	

<b>Pipe Class:</b> A11			
<b>Service:</b> Natural Gas		<b>Material:</b> Steel	
<b>Service Limits</b>	Primary ANSI Class:	150	
	Coefficient of linear expansion	6.5 x 10 <sup>-6</sup> inches per inch	Corrosion Allowance 0.05 inch

 <p>Line Pressure Regulator – (2 psig to low pressure)</p>	Design Basis	Maximum inlet pressure 5 psig (35 kPa) Pietro Fiorentini <b>Governor Overprotection Device (ODP) model</b> two stage pressure cut model
	Type	Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff
	Body	Body and Diaphragm Case: Ductile iron or die-cast aluminum.
	Standard	Comply with ANSI Z21.80.
	Springs	Manufacturer standard
	Plate	Manufacturer standard
	Seat Disc	Manufacturer standard
	Orifice	Aluminum; interchangeable
	Seal Plug	Manufacturer standard
	Overpressure:	Protection Device Factory mounted on pressure regulator.
	Inlet Filter	Yes
	Vent	Atmospheric: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping
	Pressure	Maximum Inlet Pressure: 2 psig (13.8 kPa)
	Rooftop Installations	Install a vent from the regulator to above the snow line – see venting below.
	Design Basis	Pietro Fiorentini <b>Governor model</b>
 <p>Appliance Pressure Regulators</p>	Type	Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff
	Body	Body and Diaphragm Case: die-cast aluminum.
	Standard	Comply with ANSI Z21.80.
	Springs	Manufacturer standard
	Plate	Manufacturer standard
	Seat Disc	Manufacturer standard
	Orifice	Aluminum; interchangeable
	Seal Plug	Manufacturer standard
	Inlet Filter	Yes
	Finish	Factory-Applied Finish: Minimum three-layer polyester and polyurethane, if approved by authorities having jurisdiction.
	Design Basis	
Regulator Vents	General	This applies to all regulators that require a vent line:
	Atmospheric	Install a vent from the regulator to above the snow line and terminate with a 180 degree turn down
	Screens	Field-install, a 16 mesh stainless-steel screen in opening at the end of the vent line if the service regulator has a stainless screen in the vent already and when the installer has to extend the vent above the snow line, remove and relocate the factory screen to the end of the vent extension
Generator Piping	Configuration	When regulators are provided at generators, increase pipe size immediately after the regulator and extend piping at increased pipe size to generator connection point
	Regulators	Use regulators with pilot lines. Pipe pilot line strictly by manufacturer's recommendations
	Sizes	[See Drawings] [minimum size 3 time larger than regulator size] [Insert Option Here]
Test Ports	Configuration	Provide instrument connection upstream and downstream of all pressure regulating devices
	Size	1/4 inch FPT or weld-o-let with 1/4 inch approved tee handle ball or needle valve - quarter turn

<b>Pipe Class:</b> A11			
<b>Service:</b> Natural Gas		<b>Material:</b> Steel	
<b>Service Limits</b>	Primary ANSI Class:	150	
	Coefficient of linear expansion	6.5 x 10 <sup>-6</sup> inches per inch	Corrosion Allowance 0.05 inch
	Gauge	Provide glycerine filled 304 stainless case gauge at the outlet of the ball valve with the proper pressure denominations 2-1/2 inch dial dual scale gauge brass internals, 0 - 15 psig/kpa with 1.5 percent accuracy, 1/4 inch bottom mount	
NOTES:			
1. Provide two wrenches for each gas cock size.			
2. The Contractor, at his option, may weld piping down to 1-1/4 if permitted by local codes.			
3. All welders for gas piping must be certified per the requirements of Division 22.			
4. Where multiple gas regulators are installed, regulators shall be marked with a metal tag designating the building or areas being supplied.			
5. For all underground installation, Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.			

## 2.3 MOTORIZED GAS VALVES

### A. Automatic Gas Valves: Comply with ANSI Z21.21.

1. Body: Brass or aluminum.
2. Seats and Disc: NBR.
3. Springs and Valve Trim: Stainless steel.
4. Normally closed.
5. Visual position indicator.
6. Electrical actuator operated by appliance automatic shutoff device.

### B. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Eclipse Innovative Thermal Technologies.
  - b. Honeywell Building Solutions; Honeywell International, Inc.
  - c. Johnson Controls.
2. General
  - a. Pilot operated.
  - b. Body: Brass or aluminum.
  - c. Seats and Disc: Nitrile rubber.
  - d. Springs and Valve Trim: Stainless steel.
  - e. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
  - f. NEMA ICS 6, Type 4, coil enclosure.
  - g. Normally closed.
  - h. Visual position indicator.
3. Specific

- a. Solenoid Valve Type Intrinsicly safe specifications completely encapsulated within the enclosure using epoxy material.
- b. Configuration Valve shall be furnished with NEMA 4x conduit hub and shall be explosion proof design. Operate at 120 VAC with an intrinsic safety barrier.
- c. Design Basis
  - 1) ASCO gas shutoff valve series EF-8210 brass body valve.
  - 2) AGS Merlin.
4. Note: for substituted valves that require pneumatics, furnish 40 micron filtered 1/2-inch compressed air for valve operation

## 2.4 PIPING CONNECTOR SPECIALTIES

### A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

### B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

### C. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

### D. Weatherproof Vent Cap:

1. Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

## 2.5 DIELECTRIC UNIONS

### A. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Watts Regulator.
  - b. Wilkins.
  - c. Zurn Industries, LLC.
  - d. Or Approved Equal.
2. Description:
  - a. Standard: ASSE 1079.
  - b. Pressure Rating: 125 psig minimum at 180 deg F.
  - c. End Connections: Solder-joint copper alloy and threaded ferrous.

## 2.6 BURIED PIPE LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

## 2.7 EARTHQUAKE VALVES

- A. General All valves used for gas shall be approved for use by the State Fuel Gas Code, shall be NFPA complaint and shall be accepted for use by the (AHJ) Authority Having Jurisdiction
- B. Earthquake Sensitive Gas Shut Off Valve Body Manufacturers standard.
- C. Type Swing style check valve arrangement with an acceleration-sensitive triggering mechanism whereby the horizontal motion of an earthquake activates the valve and initiates closure.
- D. Control The valve shall not require internal or external electrical power.
- E. Mechanism Springs assist the valve- flapper to close and gas pressure assists in holding the valve disc in the closed position.
  1. Actuation Trip mechanism is factory set and sealed.
  2. indicator Positive indication via a sight glass or similar mechanism such that the Open or Closed indicator can be seen, and the trip mechanism status of the valve can be easily determined.
  3. End Connections Flange
- F. Basis of Design Pacific Seismic Products series 300 series horizontal valve. **\*\*LINK\*\***
- G. Earthquake Valves, Maximum Operating Pressure of 5 psig: Comply with ASCE/SEI 25.
  1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction.

2. Maximum Operating Pressure: 5 psig.
  3. Cast-aluminum body with nickel-plated chrome steel internal parts.
  4. NBR valve washer.
  5. Sight windows for visual indication of valve position.
  6. Threaded end connections complying with ASME B1.20.1.
  7. Wall-mounting bracket with bubble level indicator.
- H. Earthquake Valves, Maximum Operating Pressure of 60 psig: Comply with ASCE/SEI 25.
1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  2. Maximum Operating Pressure: Per 0.5 psig 7 psig 60 psig.
  3. Cast-aluminum body with stainless steel internal parts.
  4. NBR, reset-stem O-ring seal.
  5. Valve position, open or closed, indicator.
  6. Composition valve seat with clapper held by spring or magnet locking mechanism.
  7. Level indicator.
  8. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

## 2.8 FIRE SAFETY VALVES

- A. General All valves used for gas shall be approved for use by the State Fuel Gas Code, shall be NFPA compliant and shall be accepted for use by the (AHJ) Authority Having Jurisdiction
- B. Fire Valve
1. Body Materials
    - a. 4 inches and larger - Iron
    - b. 3 inches and smaller -Carbon Steel w 316 SS ball
  2. Type: Quick-closing, fire safety gas shut-off valve
  3. Location: Where shown in the gas supply line on the drawings
  4. Mechanism: held open by a wire with a 165 deg F fusible link arranged so that the valve will automatically close if the link melts.
  5. Actuation: Spring-loaded
  6. End Connections: Flange or NPT per size
  7. Basis of Design
    - a. BI-Torq BT series fusible link fire safe valve
    - b. Preferred Utilities Mfg. Model 110-G

## 2.9 GAS SOLENOID SHUTDOWN FOR APPLIANCES

- A. At point of use appliances, such as kitchen ranges where solenoids are required, furnish and pipe in a gas solenoid valve for actuation by the hood ANSUL system.



- B. See Motorized Gas Valves section of this specification for details.

**2.10 BOILER AND WATER HEATER DETECTION SYSTEM**

**A. General**

1. Provide a complete installation of a combustible gas detection system to protect the designated area from harmful gas build up.
2. The system shall include, but not be limited to, the following:
  - a. Future expandability
  - b. Gas Valve and Electrical Power Control Circuits
  - c. Display of Alarm Status
  - d. Display of Toxic / Hazardous Gas Levels
  - e. Remote Panic Buttons
  - f. Relay Outputs to BMS / F.A.C.P.
  - g. Re-Set and Test Functions
3. All Products and Devices for a complete Commercial Gas Solenoid Safety Device System with all components designed to operate together as a system. The system shall and be UL listed and labelled and be as listed in the Equipment Schedule of the Section
4. Install hazardous/toxic gas monitoring equipment including sensors as shown on Contract Drawings, and as recommended by manufacturer of equipment, and as required by authorities having jurisdiction.
5. The unit shall be furnished and installed as a packaged system with single point connections for power and piping.
  - a. All control wiring shall be completed as part of the package. Any field control wiring shall be the responsibility of this contractor (div 22)

**B. Manufacturers**

1. Basis-of-Design Product: Subject to compliance with requirements, provide kitchen detection package and controls indicated as Basis-of-Design (BOD) below or a comparable product by one of the following:
  - a. BOD: American Gas Safety Systems
  - b. Drager Gas Detection
  - c. Marcurco Gas Detection

**C. Boiler or Water Heater Detection and Monitoring System Installation:**

1. Install in accordance with manufacturer's recommendations and instructions. Verify manufacturer's mounting heights to comply with ADA or other standards.
2. Finish and install all devices as shown in Drawings and as specified herein. Where device is to be installed by other trades, furnish, and then turn over to appropriate trade for installation.
3. Furnish, install, and make final connections to monitoring and Panic Buttons as indicated on Drawings and specified herein. Furnish and install low voltage and volt free control wiring from Utility Controller to connection point on BMS. Final connection by others.

4. Plumbing: Make final connections to all piping systems were indicated by Drawings and specifications. Install in accordance with this specification.
5. Electrical: Electrical Contractor shall furnish all conduit and wiring, making final wiring connections to all equipment as indicated by Drawings and specifications. Contractor shall be responsible for all system configurations, integration, test, and start-up.

D. Mechanical Room Gas Detection Systems

<b>BOILER OR WATER HEATER DETECTION SYSTEM</b>			
<b>Service:</b> Gas Detection and Control		<b>Material:</b> vendor package	
Service Limits	Primary ANSI Class:	150	
	Coefficient of linear expansion	NA	
<b>PACKAGE</b>			
Controls and Instrumentation	Panel	Gas Detection Device type AGS Mini Merlin CH4CO as the Basis Of Design The device panel will be capable of operating within relative humidity ranges of 5-95% non- condensing and temperature ranges of -4° F to 140° F (-20° C to 60° C).	
	Compliance	The unit shall be UL certified and listed Specifically, the device will be certified and listed to ANSI/UL 61010-1 3 <sup>rd</sup> edition and CAN/CSA-C22.2 No. 61010-1.	
	I/O	The device will be 120 Vac powered, individually powered and capable of accepting the inputs of multiple devices. The unit will clearly display the condition of an alarm and provide hazardous or toxic gas levels via ppm or % of VOL. The device shall provide a re-set and test function. The device shall incorporate dual sensor technology to detect Methane and CO (Carbon Monoxide) without the requirement for additional components.	
	Mounting	Mount the panel per manufacturer's instructions and recommendations.	
	Panel Architecture	The device will energize a 120v output to control gas solenoid valves and electrical contractors In alarm the device shall de-energize this control output. For local activation of audible alarms, the transmitter shall have an on-board device able to generate an audible output of 85 dBA @ 10 ft. The unit shall provide a traffic signal type colored TFT display, Green – all clear, Yellow – warning (low alarm) Red – Alarm.	
	Building Management Systems (BMS):	The device panel will be capable of transmitting alarm conditions to a BMS system through its dry contact relay output. For local activation of fans or louvers (or other equipment), the relay will change state in alarm and revert back once the alarm has been removed.	
	Fire Alarm Re-set:	The device shall provide a Re-Set function that will re-energize the gas valve and electrical power outputs allowing the gas supply and the appliances to resume. The Re-Set function shall only be permitted by the device if all detectors are reporting a clean and safe condition.	
	Natural Gas Sensor:	The unit shall integrate with the Controller and shut down all designated outputs upon detection of Natural Gas. Each Controller can utilize up to three fuel gas sensors.	
	Carbon Monoxide Sensors	The unit shall integrate with the Controller and shut down all designated outputs upon detection of unsafe levels of CO gas. Each Controller can utilize up to six CO Detectors.	
Panic Buttons, EPO	Panic Buttons	Each Controller shall be configured so that pressing Panic Buttons will disable all utilities. Each Controller shall be configured so that Gas services will automatically shut down in all alarm modes.	
	Inside Room	Type <b>AGO-EGOTW</b> <b>**LINK**</b> Panic Button will be constructed of tough polycarbonate with a stainless steel back plate capable of operating within relative humidity ranges of 0-100% and temperature ranges of -40° F to 250° F (-40° C to 121° C). Unit will be clearly labeled "EMERGENCY BOILER SHUT-OFF" with 5/8" black text on yellow background with red mushroom type button. Unit will be certified and listed to UL safety standards and be ADA compliant.	
	Outside Room	Type <b>AGS-EGOTWWM</b> <b>**LINK**</b> Panic Button in order to insure system shutdown remotely in case of an Emergency. Integrate Remote Emergency Stop Button(s) with the Controller. Locate button(s) as shown in Drawings and per manufacturer's recommendations	
	Panic Alarm/Fire Alarm	Remote Panic Button and input from fire alarm system shall activate high alarm protocol.	

BOILER OR WATER HEATER DETECTION SYSTEM			
<b>Service:</b> Gas Detection and Control		<b>Material:</b> vendor package	
Service Limits	Primary ANSI Class:	150	
	Coefficient of linear expansion	NA	
Solenoid Valves:	Gas Valve type AGSMERLINxxxx shall be 120v actuated flanged gas solenoid with an operating pressure Of 0-5PSI. Constructed of die-cast aluminum with a fluid powered actuator. The valves should be UL listed as a safety shut-off valve with a closing time of <1second.		
Fuel Gas Sensor	The sensors shall be UL listed to comply with UL2075 and incorporate filters to only look for the desired hazardous or toxic gases selected. If Methane Sensor detects 8% of LEL, the detector shall indicate Low Alarm level via TFT screen. If the hazardous gas level reaches 10% of LEL the detector shall indicate High Alarm level via TFT screen and audible alarm. The high alarm shall de-energize the power output to the gas valve and electrical contractor isolating the gas supply to the boiler room and the electrical power to the appliances. The internal relay outputs shall change state communicating the alarm condition to the BMS and F.A.C.P.		
Carbon Monoxide Sensor	If CO sensor detects Carbon Monoxide the detector shall indicate Low Alarm level via TFT screen. If CO levels continue to rise or trigger alarm thresholds as per the OSHA Dept of Labor TWA alarm thresholds the detector shall indicate High Alarm via TFT screen and audible alarm. The high alarm shall de-energize the power output to the gas valve and electrical contractor isolating the gas supply to the boiler room and the electrical power to the appliances. The internal relay outputs shall change state communicating the alarm condition to the BMS and F.A.C.P.		
Alarm	Audible/Visual alarm beacon type AGSAAB in order to provide a remote visual and audible alarm upon system activation. Integrate Alarm Beacon with the Mini Merlin Controller. Locate as shown in Drawings and per manufacturer's recommendations.		
Testing	After installation, test equipment to demonstrate operation of functions described above under sequence of operation by manufactures certified service technician. Provide testing kits (including gas bottles) for testing and calibration by Commission technician.		
Connections	Piping End Connections: Weld or Threaded spool pieces or ANSI Flange		
Signage	At each Control Panel location provide model # AGSLABELKS. Caution sign will be posted above the Control Panel to indicate the proper procedure for resetting the system in case of system activation including but not limited to systems with standing pilots to avoid gas exposure or possible explosion.		
Electrical	See schedule sheet. Field coordinate power requirement. Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application		
Wiring	Install conduit and wiring from device, gas valve, contactor and remote panic buttons as recommended by manufacturer of equipment.		
Warranty	See Part 1.		
Equivalency	See Manufacturers above.		

- E. Detector alarm levels are to be activated and the unit is to be installed in accordance with the following parameters:

Gases	TDLR Code Required Limits			Mounting Height
	1 <sup>st</sup> Alarm Set Point	2 <sup>nd</sup> Alarm Set Point	3 <sup>rd</sup> Alarm Set Point	
Carbon Monoxide	35 ppm	50 ppm	-	Per manufacturer
Methane	8% of LEL 4% of VOL	10% of LEL 5% of VOL		Per manufacturer

## PART 3 - EXECUTION

### 3.1 PIPE SCHEDULE INDEX

SERVICE	CODE	MAXIMUM SERVICE OPERATING LIMITS		PIPE CLASS	PIPE MATERIAL
		(psig)	Temp (°F)		
Gas (Natural)	G	50	70	A11	C. Steel
Gas Vent	GV	50	70	A11	C. Steel
Sleeve for Interior Under-Ground Natural Gas Piping	G-S	50	120	A17	G. Steel
Natural Gas Exterior Underground	G	30	73.4	A19	Polyethylene
Natural Gas Interior or Exterior Underground	G	30	73.4	A19a	Corrugated SS PE sleeve
Gas Condensing Flue Piping	FLUE-1-	14 inch WC	550	FLUE-1	Single Wall Stainless Steel
Gas Condensing Flue Piping	FLUE-2-	14 inch WC	550	FLUE-2	Double Wall Stainless Steel
Gas Condensing Flue Piping	FLUE-3-	14 inch WC	194	FLUE-3	CPVC Flue Gas System
Gas Condensing Flue Piping	FLUE-4	14 inch WC	149	FLUE-4	PVC Flue Gas System
<p>General Pipe Spec Notes:</p> <ol style="list-style-type: none"> <li>Each valve type shall be the product of a single manufacturer. Each system shall be provided with valves as required by code and shown on the drawings and shall be installed to facilitate operation, replacement, and repair.</li> <li>Provide access panels for concealed valves behind non-removable ceilings or walls.</li> <li>Provide shut-off valves on supply piping to individual pieces of equipment.</li> <li>Provide pipe dope and other jointing compounds as required by best standard practice and only on service as recommended by manufacturer.</li> <li>Piping routed through metal stud or wood stud partitions: provide centering such that piping does not contact metal studs and protection of piping systems routed horizontally through metal stud or wood stud partitions where the piping crosses a stud. Sleeve type protection shall be used to prevent damage to the lateral piping using screws/nails/fasteners. Provide pre-manufactured products equal to puncture solution, or on-site sleeves.</li> </ol>					

### 3.2 GENERAL NATURAL GAS SYSTEMS INSTALLATION

- A. All piping shall be cut accurately to measurements obtained at the site and shall be installed without springing or forcing due to inaccurate measurements or improper hanger installation.
- B. Piping shall be done by a licensed gas fitter (as required by Code).
- C. Gas piping shall pitch to drain and shall have drip pockets at least 6 inches long with removable caps at low points.
- D. Gas Isolation Valves
  - Provide a gas cock valve at each branch run out from main or riser serving gas outlets. This shall include all branches from the gas main and further branches from gas sub-mains. These requirements will be strictly enforced by the local plumbing inspector. This requirement shall take precedent over general arrangement drawings. Therefore, the following is called for:
  - Provide a gas shutoff valve at each Tee on both outlets of the Tee in a run of piping.

3. Provide a gas shutoff valve at each piece of equipment.
  4. Gas valves or cocks shall not be concealed and shall be readily accessible for inspection and repair.
  5. Every branch line from a main shall be furnished with a branch valve (no exceptions) and shall be taken off the top of main using such fittings as may be required by structural obstructions or other installation conditions. All service pipes, fittings, and valves shall be kept at sufficient distance from other work to permit not less than 1 inch between finished coverings on other service piping.
- E. Provide union connection between shut-off cock and equipment to permit disconnection of equipment.
- F. Piping shall be securely fastened, separately hung, and shall not support any other weight or piping. Piping dropping in concrete block walls shall be factory wrapped for corrosion protection.
- G. Welded piping shall conform to the latest requirements of the STATE Fuel Gas Code.
- H. All piping shall be supported independently and securely fastened to the building structure with appropriate anchors and pipe hangers. In general, all lines shall be installed above ceilings in finished spaces.
- I. All piping shall be cut true and threaded or welded. Cap all open ends of piping to prevent the entrance of debris when work on this system is complete or the workday has ended.
- J. Provide individual vents from regulators, pressure switches and reliefs on factory packaged equipment gas trains at all equipment located on this system. It is this contractor's responsibility to extend all vents to the atmosphere terminal at a safe location in conjunction with the fuel gas code.
- K. Gas piping and safety devices shall meet the requirements of NFPA No. 54 and shall be subject to inspection and approval of the State Gas Regulatory Board.
- L. Special Note: Provide aluminum check valves on all gas pipes that enter rooms where compressed air is installed or when both compressed air and gas piping connect to the same piece of equipment. This is required in all areas where gas and air are present.
- M. All pipes shall be run parallel and graded evenly to low points. A serviceable drip leg of at least six inches in length shall be provided at each low point, at every connection to a piece of equipment, and at the base of each riser.
- N. For gas installations of over 5,000,000 (five million) BTU/HR, submit a plan of the proposed piping system and equipment for approval to the local Gas Inspector. A letter from the servicing gas supplier indicating that the fuel supply is available shall accompany the submission. Gas utilization equipment over 12,500,000 BTU/HR, water tube boilers having outputs of 10,000 pounds of steam per hour or more, gas booster installations, cogeneration systems, and kilns, shall be submitted to and approved by the Board of State Examiners of Plumbers and Gas Fitters.
- O. Provide valved pressure gauge assemblies at each main gas service entrance, at each water heater, boiler, emergency or standby generator, incinerators, HVAC rooftop units and all other major pieces of equipment utilizing gas. Each pressure gauge assembly shall be individually valved, include a snubber, and shall have a dial range that would locate the system pressure as close to the approximate mid-point on the dial range as possible. Assembly shall be similar to TRERICE Model 760B, 2-1/2-inch diameter gauge, 735-2 valve and 872-1 snubber.

- P. The piping system shall be purged with 100 psi compressed air to remove dirt and debris.
- Q. Gas piping connections to all equipment shall include a gas shutoff valve, drip leg, union fitting and pressure gauge as well as a swing joint consisting of at least two 90-degree elbows at all HVAC equipment.

### 3.3 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the State Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipes and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
  - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- Q. Connect branch piping from top or side of horizontal piping.

- R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.
- S. Do not use natural-gas piping as grounding electrode.
- T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- U. Install pressure gauge upstream and downstream from each line regulator.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 for sleeves and sleeve seals for HVAC piping.
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 for sleeves and sleeve seals for HVAC piping.
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 specifications."

### 3.4 GAS SERVICE, METER, VENTS AND PIPING

- A. Gas meter and piping to meter from gas main will be provided by Gas Utility Company. Pay charges associated with Gas Company installation. Gas piping provided under this Section; shall begin at building side of gas meter.
- B. Provide pressure reducing valve between meter and building piping, as required by Gas Company, piped and vented to outside of building.
- C. Provide full size isolation valve at the gas meter outlet.
- D. Provide an aluminum or plastic valve tag stating the gas pressure downstream of the gas meter.

### 3.5 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 the State Fuel Gas Code and local project codes for installation and purging of natural-gas piping.
- A. All exterior gas piping, valves and fittings shall be protected and covered with Tapecoat H35 Gray corrosion protection tape with integral primer and adhesive. All fittings and joints shall be wrapped with similar protective tape.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 for earth moving for excavating, trenching, and backfilling.
  - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground natural gas piping according to ASTM D2774.
- D. Steel Piping with Protective Coating:
  - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
  - 3. Replace pipe having damaged Polyethylene coating with new pipe.

### 3.6 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

### 3.7 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
  - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
  - 2. Cut threads full and clean using sharp dies.
  - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
  - 4. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
  - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
  - 2. Bevel plain ends of steel pipe.
  - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. thermoplastic approved Natural Gas Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
  - 1. Plain-End Pipe and Fittings: Use butt fusion.
  - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

### 3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Division 22 Specifications for "Vibration and Seismic Controls"
- B. Comply with requirements for pipe hangers and supports specified in Division 22 "Hangers and Supports for Piping and Equipment."



- C. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameter, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for corrugated stainless-steel tubing, with maximum horizontal spacing and minimum rod diameter, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping within 12 inches of each fitting.
- F. Support vertical runs of steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Support vertical runs of corrugated stainless-steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.9 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

### 3.10 BOILER ROOM GAS DETECTION INSTALLATION:

- A. Install in accordance with manufacturer's recommendations and instructions. Verify manufacturer's mounting heights to comply with ADA or other standards.
- B. Plumbing Contractor to furnish all devices as shown on Drawings and as specified herein. Where device(s) is to be installed by other trades, plumbing contractor is to furnish and then turn over to appropriate trade for installation.
- C. Electrical
  - 1. Plumbing Contract shall be responsible for all costs associated with the Electrical Contractor to furnish all conduit and wiring and install the system furnished by the Plumbing Contractor, making final wiring connections to all equipment as indicated by Drawings and specifications. The contractor shall be responsible for all system configurations, integration, test, and start-up.
- D. Boiler Room Gas Detection Start Up and Test:
  - 1. Prior to placing the Gas Detection System into service, perform ALL Start-up procedures and Checklists as stated in Manufacturer's Operations and Maintenance Procedure literature.

- E. Verify that all components and control devices comply with manufacturer's requirements and recommendations and that all devices and installations conform to Drawings and Specification requirements.

### 3.11 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Division 22.
- B. Label and Painting requirements for Natural Gas Piping
  - 1. See division 22 identification and labeling requirements.
- C. Label pressure piping with system operating pressure.

### 3.12 TESTING OF GAS PIPING SYSTEM

- A. General
  - 1. Test, inspect, and purge natural gas according to NFPA 54, or the International Fuel Gas Code (as adopted and amended by State or Local codes) and local inspectional requirements.
  - 2. Test Fluid: Pressure test gas piping system with air, carbon dioxide or nitrogen pressure.
  - 3. Test Pressure: Not less than 3 psi gauge.
  - 4. Test Duration: 24 hours with no decrease in pressure, after corrected by changes in ambient temperature.
  - 5. Local Jurisdictional Requirements: Should regional Inspectors or authorities have requirements specific to the local jurisdiction, they shall be supplementary to these requirements and shall be completed in addition to the chart below.
  - 6. Disconnect all users during the test procedure by means of pipe blanks or lock out tag out valves.
  - 7. For welded piping and for piping carrying gas at pressures exceeding 14-inches of water column pressure, the test pressure shall commonly be at least 1-1/2 times the working pressure and not less than 3 psig for a period of 24 hours with no decrease in pressure. If a decrease in pressure is detected, soap or bubble test joints for leaks, repair or replace as required, and retest.
- B. Testing of large segments of pipe installation over 500 cubic feet
  - 1. Upon completion of gas piping system or section thereof, as required, test by attaching an air compressor testing apparatus to any suitable opening and, after closing all other inlets or outlets, force air into the system until a uniform pressure per the chart below for each 500 cubic feet of pipe volume without showing any drop in pressure. Pressure shall be measured with a mercury manometer, slope gauge, or an equivalent device calibrated to read in increments of no greater than 1/10 lbs.
- C. Renovation Work: Test added, altered, and repaired piping per the chart below. Test the hot connection to the existing gas piping system per the requirements of the local plumbing inspector.
  - 1. For Renovation work, submit method and means test summary to the engineer, the plumbing inspector, and the owner prior to test procedure for project record.

2. Where testing work interrupts gas service to existing building services, submit methods and means for test procedure and seek owner approval prior to any test that interrupts service to the building users.
3. Install an isolation valve between the new and renovated piping system within approximately 3 ft of connection.
4. Test all new piping separately. Then make connection and soap connection joint multiple times, monitor over an 8-hour period to verify connection is leak free.
  - a. In addition, test the stub connection and valve per the requirements of the local Plumbing Inspector.
5. Label the newly installed valve as “Renovated Service Addition, added month/day/year.”

D. The testing summary outlined below is considered minimum requirements for this project.

Application	Natural Gas System	Pipeline Pressure	Pipe Fabrication	Test Pressure	Test Duration	Additional
Commercial or Residential	Low Pressure	< 1/2 psig	Thread Weld or	3 psig	2 hours	
Commercial	High Pressure	> 1/2 psi up to 2 psig	Weld	1.5 x WP Not < 3 psig	24 hours	Note 4
Commercial or Industrial	Natural Gas (High Pressure)	> 2 psi and < 5 psig	Weld	1.5 x WP	24 hours	Note 4
Single Family Residential	Natural Gas (Low Pressure)	< 1/2 psig	Thread Weld or	10-inch mercury minimum	1 hour	Note 6
Mixed Use or Commercial/Industrial	In all cases where Natural Gas input equals or exceeds 10 <sup>6</sup> BTUH	All	Weld	10 x WP	24 hours	Note 7
Process	Natural Gas (High Pressure)	> 5.0 psi	Weld	100 psig min	24 hours	Note 5
1. Submit test protocols for all gas pipe testing to engineer prior to testing of piping systems. 2. Definition: W.C. is defined as water column 3. Definition: WP is defined as working pressure 4. § NFPA 54 8.1.4.2: Where test pressure exceeds 125 psig, the test pressure shall not exceed a value that produces a hoop stress in the piping greater than 50% of the specified min. yield strength of the pipe. 5. Consult engineer for working pressures greater than 5 psig in all cases. 6. All tests and testing outputs including gauge pressure, duration and acceptance shall be accepted to the local authority having jurisdiction (Plumbing Inspector) 7. Adhere to this requirement for all test procedures for this project. It is noted as a minimum stipulation for Massachusetts.						

E. Deficiency

1. Natural-gas piping will be considered defective if it does not pass tests and inspections.
2. At completion of the test, the system shall meet the requirements of the local Plumbing or Gas Inspector prior to engineer acceptance.
3. Identify all areas where leakage occurs via non-corrosive and nonflammable methods and means accepted by the local authority.
4. If a decrease in pressure is detected, soap or bubble test joints for leaks, repair or replace as required, and retest.
5. Document all repaired sections in the test report. All replaced or repaired deficiencies shall be re-tested and accepted by the local plumbing inspector.

F. Piping back in service

1. After acceptance of the tested system by the regional Plumbing Inspector and gas company, purge all test gas from the piping system and refill the system with product gas.
  2. Test all appliance and user connections per code before system start up
- G. Testing Report
1. Prepare test and inspection reports.
  2. Submit a testing report to the Architect and Engineer to certify gas inspector acceptance of all test results.

END OF SECTION

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## **SECTION 221119 - WATER PIPING SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. General requirements for piping
  - 2. Performance requirements
  - 3. Vacuum breakers.
  - 4. Backflow preventers.
  - 5. Water pressure-reducing valves.
  - 6. Individual fixture water tempering valves
  - 7. Single Unit Temperature-actuated, water mixing valves.
  - 8. High Low Temperature actuated mixing valves
  - 9. Central digital thermostatic water mixing valves, small to moderate flow
  - 10. Central digital thermostatic water mixing valves, moderate to large flow
  - 11. Strainers for Water piping.
  - 12. Outlet boxes.
  - 13. Hose stations.
  - 14. Hose bibbs.
  - 15. Wall hydrants.
  - 16. Post Hydrants
  - 17. Drain valves.
  - 18. Water-hammer arresters.
  - 19. Air vents.
  - 20. Trap-seal primer valves.
  - 21. Trap-seal primer systems.
  - 22. Flexible connectors.

- 23. Large capacity water hammer arrestors
- 24. Large capacity surge chambers

- B. All pipe, fittings, and valves used in this distribution system and installed after January 4, 2014 must comply with the new Federal Mandate known as the “Reduction of Lead in Drinking Water Act-2014”. Any product pipe, fittings or valve installed after the enactment date that does not comply, shall be removed and changed by this contractor at Contractor expense to comply with the Federal Law

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
  - 1. Include diagrams for power, signal, and control wiring.

### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
  - 1. Submit operational test report for thermostatic mixing valves
  - 2. Submit operational test reports for digital mixing valves
  - 3. Submit operational test reports for all Backflow Preventers
  - 4. Submit operational test reports for Large capacity Water Hammer Arrestors
  - 5. Submit operational test reports for large capacity surge chambers

### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. All pipe, fittings, and valves used in this distribution system and installed after January 4, 2014 must comply with the new Federal Mandate known as the “Reduction of Lead in Drinking Water Act-2014”. Therefore, after the enactment date of 1/4/14, all products installed must comply. Any product pipe, fittings, valve, or specialty item installed after the enactment date that does not comply, shall be removed and changed by this contractor at his/her own expense to comply with the Federal Law
- B. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Water Piping Specialties: 150 psig unless otherwise indicated.
  - 1. Note, where pressures exceed 150 psig, submit and use class 250 apparatuses.

## 2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - 1. Ames Co.
  - 2. Watts; a Watts Water Technologies company.
  - 3. Zurn Industries, LLC.
  - 4. Or Approved Equal.
- C. Data
  - 1. Standard: ASSE 1001.
  - 2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
  - 3. Body: Bronze.
  - 4. Inlet and Outlet Connections: Threaded.
  - 5. Finish: Rough bronze.
  - 6. Basis of Design for Cold Water: Watts LF288A, [\\*\\*LINK\\*\\*](#) Cash Acme V101.
  - 7. Basis of Design for Hot Water: Cash Acme V101. [\\*\\*LINK\\*\\*](#).
- D. Hose-Connection Vacuum Breakers :
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Watts; a Watts Water Technologies company.
    - b. Woodford Manufacturing Company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  - 2. Standard: ASSE 1011.
  - 3. Body: Bronze, non-removable, with manual drain.
  - 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
  - 5. Finish: Match finish of HB Chrome, stainless steel or nickel-plated bronze.
  - 6. Basis of Design: Cash Acme VB-222. [\\*\\*LINK\\*\\*](#)
- E. Pressure Vacuum Breakers:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. FEBCO.
    - b. Watts; a Watts Water Technologies company.

- c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  - 2. Standard: ASSE 1020.
  - 3. Operation: Continuous-pressure applications.
  - 4. Pressure Loss: 5 psig maximum, through middle third of flow range.
  - 5. Accessories:
    - a. Valves: Ball type, on inlet
  - 6. Basis of Design Cold Water: Watts series LF800M4QT
  - 7. Basis of Design Hot Water: Cash Acme PVB
  - 8. Basis of Design Freeze Proof Cold Water: Watts series 800M4FR
- F. Spill-Resistant Vacuum Breakers :
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Watts; a Watts Water Technologies company.
    - b. Woodford Manufacturing Company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  - 2. Standard: ASSE 1056.
  - 3. Operation: Continuous-pressure applications.
  - 4. Accessories:
    - a. Valves: Ball type, on inlet and outlet.
  - 5. Basis of Design: Zurn Model 460, Watts LF008PCQT

## 2.4 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:
  - 1. Manufacturers: Subject to compliance with requirements, , provide products by one of the following, or approved equal.
    - a. FEBCO.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  - 2. Standard: ASSE 1013.
  - 3. Operation: Continuous-pressure applications.
  - 4. Pressure Loss: 8 PSIG maximum, through middle third of flow range.



5. Body: Bronze for NPS 2 and smaller; steel with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
  6. End Connections: Threaded for NPS 2 and smaller; flanged or mechanical for NPS 2-1/2 and larger.
  7. Configuration: Designed for horizontal, straight-through flow.
  8. Accessories:
    - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
  9. Basis of Design: Watts 957
  10. Basis of Design: Watts 009-QT-S
  11. Basis of Design: Special Flow Patterns: Febco 825YA, Febco 880V
- B. Backflow Preventer Anti-Flood Device**
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. Cla-Val
    - b. FEBCO.
    - c. Watts; a Watts Water Technologies company.
    - d. Or Approved Equal.
  2. The Flood Protection Shutdown Valve shall be a normally open Diaphragm Valve installed upstream of the Reduced Pressure Zone Backflow Assembly, and automatically close if the RPZ relief valve begins to discharge. A Time Delay supplied in the JB113 Junction Box shall prevent the valve from closing on intermittent discharges from the RPZ relief valve. If continuous Relief Valve discharge occurs, the FS99 Flow Sensor installed horizontally in the RPZ Relief Valve discharge piping shall send a signal to the JB113 Junction Box energizing Solenoid to close the main valve. Once closed the Flood Protection Shutdown Valve must be manually reset.
  3. The JB113 Junction Box shall be valve mounted with the Solenoid pre-wired. The FS99 Flow Sensor shall be provided with the valve package and shall be field installed in a horizontal position in the RPZ Relief Valve discharge piping. Vertical installation of the Flow Sensor shall not be acceptable. The valve shall be equipped with a Limit Switch to provide local visual and remote electrical indication of valve closure.
  4. The Reduced Pressure Zone Backflow Assembly, Flood Protection Shutdown Valve, JB113 Junction Box and FS99 Flow Sensor shall be provided by the same manufacturer and be covered by a single warranty policy.
  5. The main valve shall be a hydraulically operated, single diaphragm actuated, globe or angle pattern valve. Y-pattern valves shall not be permitted. The valve shall contain a disc and diaphragm assembly that forms a sealed chamber below the valve cover, separating operating pressure from line pressure. The diaphragm shall be constructed of nylon reinforced Buna-N and shall not seal directly against the valve seat and shall be

fully supported by the valve body and cover. Rolling diaphragm construction will not be allowed and there shall be no pistons operating the main valve or any pilot controls.

6. The main valve body and cover shall be Ductile Iron ASTM A536, and all internal cast components shall be Ductile Iron or CF8M (316) Stainless Steel. All Ductile Iron components, including the body and cover, shall be lined and coated with an NSF 61 Certified Epoxy Coating applied by the electrostatic heat fusion process. All main valve throttling components (valve seat and disc guide) shall be Stainless Steel. The valve body and cover must be machined with a 360-degree locating lip to assure proper alignment.
  7. The disc and diaphragm assembly shall contain a Buna-N synthetic rubber “Quad Seal” that is securely retained on 3-1/2 sides by a disc retainer and disc guide. Diaphragm assemblies utilizing bolts or cap screws for component retention will not be permitted. Direction of flow through the valve shall be the over-the-disc design, causing the valve to close upon diaphragm failure.
  8. The exposed portion of the Quad Seal shall contact the valve seat and seal drip-tight. The disc and diaphragm assembly must be guided by two separate bearings, one installed in the valve cover and one concentrically located within the valve seat, to avoid deflection and assure positive disc-to-seat contact. Center guided valves will not be permitted. The main valve stem shall be Xylan coated to avoid the effects of mineral or hard water build-up. The main valve spring shall be the manufacturer’s heavy or extra heavy spring design. All necessary repairs shall be made from the top of the valve while the body remains in line.
  9. The Pilot Control System shall contain a Flo-Clean Strainer, 3-Way Accelerator, NEMA 4, 120 VAC 60HZ 3-Way Solenoid with Manual Operator, Manual Reset Ball Valve, Pressure Gauge, separate Adjustable Opening and Closing Speed Controls, Single Limit Switch, JB113 Junction Box and Isolation Ball Valves on all body connections. The JB113 Junction Box shall be valve mounted and the FS99 Flow Sensor shall be field installed.
  10. Accessories:
    - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    - b. Valves NPS 2-1/2 and Larger: Flanged ends on inlet and outlet.
  11. Basis of design: Watts Model 113-6RFP (globe) or 1113-6RFP (angle) Flood
- C. Double-Check, Backflow-Prevention Assemblies:
1. Manufacturers: Subject to compliance with requirements, , provide products by one of the following, or approved equal.
    - a. FEBCO.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASSE 1015.
  3. Operation: Continuous-pressure applications unless otherwise indicated.
  4. Pressure Loss: 5 psig maximum, through middle third of flow range.

5. Body: Bronze for NPS 2 and smaller; steel with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
  6. End Connections: Threaded for NPS 2 and smaller; flanged or mechanical for NPS 2-1/2 and larger.
  7. Configuration: Designed for horizontal, straight-through flow.
  8. Accessories:
    - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
  9. Basis of Design: Watts LF007.
- D. Beverage-Dispensing-Equipment Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, , provide products by one of the following, or approved equal.
    - a. FEBCO.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASSE 1022.
  3. Operation: Continuous-pressure applications.
  4. Size: NPS 1/4 or NPS 3/8.
  5. Body: Stainless steel.
  6. End Connections: Threaded.
- E. Hose-Connection Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, , provide products by one of the following, or approved equal.
    - a. Watts; a Watts Water Technologies company.
    - b. Woodford Manufacturing
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASSE 1052.
  3. Operation: Up to 10-foot head of water back pressure.
  4. Inlet Size: NPS 1/2 or NPS 3/4.
  5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
  6. Capacity: At least 3-gpm flow.
- F. Backflow-Preventer Test Kits :

1. Manufacturers: Subject to compliance with requirements, , provide products by one of the following, or approved equal.
  - a. FEBCO.
  - b. Watts; a Watts Water Technologies company.
  - c. Zurn Industries, LLC.
  - d. Or Approved Equal.
2. Description: Factory calibrated, with gauges, fittings, hoses, and carrying case with test-procedure instructions.

## 2.5 WATER PRESSURE-REDUCING VALVES

### A. Water Regulators: See drawings for sizes, pressures and flow rates

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Conbraco Industries, Inc.
  - b. Watts; a Watts Water Technologies company.
  - c. Zurn Industries, LLC.
  - d. Or Approved Equal.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size: See drawings.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
6. Valves for Booster Heater Water Supply: Include integral bypass.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

### B. Water-Control Valves: See drawings for sizes, pressures and flow rates

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. OCV Control Valves.
  - b. Watts; a Watts Water Technologies company.
  - c. Zurn Industries, LLC.
  - d. Or Approved Equal.
2. Description: Pilot-operated, diaphragm-type, single-seated, main water-control valve.
3. Pressure Rating: Initial working pressure of 150 psig 1035 kPa minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.

4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
5. End Connections: Threaded for NPS 2 DN 50 and smaller; flanged for NPS 2-1/2 DN 65 and larger.

2.6 INDIVIDUAL-FIXTURE, WATER TEMPERING VALVES:

A. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.**

1. Leonard Valve Company.
2. Watts; a Watts Water Technologies company.
3. Zurn Industries, LLC.
4. Or Approved Equal.

B. Description

1. Standard: ASSE 1070, thermostatically controlled, water tempering valve.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Body: Bronze body with corrosion-resistant interior components.
4. Temperature Control: Adjustable.
5. Inlets and Outlet: Threaded.
6. Finish: Rough -plated bronze if concealed. or chrome plated if exposed
7. Tempered-Water Setting: 110 deg F.

C. Basis of Design:

1. **Zurn ZW3870XLT**
2. **Watts LFMMV**
3. Powers LFE480

2.7 SINGLE UNIT TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Leonard Valve Company.
  - b. Powers.
  - c. Zurn Industries, LLC.
  - d. Or Approved Equal.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.

4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: See drawings.
9. Valve Finish: Rough bronze.
10. Piping Finish: Copper.
11. Basis of Design:
  - a. Zurn Model ZW1017XL
  - b. Lawler 803 series
  - c. Powers LFSH 1430 series

## 2.8 HIGH-LOW TEMPERATURE-ACTUATED, WATER MIXING VALVES

- A. Manifold, Thermostatic, Water Mixing-Valve Assemblies: See drawing schedule sheet for valve duty.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. **Leonard Valve Company.**
    - b. **Powers.**
    - c. **Symmons Industries, Inc.**
    - d. **Or Approved Equal.**
  2. Description: Factory-fabricated, exposed-mounted, thermostatically controlled, water mixing-valve assembly in two-valve parallel arrangement.
  3. Large-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gauges on inlet and outlet.
  4. Intermediate-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gauges on inlet and outlet.
  5. Small-Flow Parallel: Thermostatic, water mixing valve.
  6. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
  7. Water Regulator(s): Comply with ASSE 1003. Include pressure gauge on inlet and outlet.
  8. Pressure Rating: 125 psig minimum unless otherwise indicated.
  9. Thermostatic Mixing Valve and Water Regulator Finish: Rough bronze.
  10. Piping Finish: Copper.
  11. Basis of Design:

- a. Powers 1430 series
- b. Lawler 803 series

## 2.9 CENTRAL DIGITAL THERMOSTATIC VALVES, SMALL TO MODERATE FLOW:

- A. Manufacturers: Subject to compliance with requirements, , provide products by one of the following, or approved equal.
  - 1. Leonard Valve
  - 2. Powers/Watts Intellistation Jr.
  - 3. PVI Heaters
- B. General Requirements
  - 1. Standard: ASSE 1017.
  - 2. Pressure Rating:
    - a. Where circuit line pressure is 125 psi or less, 125 psig minimum unless otherwise indicated.
    - b. Where circuit line pressure is greater than 150 psi but less than 250 psig use class 250 valves minimum unless otherwise indicated.
  - 3. Material: manufacturer standard corrosion-resistant interior components.
  - 4. Accessories: Digital temperature control, package factory piped and factory wired for single point connections.
  - 5. The system is ready for connection to the Building Automation System
  - 6. Tempered-Water Setting: See Drawings

CENTRAL DIGITAL WATER MIXING SMALL TO MODERATE FLOW		
<b>Service:</b>	Building Hot Water	<b>Material:</b> Coper, Brass or Stainless
Service Limits	Primary ANSI Class:	150
GENERAL		
Description	Type	Electronic water mixing valves providing user-directed control and monitoring water distribution, with an electronic Control Module, an electronically actuated valve that mixes hot and cold water.
	Listing /Compliance	ASSE 1017, cUPC, NSF, CSA 24/UL873,
	Number Valves per Mixing Valve Station	See Schedule Sheet
	Fabrication	System shall be a pre-piped and mounted
MIXING VALVE/S		
Digital Mixing Station	Material	Lead free construction, with manufacturers standard finish
	Capacity and Flows	See Schedule Sheet
	Maximum Operating Pressure	200psi
	Maximum Hot Water Temperature	200 deg F
	Minimum Hot Water Supply Temperature	2 deg F above set point Hot Water Inlet Temperature Range 120-180 deg F in accordance with ASSE 1017 and resist "temperature creep" during periods of low/zero demand.
	Ambient Temperature	32 deg F to 122 deg F (50 deg C) Ambient Humidity ... 0 - 90 RH non-condensing
	Fail safe Design	In the event of a power failure, system will open full cold supply. In case of a loss of cold water, the system will close hot water supply
	Minimum Flow	0.5gpm
	Sundries	Furnish and install check valves, strainers, thermometers, pressure gauges, ball valves, inlet

CENTRAL DIGITAL WATER MIXING SMALL TO MODERATE FLOW		
<b>Service:</b>	Building Hot Water	
<b>Material:</b>	Coper, Brass or Stainless	
<b>Service Limits</b>	Primary ANSI Class:	150
Connections		hot water to outlet mixed water by-pass and shall be mounted onto an enameled steel frame.
	Recirculation	The unit shall be furnished with a Digital Re-Circulating Valves (DRV) Each recirculating valve shall be digital of lead-free stainless steel/polymer construction.
	End Connections	Furnish and install all isolation valves on all service connections Furnish balancing valves and flow meters per drawing details
	Outlet valves	Furnish check valves and shut-off Ball/Butterfly valves on pump outlet piping for each pump. Manifold piping at outlet.
	Connections	Threaded spool pieces or ANSI Flange
	Mounting	Mount per manufacturer's standard. Pre piped ready for single point connections
<b>CONTROL</b>		
Controller	Panel	Touch screen digital display to select desired outlet water temperature
	Sensor	A quick response temperature sensor and check valves.
	Tout	Electronic mixing valves monitor mixed outlet temperature.
	Sanitize	System will feature a user-set, high-temperature sanitization mode for thermal disinfection of bacteria and a programmable temperature set back feature to improve energy efficiency User programmable high temperature Sanitization mode to help limit water borne bacteria as part of a user-directed and controlled thermal eradication protocol.
	Controller Access	Controller shall be password protected and feature a user-adjustable outlet temperature Mixed outlet temperature can be adjusted/monitored at the valve or remotely by BAS (Building Automation System) or Mobile and Web Apps
	BMS	Controller shall integrate with building automation systems (separate module not required) through BACnet and Modbus protocols and feature local and remote temperature alarms. Systems via either ModBus, Bacnet™ and LonWorks™ protocols* with an Ethernet port for access via a web browser.
	Remote Monitoring	System shall provide monitoring and visibility of mixing valve assets across multiple locations/sublocations. System shall offer the ability to remote temperature control for owner and admin levels
	App	App shall be capable of sending system alerts via text and/or email and prioritizes alerts based on levels of safety and potential liability. System offers three user levels for security.
	Other	Programmable hi/lo temperature alert • Programmable schedule for setback of temperature • On board clock for time stamping of error messages • Wi-Fi enable for software upgrades, temperature monitoring, control and alerts • Pre-piped system
Electrical	Power	115-230 V (ac) ± 10%, 50/60 Hz, 20 VA
	Actuator Load	24 V (dc), 0.55 A, 13 W
Warranty	See part 1	
Equivalency	Powers/Watts Intellistation Jr Armstrong Brain 40	



2.10 CENTRAL DIGITAL THERMOSTATIC VALVES, MODERATE TO LARGE FLOW:

- A. Manufacturers: Subject to compliance with requirements, , provide products by one of the following, or approved equal.
1. Leonard Valve
  2. Powers/Watts Intellistation Senior.
  3. PVI Heaters DigiTemp
  4. Or Approved Equal.
- B. General Requirements
1. Standard: ASSE 1017.
  2. Pressure Rating:
    - a. Where circuit line pressure is 125 psi or less, 125 psig minimum unless otherwise indicated.
    - b. Where circuit line pressure is greater than 150 psi but less than 250 psig use class 250 valves minimum unless otherwise indicated.
  3. Material: manufacturer standard corrosion-resistant interior components.
  4. Accessories: Digital temperature control, package factory piped and factory wired for single point connections.
  5. The system is ready for connection to the Building Automation System
  6. Tempered-Water Setting: See Drawings

CENTRAL DIGITAL WATER MIXING MODERATE TO LARGE FLOW			
Service:	Building Hot Water		Material: Coper, Brass or Stainless
Service Limits	Primary ANSI Class:	150	
GENERAL			
Description	Type	Electronic water mixing valves providing user-directed control and monitoring water distribution, with an electronic Control Module, an electronically actuated valve that mixes hot and cold water,	
	Listing /Compliance	ASSE 1017, cUPC, NSF, CSA 24/UL873,	
	Number Valves per Mixing Valve Station	See Schedule Sheet	
	Fabrication	System shall be a pre-piped and mounted	
MIXING VALVE/S			
Digital Mixing Station	Material	Lead free construction, with manufacturers standard finish	
	Capacity and Flows	See Schedule Sheet	
	Maximum Operating Pressure	200psi	
	Maximum Hot Water Temperature	200°F	
	Minimum Hot Water Supply Temperature	*2°F above set point Hot Water Inlet Temperature Range 120-180°F in accordance with ASSE 1017 and resist "temperature creep" during periods of low/zero demand.	
	Ambient Temperature	32°F to 122°F (50°C) Ambient Humidity ... 0 - 90 RH non-condensing	
	Fail safe Design	In the event of a power failure, system will open full cold supply. In case of a loss of cold water, the system will close hot water supply	
	Minimum Flow	*0.5gpmMinimum circulation of 10 gpm per valve	
	Sundries	Furnish and install check valves, strainers, thermometers, pressure gauges, ball valves, inlet hot water to outlet mixed water by-pass and shall be mounted onto an enameled	

CENTRAL DIGITAL WATER MIXING MODERATE TO LARGE FLOW			
Service:		Building Hot Water	
Material:		Coper, Brass or Stainless	
Service Limits	Primary ANSI Class:	150	
Connections		steel frame.	
	Recirculation	The unit shall be furnished with a Digital Re-Circulating Valves (DRV) Each Re-Circulating Valve shall be digital of lead-free stainless steel/polymer construction.	
	End Connections	Furnish and install all isolation valves on all service connections Furnish balancing valves and flow meters per drawing details	
	Outlet valves	Furnish check valves and shut-off Ball/Butterfly valves on pump outlet piping for each pump. Manifold piping at outlet.	
	Connections	Threaded spool pieces or ANSI Flange	
	Mounting	Mount per manufacturer's standard. Pre piped ready for single point connections	
CONTROL			
Controller	Panel	LCD display that indicates set point, delivered temperature, error codes and alarm conditions Touch screen digital display to select desired outlet water temperature	
	Sensor	A quick response temperature sensor and check valves.	
	Tout	Electronic mixing valves monitor mixed outlet temperature.	
	Sanitize	System will feature a user-set, high-temperature sanitization mode for thermal disinfection of bacteria and a programmable temperature set back feature to improve energy efficiency User programmable high temperature Sanitization mode to help limit water borne bacteria as part of a user-directed and controlled thermal eradication protocol.	
	Controller Access	Controller shall be password protected and feature a user-adjustable outlet temperature Mixed outlet temperature can be adjusted/monitored at the valve or remotely by BAS (Building Automation System) or Mobile and Web Apps	
	BMS	Settings can be adjusted/monitored at the controller or remotely through BAS (Building Automation System) Controller shall integrate with building automation systems (separate module not required) through BACnet and Modbus protocols and feature local and remote temperature alarms. Systems via either ModBus, Bacnet™ and LonWorks™ protocols* with an Ethernet port for access via a web browser.	
	Remote Monitoring	System shall provide monitoring and visibility of mixing valve assets across multiple locations/sublocations. System shall offer the ability to remote temperature control for owner and admin levels	
	App	App shall be capable of sending system alerts via text and/or email and prioritizes alerts based on levels of safety and potential liability. System offers three user levels for security.	
	Other	Programmable hi/lo temperature alert • Programmable schedule for setback of temperature • On board clock for time stamping of error messages • Wi-Fi enable for software upgrades, temperature monitoring, control and alerts • Pre-piped system	
Electrical	Power	115/230V (ac) ±10% 50/60HZ, 30VA, 1180VA fully loaded	
	Actuator Load	24 V (dc), 0.55 A, 13 W	
	Relay Specification	Pump relay: 16A @ 250 VAC Alert relay 5A @ 250 VAC, 5A @ 30 VDC	
Warranty	See part 1		
Equivalency	Powers/Watts Intellistation Senior Armstrong Brain 80		

## 2.11 STRAINERS FOR WATER PIPING

### A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
  - a. Strainers NPS 2 and Smaller: 0.020 inch.
  - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
  - c. Strainers NPS 5 and Larger: 0.25 inch.
6. Drain: 1/2 to 2 inch pipe plug 2-1/2 inches and larger - Factory-installed, hose-end drain valve.

## 2.12 OUTLET BOXES

### A. Clothes Washer Outlet Boxes:

### B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.

1. Acorn Engineering Company.
2. Watts; a Watts Water Technologies company.
3. Zurn Industries, LLC.
4. Or Approved Equal.

### C. Data

1. Mounting: Recessed.
2. Material and Finish: Plastic or Stainless-steel box and faceplate.
3. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
4. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
5. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
6. Inlet Hoses: Two 60-inch- long, braided stainless steel household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
7. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.
8. Basis of Design: Watts DWB

- D. Icemaker Outlet Boxes:
- E. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.**
  - 1. Acorn Engineering Company.
  - 2. IPS Corporation.
  - 3. Oatey.
  - 4. Or Approved Equal.
- F. Data
  - 1. Mounting: Recessed.
  - 2. Material and Finish: Plastic or Stainless-steel box and faceplate.
  - 3. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
  - 4. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.
  - 5. Integral Water Hammer Arrestor
  - 6. Basis of Design: Sioux Chief Ox Box with water hammer arrestor

#### 2.13 HOSE STATIONS

- A. **Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.**
  - 1. Leonard Valve Company.
  - 2. Strahman Valves, Inc.
  - 3. T & S Brass and Bronze Works, Inc.
- B. Single-Temperature-Water Hose Stations HS-1:
  - 1. Standard: ASME A112.18.1.
  - 2. Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.
  - 3. Hose-Rack Material: Stainless steel.
  - 4. Body Material: Bronze with stainless-steel wetted parts.
  - 5. Body Finish: Chrome plated.
  - 6. Mounting: Wall, with reinforcement.
  - 7. Supply Fittings: NPS 3/4 gate, globe, or ball valve and check valve and NPS 3/4 copper, water tubing. Omit check valve if check stop is included with fitting.
  - 8. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 50 feet long.
  - 9. Nozzle: With hand-squeeze, on-off control.

10. Vacuum Breaker:
    - a. Integral or factory-installed, non-removable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    - b. Garden-hose thread complying with ASME B1.20.7 on outlet.
  11. Basis of Design: Strahman
- C. Hot- and Cold-Water Hose Stations: HS-2
1. Standard: ASME A112.18.1.
  2. Faucet Type: Thermostatic mixing valve.
  3. Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
  4. Hose-Rack Material: Stainless steel.
  5. Body Material: Bronze with stainless-steel wetted parts.
  6. Body Finish: Chrome plated.
  7. Mounting: Wall, with reinforcement.
  8. Supply Fittings: Two NPS 3/4 gate, globe, or ball valves and check valves and NPS 3/4 copper, water tubing. Omit check valves if check stops are included with fitting.
  9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 50 feet long.
  10. Nozzle: With hand-squeeze, on-off control.
  11. Vacuum Breaker: Integral or factory-installed, non-removable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.
  12. Basis of Design: Strahman
- 2.14 HOSE BIBBS
- A. Hose Bibbs :
1. Standard: ASME A112.18.1 for sediment faucets.
  2. Body Material: Bronze.
  3. Seat: Bronze, replaceable.
  4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
  5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
  6. Pressure Rating: 125 psig.
  7. Vacuum Breaker: Integral non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
  8. Finish for Mechanical Rooms: Bronze.
  9. Basis of Design: **Watts HB-1** 3/4 inch

10. Finish for Equipment Rooms: Chrome or nickel plated.
  - a. Basis of Design: Chicago 952-CP
11. Finish for Service Areas: Chrome or nickel plated.
  - a. Basis of Design: Chicago 998-633RCF
12. Finish for Finished Rooms, including toilet rooms: Chrome or nickel plated. verify finish with architect
  - a. Basis of Design: Chicago 952-CP, handle to be turned over to owner
13. Operation for Finished Rooms: key handle, furnish a key for each device installed
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

## 2.15 WALL HYDRANTS

### A. Non-freeze, Cold-Water Wall Hydrants

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Smith, Jay R. Mfg. Co.
  - b. Watts; a Watts Water Technologies company.
  - c. Zurn Industries, LLC.
  - d. Or Approved Equal.
2. Standard: ASME A112.21.3M for concealed or exposed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Match architect's selection for finish. .
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Match architects' selection for finish.
12. Operating Keys(s): Two with each wall hydrant.

### A. Non-freeze, Hot- and Cold-Water Wall Hydrants: Tag # WH-2

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Smith, Jay R. Mfg. Co.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASME A112.21.3M for concealed or exposed-outlet, self-draining wall hydrants.
  3. Pressure Rating: 125 psig.
  4. Operation: Loose key.
  5. Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.
  6. Inlet: NPS 3/4 or NPS 1.
  7. Outlet: Concealed.
  8. Box: Deep, flush mounted with cover.
  9. Box and Cover Finish: Chrome plated.
  10. Vacuum Breaker:
    - a. Non-removable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    - b. Garden-hose thread complying with ASME B1.20.7 on outlet.
  11. Operating Keys(s): Two with each wall hydrant.
- A. Vacuum Breaker Wall Hydrants
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Smith, Jay R. Mfg. Co.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASSE 1019, Type A or Type B.
  3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
  4. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
  5. Pressure Rating: 125 psig.
  6. Operation: Loose key or wheel handle.

7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 1/2 or NPS 3/4.
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.
- 10. Basis of design:     Woodford Y95**

B. Non-freeze, Automatic Draining Roof Hydrants with Roof Mounting System

1. Standard: ASSE 1052
2. Operation: Lever piston operating mechanism with drain port designed to discharge into the drainage system automatically via 1/8 inch NPT thus not requiring a flushing maintenance procedure.
3. Roof attachment: Separate mounting system consisting of cast iron basin to be installed by the roofing contractor.
4. Length: Valve body inlet to be in heated area.
5. Inlet: 1" NPT
6. Outlet: Woodford Model 50HF dual check vacuum breaker compliant with ASSE 1052
  - a. Garden-hose thread complying with ASME B1.20.7 on outlet.
7. Venturi style drain free roof hydrants not recommended.
8. Basis of Design: Woodford Model RHY2-MS

2.16 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.



5. Drain: NPS 1/8 side outlet with cap.

## 2.17 WATER-HAMMER ARRESTERS

### A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Smith, Jay R. Mfg. Co.
  - b. Watts; a Watts Water Technologies company.
  - c. Zurn Industries, LLC.
  - d. Or Approved Equal.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows or Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

## 2.18 AIR VENTS

### A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

### B. Welded-Construction Automatic Air Vents :

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

## 2.19 TRAP-SEAL PRIMER DEVICE

### A. Supply-Type, Trap-Seal Primer Device

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Smith, Jay R. Mfg. Co.

- b. Watts; a Watts Water Technologies company.
  - c. Zurn Industries, LLC.
  - d. Or Approved Equal.
- 2. Standard: ASSE 1018.
- 3. Pressure Rating: 125 psig minimum.
- 4. Body: Bronze.
- 5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
- 6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
- 7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
- 8. Basis of Design: Precision Plumbing model PRO1-500 Brass
- 9. Precision Plumbing model PRO1-ULP500 chrome

## 2.20 TRAP-SEAL PRIMER SYSTEMS

### A. Trap-Seal Primer Systems

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Precision Plumbing Products.
  - b. Zurn Industries, LLC.
  - c. Or Approved Equal.
- 2. Standard: ASSE 1044.
- 3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
- 4. Cabinet: Recessed or Surface per the architect, -mounted steel box with stainless-steel cover.
- 5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
  - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 6. Vacuum Breaker: ASSE 1001.
- 7. Number Outlets: field verify.per number of traps
- 8. Size Outlets: NPS 1/2.
- 9. Basis of Design: Zurn Z-1020

## 2.21 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.

1. Flexicraft Industries.
  2. Metraflex Company (The).
  3. Universal Metal Hose.
  4. Or Approved Equal.
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
1. Working-Pressure Rating: Minimum 250 psig.
  2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
  3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: Minimum 250 psig.
  2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
  3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

## 2.22 LARGE CAPACITY WATER HAMMER ARRESTORS

- A. Equipment
1. Tee to main line
  2. Isolation valve
  3. P-Style fitting below absorber
  4. Shock absorber
  5. Pressure gauge
- B. Manufacturers:
1. Basis-of-Design Product: Subject to compliance with requirements, provide packaged hytol indicated as BOD below or a comparable product by one of the following:
    - a. BOD: Zurn 1712 Series Accumutrol Water Hammer Arrestor **\*\*LINK\*\***
    - b. JR Smith
    - c. Watts Regulator
    - d. Or Approved Equal.
- C. Shock Absorbing Equipment
1. Location: See Drawings.
  2. ZURN Z1712 Shock associated with solenoid or other quick-closing valves serving heavy equipment shall be controlled by installation of ZURN Z1712 ACCUMUTROL, complete with floating stainless steel spherical piston, surge chamber, valve and gauge assembly
  3. Maximum Temperature: 500 deg F .
  4. Maximum Pressure: 200 PSI Residual

5. Orientation: Vertical
6. Size: See Schedule Sheet
7. Support: Anchor supply pipe to building structure

## 2.23 LARGE CAPACITY SURGE CHAMBER

### A. General

1. Description
  - a. This specification describes the requirements for a Bladder Surge Control System. The purpose of the system is to minimize transient pressures from shock waves due to pump start- up, shutdown or valve shut-off.
  - b. The work included in this section consists of the furnishing of all labor, materials, equipment and appurtenances for surge protection at the discharge side of each well pump to prevent column separation and/or to limit surge upon pump shutdown including a power failure situation.
  - c. The bladder type surge arrestor shall consist of a cylindrical pressure tank for surge control, including: bladder, shell assembly, gas plate assembly, rupture disc, pressure gauges, other miscellaneous appurtenances and constructed in accordance with ASME Section VIII Pressure Vessel Code Division I. Design pressure shall be 114 psig and verified by the surge suppressor manufacturer.
  - d. The surge arrestor shall be constructed on a reinforced concrete foundation with steel supports as detailed on the Drawings.
2. General Requirements
  - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) Young Engineering and Manufacturing Inc.
    - 2) Blacoh Fluid Control
    - 3) ARI Optimal Flow Solutions
    - 4) Wessels Co Inc.
    - 5) Or Approved Equal.
  - b. The supplier must have a minimum of five years' experience and must submit a surge analysis for the engineer's approval (or verify analysis performed by others) showing: input data for the piping system, initial flow rate, initial and maximum expanded air volume and envelope of maximum and minimum line pressure throughout the pipe system. In addition, a predicted pressure-time history at the pump station and at other critical points in the pipe system will also be required.
  - c. The bladder surge control system shall include a surge tank, bladder, gas valve and other miscellaneous appurtenances.
  - d. The surge tank must be designed to match the dynamics of the pumping system.
  - e. The surge tank supplier shall indicate the percent of fluid in the tank, with a nominal value of 60% fluid to 40% nitrogen gas.

- f. An operation and maintenance manual must be provided and personnel representing the bladder type surge arrestor manufacturer are required to check the installation and instruct the owner's personnel in the operating of the surge control system. A field test of the equipment will be performed in conjunction with this site visit.
  - 3. Reference Specifications, Codes and Standards
    - a. Pressure vessels shall be in accordance with the latest revision of the American Society of Mechanical Engineers (ASME) Code for Unfired Pressure Vessels, Section VIII, Division 1.
    - b. All local Plumbing Codes shall be met.
    - c. The system and anchorage of the tank shall conform to the Uniform Building Code (UBC).
  - 4. Surge Analysis
    - a. The manufacturer shall review the plans and specifications and the surge analysis as performed by others in regard to the system hydraulics and the surge vessels.
    - b. Results of the analysis shall indicate that the design and size of the surge arrestor provided will adequately protect the system from excessive pressure surges and shall show the hydro pneumatic bladder type surge control system will meet the Performance Guarantees.
- B. Materials
  - 1. The surge vessel shall be rated for use with Potable Water Systems
  - 2. Bladder Surge Tank
    - a. The surge tank shall be constructed of carbon steel for the maximum allowable working pressure in accordance with the ASME Pressure Vessel Code, Section VIII. The surge arrestor shall be provided with a flanged line connection, adequate supports, lifting lugs and couplings for a drain, pressure gauge, bladder, gas inlet nozzle, energy dissipater plate and manway.
    - b. The surge tank Volume: see schedule sheet
    - c. The shell shall be constructed of carbon steel and have a manufacturer's standard manway for internal inspection and access to rubber bladder. The tank shall be internally sand blasted and coated with epoxy to meet potable water standards (10-12 MDFT).
    - d. The bladder shall have a gas valve to add or release gas to a given pre-charge with nitrogen gas. The unit shall also have a 4" diameter pressure gauge.
    - e. Breaker. The nozzle loss factor shall be an outflow  $k=2.0$  and an inflow  $k=3.2$  to the full equivalent flow area of the inlet diameter nozzle. The tank shall be fitted with a 304-stainless steel perforated plate to prevent the bladder from escaping through the fluid port.
    - f. The unit shall have support legs or saddles designed by manufacturer verified per UBC Seismic Zone requirements to withstand earthquake loading.
    - g. The bladder surge tank shall be equipped with a non-intrusive volume indicator device to monitor gas pre-charge levels without disrupting tank operations.

- h. This device shall be portable and be able to be used on bladder surge tank to determine the condition of the bladder gas pre-charge.
  - 3. Miscellaneous Components
    - a. Pressure Gauge
    - b. Gas Charging Nozzle
    - c. Rupture Disc
    - d. Electronic Volume Indicator (Portable)
- C. System Data
- 1. For surge protection purposes, the following criteria and data shall be used for designing and sizing the surge arrestor.
    - a. Pump Size and Pumping Conditions
    - b. Approximate System-Head Curve Data for Design Flow Rates (Interim and Ultimate) the individual well information regarding the pump column length, diameter, bowl setting, pump (dynamic) well water level and other critical hydraulic parameters can be obtained in the plans, specifications and engineering documentation.
    - c. Pipeline and Elevation Data
  - 2. Detailed distribution system information can be obtained from the owner or owner's engineer.
    - a. Hydraulic Design Criteria
    - b. Friction Factor: Hazen-Williams
    - c. The surge vessel is to be connected to the discharge pipeline as shown on the Plans. Non- slam check valves are utilized on the discharge of each pumping unit.
    - d. The manufacturer shall include surge/flow conditions in the design of the surge vessel.
  - 3. The minimum net tank volume shall be calculated in gallons.
  - 4. The surge tank shall contain approximately 60-percent fluid under steady state flow conditions and be connected to the discharge pipeline with a minimum-size same as drain pipe.
  - 5. Physical Sizing
    - a. The surge arrestor shall be sized to fit the pump station site area limitations as shown on the Drawings. Any variation of the size indicated on the Drawings shall be subject to approval by the Engineer and Owner.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
  2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
  3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gauges on inlet and outlet.
- C. Install water-control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gauges on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install Y-pattern strainers for water on supply side of each control valve water pressure-reducing valve solenoid valve and pump.
- G. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Division 06.
- H. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Division 06.
- I. Install ground hydrants with 1 cubic yard of crushed gravel around drain hole. Set ground hydrants with box flush with grade.
- J. Install draining-type post hydrants with 1 cubic yard of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 cubic foot of concrete block at grade.
- K. Set non-freeze, non-draining-type post hydrants in concrete or pavement.
- L. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.
- M. Install water-hammer arresters in water piping according to PDI-WH 201.
- N. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
- O. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- P. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- Q. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

### 3.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Division 26.
- B. Fire-retardant-treated-wood blocking is specified in Division 26 for electrical connections.

### 3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Pressure vacuum breakers.
  - 2. Intermediate atmospheric-vent backflow preventers.
  - 3. Reduced-pressure-principle backflow preventers.
  - 4. Double-check, backflow-prevention assemblies.
  - 5. Carbonated-beverage-machine backflow preventers.
  - 6. Dual-check-valve backflow preventers.
  - 7. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
  - 8. Double-check, detector-assembly backflow preventers.
  - 9. Water pressure-reducing valves.
  - 10. Calibrated balancing valves.
  - 11. Primary, thermostatic, water mixing valves.
  - 12. Manifold, thermostatic, water mixing-valve assemblies.
  - 13. Photographic-process, thermostatic, water mixing-valve assemblies.
  - 14. Primary water tempering valves.
  - 15. Outlet boxes.
  - 16. Hose stations.
  - 17. Supply-type, trap-seal primer valves.
  - 18. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer Insert type according to authorities having jurisdiction and the device's reference standard.
- B. Water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.



3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated or Digital type water mixing valves.

END OF SECTION

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## SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Backwater valves.
  - 2. Cleanouts.
  - 3. Floor drains.
  - 4. Trench drains.
  - 5. Channel drainage systems.
  - 6. Roof flashing assemblies.
  - 7. Through-penetration firestop assemblies.
  - 8. Miscellaneous sanitary drainage piping specialties.
  - 9. Drain heat recovery devices
  - 10. Flashing materials.
  - 11. FOG disposal systems.
- B. Related Requirements:
  - 1. Division 33 for storm draining piping and piping specialties outside the building.

#### 1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PVC: Polyvinyl chloride plastic.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
  - 1. FOG disposal systems.
  - 2. Grease interceptors.
  - 3. Grease removal devices.
  - 4. Oil interceptors.
- B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
  - 1. Wiring Diagrams: Power, signal, and control wiring.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that FOG disposal systems, grease interceptors, grease removal devices, oil interceptors, accessories, and components will withstand seismic forces defined in Division 22. Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

#### 1.7 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

1.9 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Cultures: Provide 1-gal. bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to 200 percent of amount installed, but no fewer than two 1-gal. bottles.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

- A. Horizontal, Cast-Iron Backwater Valves:
  - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Smith, Jay R. Mfg. Co.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  - 2. Standard: ASME A112.14.1.
  - 3. Size: Same as connected piping.
  - 4. Body: Cast iron.
  - 5. Cover: Cast iron with bolted or threaded access check valve.
  - 6. End Connections: Hub and spigot or hubless.
  - 7. Type Check Valve: Removable, bronze, swing check, factory assembled, or field modified to hang open for airflow unless subject to backflow condition.
  - 8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
- B. Drain-Outlet Backwater Valves:
  - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Smith, Jay R. Mfg. Co.
    - b. Watts; a Watts Water Technologies company.

- c. Zurn Industries, LLC.
  - d. Or Approved Equal.
- 2. Size: Same as floor drain outlet.
- 3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
- 4. Check Valve: Removable ball float.
- 5. Inlet: Threaded.
- 6. Outlet: Threaded or spigot.
- C. Horizontal, Plastic Backwater Valves
  - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Oatey.
    - b. Sioux Chief Manufacturing Company, Inc.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  - 2. Size: Same as connected piping.
  - 3. Body: PVC.
  - 4. Cover: Same material as body with threaded access to check valve.
  - 5. Check Valve: Removable swing check.
  - 6. End Connections: Socket type.

## 2.2 CLEANOUTS

- A. See Part 3 of this specification for cleanout schedule
- B. Horizontal Cast-Iron Exposed Cleanouts: Type A
  - 1. Application: exposed horizontal pipe runs above slab in line or end cleanout
  - 2. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following, or approved equal.
    - a. Jay R. Smith Mfg Co; a division of Morris Group International.
    - b. WATTS.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  - 3. Standard: ASME A112.36.2M.
  - 4. Size: Same as connected drainage piping
  - 5. Body Material: cast-iron soil pipe in line or end placed into fitting approved tee as required to match connected piping.
  - 6. Closure: Countersunk or raised-head, brass plug.

7. Closure Plug Size: Same as cleanout size.
  8. Basis of Design: **Watts 460** or TY with **Generic**
- C. Finish Area Floor Cleanouts for Cast Iron Systems: Type B
- Application: Cast iron pipe horizontal runs, finish areas. i.e. tile or terrazzo or epoxy finish.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. **Smith, Jay R. Mfg. Co.**
    - b. **Watts; a Watts Water Technologies company.**
    - c. **Zurn Industries, LLC.**
    - d. Or Approved Equal.
  2. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
  3. Size: Same as connected branch.
  4. Body or Ferrule Material: Match Piping.
  5. Clamping Device: match pipe material
  6. Closure: Brass plug with tapered threads.
  7. Adjustable Housing Material: Cast iron with threads set-screws or other device.
  8. Frame and Cover Material and Finish: Nickel-bronze
  9. Frame and Cover Shape: Round.
  10. Top-Loading Classification: Heavy Duty.
  11. For Carpeted areas use carpet marker
  12. Basis of Design: **Watts Model CO-200R**
- D. Industrial Area Floor Cleanouts for Cast Iron Systems: Type B XH
1. Application: Cast iron pipe horizontal or vertical runs, non-finish industrial areas mechanical rooms, penthouses or areas where forklifts or pallet jacks are used
  2. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. **Smith, Jay R. Mfg. Co.**
    - b. **Watts.**
    - c. **Zurn Industries, LLC.**
    - d. Or Approved Equal.
  3. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
  4. Size: Same as connected branch.
  5. Body or Ferrule Material: Match Piping.
  6. Clamping Device: match pipe material

7. Closure: Brass plug with tapered threads.
8. Adjustable Housing Material: Cast iron with threads set-screws or other device.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy or Stainless steel.
10. Frame and Cover Shape: Round.
11. Top-Loading Classification: Extra Heavy Duty.
12. For Carpeted areas use carpet marker
13. Basis of Design: Watts CO-200-RX, for large sizes Watts Model CO-300 MF with inside cleanout added

E. Exposed Floor Cleanouts for Stainless Steel Systems Type C

1. Application: For stainless steel piping systems where specified for kitchens and other uses
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal.
  - a. BLÜCHER; A Watts brand.
  - b. Watts
  - c. Zurn Industries, LLC.
  - d. Or Approved Equal.
3. Standards: ASME A112.3.1; NSF listed.
4. Size: Same as connected branch.
5. Housing: Type 316 stainless steel.
6. Closure: Stainless steel with seal Plastic plug.
7. Riser: ASTM A74, Service Class, stainless steel drainage pipe fitting and riser to cleanout.
8. Body or Ferrule: Stainless steel.
9. Clamping Device: Required.
10. Outlet Connection: Inside caulk Spigot Threaded Butt-weld field selected
11. Adjustable Housing Material: Stainless steel with threads setscrews or other device.
12. Frame and Cover Material and Finish: Stainless steel.
13. Frame and Cover Shape: Square.
14. Top-Loading Classification: Heavy Duty.
15. Basis of Design:
  - a. Type C1: Kitchens and finish floor areas. Blucher BCO 140 heavy duty
  - b. Type C2: For industrial areas. Watts 1200-RX-28. Stainless steel extra heavy duty

F. Test Tees for Cast Iron Systems: Type D

Application: Exposed horizontal or vertical in line or “Dandy” cleanout

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. **Smith, Jay R. Mfg. Co.**
    - b. **Watts; a Watts Water Technologies company.**
    - c. **Zurn Industries, LLC.**
    - d. Or Approved Equal.
  2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
  3. Size: Same as connected drainage piping.
  4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
  5. Closure Plug: Countersunk.
  6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
  7. Basis of Design: **Watts Model CO-460**
- G. Wall Cleanouts for Cast Iron Systems: Type E
- Application: Finish area vertical in line or “Dandy” cleanout
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. **Smith, Jay R. Mfg. Co.**
    - b. **Watts; a Watts Water Technologies company.**
    - c. **Zurn Industries, LLC.**
    - d. Or Approved Equal.
  2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
  3. Size: Same as connected drainage piping.
  4. Body Material: T-branch as required to match connected piping.
  5. Closure: Drilled and threaded brass plug.
  6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
  7. Wall Access: Square, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.
  8. Basis of Design: **Watts Model CO-460-RD**
- H. Floor Cleanouts for PVC systems: Type F
- Application: Floor Cleanout plastic piping Systems
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.



- a. Sioux Chief Manufacturing Company, Inc.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Size: Same as connected branch.
  3. Body Material: PVC.
  4. Closure Plug: PVC or PP.
  5. Cover: Round
  6. Riser: Drainage pipe fitting and riser to clean out of same material as drainage piping.
  7. Basis of Design: Watts 200 R -60 for PVC
- I. Penthouse Industrial Floor Cleanouts for Cast Iron Systems: Type G
1. Application: cast iron pipe horizontal for concrete penthouse floor
  2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Smith, Jay R. Mfg. Co.
    - b. Watts.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  3. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
  4. Size: Same as connected branch.
  5. Body or Ferrule Material: Match Piping.
  6. Clamping Device: match pipe material
  7. Closure: Brass plug with tapered threads
  8. Adjustable Housing Material: Cast iron with threads set screws or another device.
  9. Frame and Cover Material and Finish: Stainless steel.
  10. Frame and Cover Shape: Round.
  11. Top-Loading Classification: Heavy Duty.
  12. For Carpeted areas use carpet marker
  13. Basis of Design:
    - a. For a membrane floor with surface membrane clamp: Watts CO-200-R with C option
    - b. For a poured waterproof floor: Watts CO-200-H with an elastomeric flange
- J. Penthouse Industrial Floor Cleanouts for Cast Iron Systems: Type H
1. Application: cast iron pipe horizontal for concrete floor with membrane

2. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. **Smith, Jay R. Mfg. Co.**
  - b. **Watts.**
  - c. **Zurn Industries, LLC.**
  - d. Or Approved Equal.
3. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
4. Size: Same as connected branch.
5. Body or Ferrule Material: Match Piping.
6. Clamping Device: match pipe material
7. Closure: Brass plug with tapered threads
8. Adjustable Housing Material: Cast iron with threads set-screws or another device.
9. Frame and Cover Material and Finish: Nickle Bronze or Stainless steel.
10. Frame and Cover Shape: Round.
11. Top-Loading Classification: Heavy Duty.
12. For Carpeted areas use carpet marker
  - a. Basis of Design: for a membrane floor with surface membrane clamp: **Watts CO-200-Rwith C option**

## 2.3 FLOOR DRAINS

### A. Cast-Iron Floor Drains : SEE DRAWING SCHEDULE SHEET

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. **Smith, Jay R. Mfg. Co.**
  - b. **Watts; a Watts Water Technologies company.**
  - c. **Zurn Industries, LLC.**
  - d. Or Approved Equal.

### B. Stainless-Steel Floor Drains SEE DRAWING SCHEDULE SHEET

1. ASME A112.6.3, Stainless-Steel Floor Drains:
  - a. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - 1) **Smith, Jay R. Mfg. Co.**
    - 2) **Watts; a Watts Water Technologies company.**
    - 3) **Zurn Industries, LLC.**

4) Or Approved Equal.

C. Plastic Floor Drains SEE DRAWING SCHEDULE SHEET

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Oatey.
  - b. Sioux Chief Manufacturing Company, Inc.
  - c. Zurn Industries, LLC.
  - d. Or Approved Equal.

2.4 TRENCH DRAINS SEE DRAWING SCHEDULE SHEET

A. Trench Drains

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Smith, Jay R. Mfg. Co.
  - b. Watts; a Watts Water Technologies company.
  - c. Zurn Industries, LLC.
  - d. Or Approved Equal.
2. Standard: ASME A112.6.3 for trench drains.
3. Top Loading Classification: Extra Heavy-Duty.
4. Trap Material: Cast iron or Stainless steel. See schedule sheet
5. Trap Pattern: Standard P-trap.

2.5 CHANNEL DRAINAGE SYSTEMS

A. Stainless-Steel Channel Drainage Systems:

1. Non-ASME A112.3.1, Stainless-Steel Channel Drainage Systems:
  - a. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - 1) Multi Drain Systems, Inc.
    - 2) Zurn Industries, LLC.
    - 3) Or Approved Equal.
2. Type: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
  - a. Channel Sections: Interlocking-joint, stainless steel with level invert.

- 1) Dimensions: wide. Include number of units required to form total lengths indicated. On schedule
  - b. Grates: Manufacturer's designation "heavy duty," with slots or perforations and of width and thickness that fit recesses in channels.
    - 1) Material: Stainless steel.
    - 2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
  - c. Covers: Solid stainless steel, of width and thickness that fit recesses in channels, and of lengths indicated.
  - d. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
  - e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- B. Polymer-Concrete Channel Drainage Systems
  1. Narrow, Sloped-Invert, Polymer-Concrete Channel Drainage Systems:
    - a. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
      - 1) ACO USA.
      - 2) Polycast: Hubbell Power Systems, Inc.
      - 3) Smith, Jay R. Mfg. Co.
      - 4) Or Approved Equal.
  2. Narrow, Level-Invert, Polymer-Concrete Channel Drainage Systems:
    - a. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
      - 1) ACO USA.
      - 2) Forté Composites, Inc.
      - 3) Josam Company.
      - 4) Or Approved Equal.
  3. Wide, Level-Invert, Polymer-Concrete Channel Drainage Systems:
    - a. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
      - 1) ACO USA.
      - 2) Josam Company.
      - 3) Polycast: Hubbell Power Systems, Inc.

- 4) Or Approved Equal.
4. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
  - a. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated. Include extension sections necessary for required depth.
    - 1) Dimensions: 4-inch inside width. Include number of units required to form total lengths indicated.
    - 2) Frame: Gray-iron or galvanized steel for grates.
  - b. Grates: Manufacturer's designation "heavy duty," with slots or perforations and of width and thickness that fit recesses in channel sections.
    - 1) Material: Ductile iron OR Stainless steel.
    - 2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
  - c. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
  - d. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
  - e. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
    - 1) Dimensions: see schedule sheet Include number of units required to form total lengths indicated.
    - 2) Frame: Gray-iron or galvanized steel for grates.
  - f. Grates: Manufacturer's designation "heavy duty," with slots or perforations and of width and thickness that fit recesses in channel sections.
    - 1) Material: Stainless steel.
    - 2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
  - g. Covers: Solid see schedule of width and thickness that fit recesses in channel sections, and of lengths indicated.
  - h. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
  - i. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- C. Polymer-Concrete Sediment Interceptor
  1. Description: 27-inch- square, precast, polymer-concrete body, with outlets in number and sizes indicated. Include 24-inch- square, gray-iron slotted grate.

2. Frame: Gray-iron or galvanized steel for grate.
- D. Plastic Channel Drainage Systems
  1. HDPE, PE, PP, or PVC Channel Drainage Systems:
    - a. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
      - 1) NDS Inc.
      - 2) Smith, Jay R. Mfg. Co.
      - 3) Zurn Industries, LLC.
      - 4) Or Approved Equal.
  2. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
    - a. Channel Sections: Interlocking-joint, HDPE or PE PP or PVC modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.
      - 1) Dimensions: 4 inches wide. Include number of units required to form total lengths indicated.
    - b. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.
      - 1) Material: Stainless steel.
    - c. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
    - d. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

## 2.6 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies
  1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Acorn Engineering Company.
    - b. Thaler Metal Industries Ltd.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- OR 6.0-lb/sq. ft., 0.0938-inch- thick, lead flashing collar and skirt extending at least 10 inches from pipe, with galvanized-steel boot reinforcement and counter flashing fitting.
    - a. Extended Vent Cap: With field-installed, vandal-proof vent cap.

## 2.7 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

### A. Through-Penetration Firestop Assemblies

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. ProSet Systems Inc.
  - b. Hilti
  - c. 3M
  - d. Or Approved Equal.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

## 2.8 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

### A. Open Drains

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting two sizes larger than connected pipe.

### B. Deep-Seal Traps

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
  - a. NPS 2: 4-inch- minimum water seal.
  - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
  - c. Trap Primer System – see drawings for type and schedule

### C. Floor-Drain, Trap-Seal Primer Fittings

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

### D. Trap Guard Devices

1. General:

- a. Rubber trap guard devices may be used only where approved by the Plumbing Inspector
  - b. Compliance: ASSE, ICC, IAPMO listed
  - c. Seek approval for use of these alternative materials, methods and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any method of construction not specifically prescribed by the prevailing plumbing code, provided that any such alternative has been approved.
  - d. An alternative material or method of construction shall be approved where the code official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that described.
    - 1) 2006 International Plumbing Code Sec. 105.2 Sec. 1002.4 Trap Seals
    - 2) 2006 International Residential Code Sec. R104.1.1 Sec. P3201 Trap Seals
    - 3) 2006 Uniform Plumbing Code Sec. 301.2 Sec. Sanitary Drainage
    - 4) NSF 14 Plastic Piping System Components & Related Materials
    - 5) CAN/CSA B602-06 Elastomeric Mechanical Couplings for DWV Pipe
2. Product Description:
- a. An Elastomeric, Normally Closed Trap Guard Device utilizes a normally closed seal to prevent evaporation of the trap seal and also protect against sewer gases from backing up into habitable areas. It opens with fluid and allows liquid drainage to flow through into the building drain.
  - b. Product Identification: The Trap Guard device package shall be legibly marked or labeled with the Trap Guard name, trademark and model number.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
- a. Zurn ZShield
  - b. Rectorseal series Sure Seal
  - c. JR Smith Quad Close
  - d. Or Approved Equal.
- E. Air-Gap Fittings
1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
  2. Body: Bronze or cast iron.
  3. Inlet: Opening in top of body.
  4. Outlet: Larger than inlet.
  5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- F. Sleeve Flashing Device



1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

2. Size: As required for close fit to riser or stack piping.

**G. Stack Flashing Fittings**

1. Description: Counter flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2. Size: Same as connected stack vent or vent stack.

**H. Vent Caps**

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.

2. Size: Same as connected stack vent or vent stack.

**I. Frost-Resistant Vent Terminals**

1. Description: Manufactured or shop-fabricated assembly constructed of copper, or galvanized steel.

2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counter flashing.

**J. Expansion Joints**

1. Standard: ASME A112.21.2M.

2. Body: Cast iron with bronze sleeve, packing, and gland.

3. End Connections: Matching connected piping.

4. Size: Same as connected soil, waste, or vent piping.

**2.9 DRAIN HEAT RECOVERY DEVICES**

**A. Description**

1. Drain water heat recovery device consisting of one or more copper tubes helically wound around copper drain water pipe.

2. The package equipment is designed to recover heat from hot drain lines and transfer said recovery to the water piping at an end user

**B. Design and Performance Criteria**

1. Design drain water heat recovery device in accordance with manufacturer's written recommendations and to UL MJAT, Specialty Heating and Heating-Cooling Appliance Accessories.

2. Drain water Size: see schedule

3. Available Active Drain Water Pipe Length: see schedule .

4. Efficiency: 56 percent minimum at an equal flow rate of 4.5 gpm.

5. Pressure Loss: 6 psi maximum at flow rate of 6.7 gpm on potable water side of drain water heat recovery device.

C. Materials

1. Heat Exchanger: To CSA B55.1.
2. Water Piping: To ASTM B88M, copper tube, hard drawn, Type L minimum.
3. Drain water Piping: To ASTM B306, copper tube, Type DWV

D. Accessories

1. Bottom Pipe Coupling: Top Pipe Coupling
  - a. Acceptable Material: use no hub connector specified in sanitary pipe specification section for see schedule 2] NPS Hubless Connector.
2. Pipe Insulation: In accordance piping Division 22 for Plumbing Piping Insulation.

E. Basis of design: [Power pipe drain/water heat recovery R series or C series](#)

2.10 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
  1. General Applications: 12 oz. /sf..
  2. Vent Pipe Flashing: 8 oz. /sf.
- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.
- G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.11 FOG DISPOSAL SYSTEMS

A. FOG Disposal Systems:

1. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Highland Tank Inc.
  - b. [Smith, Jay R. Mfg. Co.](#)
  - c. Or Approved Equal.
2. Standard: IAPMO PS 118, for removing solids from and breaking down and digesting suspended fats, oils, and greases from food-preparation or -processing wastewater.
3. Flow-Control Fitting: Matching unit size.

4. Strainer Unit: Stainless-steel housing with aluminum cover and removable-basket-type, stainless-steel, wire-mesh strainer. Include pressure plug instead of cover. Include extra basket. Include stainless-steel extension.
5. Media Chamber: Stainless-steel housing and aluminum cover, with internal baffles, piping, plastic coalescing surfaces, and clarifier section with test ports. Include stainless-steel extension.
6. Shelf: Stainless steel, 19.5 inches wide by 13 inches high by 8.75 inches deep, for metering pump, control devices, and culture bottle.
7. Culture Metering Pump, Timer, Control, and Tubing: Proprietary.
8. Culture: Include 1-gal. bottle, as recommended by unit manufacturer.
9. Strainer and Media-Chamber, Unit Size: see schedule
10. Inlet and Outlet: NPS 2.
11. Strainer and Media-Chamber, Unit Size: see schedule **5**
12. Inlet and Outlet: NPS 3.
13. Piping: Waste and vent piping is specified in Division 22.
14. Power Requirement: see schedule.
15. Full-Load Amperes: see schedule .
16. Minimum Circuit Ampacity: < see schedule
17. Maximum Over current Protection: see schedule .

### **PART 3 - EXECUTION**

#### **3.1 SCHEDULE FOR FLOOR CLEANOUT INSTALLATION**

- A. All drainage cleanouts to be Buy American Compliant
  1. Schedule all drainage equipment on the drawings

Service	Piping	Duty	Type	Cleanout Top
Floor cleanouts in finished areas	Cast Iron	Medium	B	See part 2
Floor cleanouts in carpeted finished areas	Cast Iron	Medium	B add carpet marker	See -part 2
Floor cleanouts in unfinished areas	Cast Iron	Heavy	B-XH	Round Stainless Steel or Ductile Iron
Floor cleanouts in warehouses and loading docks	Cast Iron	Extra Heavy	B-HX	Round Stainless, Ductile or Durisist
Floor cleanouts in Industrial anywhere forklifts or pallet-jack equipment is used	Cast Iron	Extra Heavy	B-HX	Round Stainless, Ductile or Durisist
Floor cleanouts in kitchen finished areas	Stainless Steel	Medium	C1	For kitchen and finish floor areas
Floor cleanouts in kitchen outside kitchen for mechanical areas or industrial areas	Stainless Steel	Extra Heavy	C2	Non finished areas
Floor cleanouts in unfinished areas	Stainless Steel	Heavy	C	Round Stainless Steel
Floor cleanouts in warehouses and loading docks	Stainless Steel	Extra Heavy	C	Round Stainless Steel Extra Heavy Duty model
Floor cleanouts in Industrial anywhere forklifts or pallet-jack equipment is used	Stainless Steel	Extra Heavy	C	Round Stainless Steel Extra Heavy Duty model
Floor cleanouts in finished areas	PVC	Medium	F	Round
Floor cleanouts in carpeted finished areas	PVC	Medium	F	Round add carpet marker
Floor cleanouts for penthouses	Cast Iron	Heavy	G	Round Stainless Steel
Floors with waterproof membrane	Per Pipe	Heavy	H	Round Stainless Steel or Nickle Chrome

### 3.2 INSTALLATION

#### A. Equipment Mounting:

1. Install FOG disposal systems grease interceptors grease removal devices and solids interceptors on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03.
2. Comply with requirements for vibration isolation and seismic control devices specified in Division 22.

- B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  - 2. Locate at each change in direction of piping greater than 45 degrees.
  - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  - 4. Locate at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  - 1. Position floor drains for easy access and maintenance.
  - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
  - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
  - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- G. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- H. Assemble non-ASME A112.3.1, stainless-steel channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- I. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- J. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- K. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
- L. Assemble open drain fittings and install with top of hub 2 inches above floor.

- M. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- N. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
  - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
  - 2. Size: Same as floor drain inlet.
- O. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- P. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- Q. Install vent caps on each vent pipe passing through roof.
- R. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- S. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- T. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- U. Assemble components of FOG disposal systems and install on floor. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.
- V. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
  - 1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
  - 2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
  - 3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
  - 4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.
- W. Install grease removal devices on floor. Install trap, vent, and flow-control fitting according to authorities having jurisdiction. Install control panel adjacent to unit, unless otherwise indicated.
- X. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain with Division 23.
- Y. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.
- Z. Install wood-blocking reinforcement for wall-mounting-type specialties.

- AA. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

### 3.3 CONNECTIONS

- A. Install piping adjacent to equipment to allow service and maintenance.
- B. FOG Disposal Systems: Connect inlet and outlet to unit, connect flow-control fitting and fresh-air inlet piping to unit inlet piping, and connect vent piping between trap and media chamber. Connect electrical power.
- C. Ground equipment according to Division 26.
- D. Connect wiring according to Division 26.

### 3.4 DRAIN HEAT RECOVERY INSTALLATION

- A. Install drain water heat recovery device in accordance with manufacturer's written recommendations.
- B. De-burr drainpipe top cut.
- C. Use hubless connector with full steel band for bottom connection of drain water heat recovery device.
- D. Use hubless connector with full steel band for top of drain water heat recovery device.
- E. Tighten connectors on both top and bottom hubless connectors to secure drain water heat recovery device in correct position.
- F. Connect incoming cold water to bottom of drain water heat recovery device coil manifold.

### 3.5 FLASHING INSTALLATION

- A. Flash floor membranes provided under divisions 7 in floors into penetration flashing collars
- B. As listed below, where floor membranes are not provided under division 7, furnish and install flashing material
- C. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
  - 1. Copper Sheets: Solder joints of copper sheets.
  - 2. Approved Membrane Materials
    - a. Submit flashing material prior to use and in timely manner to suit construction progress to architect/engineer approval.
- D. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
  - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

- E. Install floor drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
- F. Penthouse and containment cleanouts and floor drains
  - 1. Provide waterproofing membrane extending a minimum of 12 inches from drain in all directions
  - 2. Extend waterproofing membrane into seepage pan and secure with clamping collar
  - 3. Provide underdeck clamp on thin slab installations of 5 inches or less, above grade installations only. Secure clamp to drain.
- G. Drains or cleanouts cored into existing floors:
  - 1. For drains in existing floors, where a core hole is used, replace and patch floor construction with 5000 psi non-shrink concrete
  - 2. Use dowels with the approval of the structural engineer to maintain the new to existing patch
  - 3. Apply with brush a continuous coat of epoxy bonding agent, (EPO bond) all around perimeter of core and body of drain assembly
  - 4. Provide underdeck clamp
- H. Set flashing on floors and roofs in solid coating of bituminous cement.
- I. Secure flashing into sleeve and specialty clamping ring or device.
- J. Install flashing for piping passing through roofs with counter flashing or commercially made flashing fittings, according to Division 07.
- K. Fabricate and install flashing and pans, sumps, and other drainage shapes.

### 3.6 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. FOG disposal systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22.

### 3.7 RUBBER TRAP SLEEVE INSTALLATION:

- A. Product shall be installed in accordance with the Manufacturer's instructions and the requirements of the applicable codes. Device can be installed inside other manufacturer's drain tail pieces or optionally inside 2 inches, 3 inches or 4 inches pipe that connects the various types of floor or hub drains. If a T&P relief valve is discharged into the Trap Guard device, it must be discharged into the center opening of the device. A strainer with a center hole is available for that purpose.
- B. Protect the elastomeric device materials from being touched with solvent cement or primers during installation. Protect material from being distorted or damaged during storage, handling and installation.
- C. Test Methods and Performance Requirements:



1. The Elastomeric membrane material shall be field pressure tested to determine the back pressure of the device to hold back compressed air from 1 inch WC and then increased to 2 inch WC with no leakage.
  2. Testing shall be performed to verify that a plumbing snake can be effectively used with the Trap Guard device installed. For a typical 4 inch diameter floor drain, a 1-1/2 inch PVC pipe shall be inserted the entire length of the device with lubrication to provide an adequate pathway for a plumbing snake.
  3. Testing shall be performed to determine the maximum water flow the device could accommodate using an electric sump pump and a portable water reservoir. The pump discharge shall be into the Trap Guard device installed into a simulated drain assembly. Test acceptance is 30 GPM.
- D. Commission the device by flushing out thoroughly with clear warm water.

### 3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled FOG disposal systems and their installation, including piping and electrical connections, and to assist in testing.
- B. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

### 3.9 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

### 3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain FOG disposal systems. Refer to Division 01.

END OF SECTION

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## SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Metal roof drains.
  - 2. Miscellaneous storm drainage piping specialties.
  - 3. Roof Drain Markers
  - 4. Cleanouts.
  - 5. Backwater valves.
  - 6. Trench drains.
  - 7. Channel drainage systems.
  - 8. Through-penetration firestop assemblies.
  - 9. Flashing materials.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

#### 1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

### PART 2 - PRODUCTS

#### 2.1 METAL ROOF DRAINS

- A. Cast-Iron, Large-Sump, General-Purpose Roof Drains **see drawings for schedule information.**
  - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.

- a. Smith, Jay R. Mfg. Co.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASME A112.6.4, for general-purpose roof drains.
  3. Body Material: Cast iron.
  4. Combination Flashing Ring and Gravel Stop
  5. Under deck Clamp
  6. Expansion Joint:
  7. Basis of Design: Watts Model RD-300
- B. Cast-Iron, Large-Sump, Dual Outlet Roof Drain/Overflow; **see drawings for schedule information.**
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Smith, Jay R. Mfg. Co.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASME A112.6.4, for general-purpose roof drains.
  3. Body Material: Cast iron.
  4. Combination Flashing Ring and Gravel Stop
  5. Under deck Clamp
  6. Expansion Joint:
  7. 4 inch High Overflow
  8. Basis of Design: Watts Model RD-700
- C. Cast-Iron, Medium-Sump, Small Area Roof Drains see drawings for schedule information.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Smith, Jay R. Mfg. Co.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASME A112.6.4, for general-purpose roof drains.
  3. Body Material: Cast iron.

4. Dimension of Body: 8- to 12-inch diameter.
  5. Combination Flashing Ring and Gravel Stop: Required.
  6. Under deck Clamp
  7. Basis of Design: Watts Model RD-100
  8. REMOVED COPPER DRAINS FROM THE SPEC. NO ONE USES, IF SPECIFIC NEED GO BACK TO MASTER FOR INFORMATION.
- D. Cast-Iron, Small-Sump, General-Purpose Roof Drains, see drawings for schedule information.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Smith, Jay R. Mfg. Co.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASME A112.6.4, for general-purpose roof drains.
  3. Body Material: Cast iron.
  4. Dimension of Body: Nominal 8-inch diameter.
  5. Combination Flashing Ring and Gravel Stop.
  6. Under deck Clamp:
  7. Expansion Joint:
  8. Basis of Design: Watts Model 200

## 2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

- A. Downspout Adaptors :
1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
  2. Size: Inlet size to match parapet drain outlet.
- B. Downspout Boots :
1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
  2. Size: Inlet size to match downspout and NPS 4 outlet.
- C. Conductor Nozzles :
1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
  2. Size: Same as connected conductor.

## 2.3 ROOF DRAIN MARKERS

- A. Roof Drain Marker: Drain dome-mounted vertical fiberglass flag marker secured in aluminum socket by set-screw in turn secured with pre-punched aluminum bracket configured for secure through-bolting centered over roof drain dome.
  - 1. Flag Marker: Pultruded fiber-reinforced polymer rod, 1/2 inch (12 mm) diameter by 48 inch (1219 mm) long, with reflective dual-colored reversible ends enabling marking of selected drains.
    - a. Flexural Strength, minimum, ASTM D 790, 700,000 psi (689 MPa).
    - b. Impact Strength, minimum, ASTM D 256: 40 ft-lb/in.
  - 2. Marker Base: 1 by 1 by 4 inch (25 by 25 by 102 mm) extruded aluminum bar, ASTM B 209 (ASTM B 209M), with milled flag receiver, threaded flag set screw retainer, and threaded base.
  - 3. Flag Bracket: 1 by 11 by 0.063 inch (25 by 25 by 1.60 mm) aluminum plate bracket, ASTM B 221 (ASTM B 221M).
  - 4. Fasteners: Alloy Group 2 (A4) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
- B. Basis-of-Design Product: [Roof Drain Marker Co., LLC.](#), West Bridgewater, MA;

## 2.4 CLEANOUTS

- A. See part 3 of this specification for cleanout schedule
- B. Horizontal Cast-Iron Exposed Cleanouts: **Type A**
  - 1. Application: exposed horizontal pipe runs above slab in line or end cleanout
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal.
    - a. [Jay R. Smith Mfg Co; a division of Morris Group International.](#)
    - b. [WATTS.](#)
    - c. [Zurn Industries, LLC.](#)
    - d. Or Approved Equal.
  - 3. Standard: ASME A112.36.2M.
  - 4. Size: Same as connected drainage piping
  - 5. Body Material: cast-iron soil pipe in line or end placed into fitting approved tee as required to match connected piping.
  - 6. Closure: Countersunk or raised-head, brass plug.
  - 7. Closure Plug Size: Same as cleanout size.
  - 8. Basis of Design: [Watts 460](#) or TY with [Generic](#)
- C. Finish Area Floor Cleanouts for Cast Iron Systems: **Type B**
  - Application: cast iron pipe horizontal runs, finish areas. i.e. tile or terrazzo or epoxy finish.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. **Smith, Jay R. Mfg. Co.**
    - b. **Watts; a Watts Water Technologies company.**
    - c. **Zurn Industries, LLC.**
    - d. Or Approved Equal.
  2. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
  3. Size: Same as connected branch.
  4. Body or Ferrule Material: Match Piping .
  5. Clamping Device: match pipe material
  6. Closure: Brass plug with tapered threads.
  7. Adjustable Housing Material: Cast iron with threads set-screws or other device.
  8. Frame and Cover Material and Finish: Nickel-bronze
  9. Frame and Cover Shape: Round.
  10. Top-Loading Classification: Heavy Duty.
  11. For Carpeted areas use carpet marker
  12. Basis of Design: **Watts Model CO-200R**
- D. Industrial Area Floor Cleanouts for Cast Iron Systems: **Type B XH**
- Application: cast iron pipe horizontal or vertical runs, non-finish industrial areas mechanical rooms, penthouses or areas where forklifts or pallet jacks are used
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. **Smith, Jay R. Mfg. Co.**
    - b. **Watts.**
    - c. **Zurn Industries, LLC.**
    - d. Or Approved Equal.
  2. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
  3. Size: Same as connected branch.
  4. Body or Ferrule Material: Match Piping .
  5. Clamping Device: match pipe material
  6. Closure: Brass plug with tapered threads.
  7. Adjustable Housing Material: Cast iron with threads set-screws or other device.
  8. Frame and Cover Material and Finish: Nickel-bronze, copper alloy or Stainless steel.
  9. Frame and Cover Shape: Round.

10. Top-Loading Classification: Extra Heavy Duty.
  11. For Carpeted areas use carpet marker
  12. Basis of Design: Watts CO-200-RX, for large sizes Watts Model CO-300 MF with inside cleanout added
- E. Exposed Floor Cleanouts for Stainless Steel Systems **Type C**
1. Application: for stainless steel piping systems where specified for kitchens and other uses
  2. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following, or approved equal.
    - a. BLÜCHER; A Watts brand.
    - b. Watts
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  3. Standards: ASME A112.3.1; NSF listed.
  4. Size: Same as connected branch.
  5. Housing: Type 316 stainless steel.
  6. Closure: Stainless steel with seal Plastic plug.
  7. Riser: ASTM A74, Service Class, stainless steel drainage pipe fitting and riser to cleanout.
  8. Body or Ferrule: Stainless steel.
  9. Clamping Device: Required.
  10. Outlet Connection: Inside caulk Spigot Threaded Butt-weld field selected
  11. Adjustable Housing Material: Stainless Steel with threads setscrews or other device.
  12. Frame and Cover Material and Finish: Stainless steel.
  13. Frame and Cover Shape: Square.
  14. Top-Loading Classification: Heavy Duty.
  15. Basis of Design:
    - a. Type C1: Kitchens and finish floor areas Blucher BCO 140 heavy duty
    - b. Type C2: For industrial areas Watts 1200-RX-28 stainless steel Extra Heavy Duty
- F. Test Tees for Cast Iron Systems: **Type D**
- Application: Exposed horizontal or vertical in line or “Dandy” cleanout
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Smith, Jay R. Mfg. Co.
    - b. Watts; a Watts Water Technologies company.

- c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
  3. Size: Same as connected drainage piping.
  4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
  5. Closure Plug: Countersunk.
  6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
  7. Basis of Design: Watts Model CO-460
- G. Wall Cleanouts for Cast Iron Systems: **Type E**
- Application: finish area vertical in line or “Dandy” cleanout
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Smith, Jay R. Mfg. Co.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
  3. Size: Same as connected drainage piping.
  4. Body Material: T-branch as required to match connected piping.
  5. Closure: Drilled and threaded brass plug.
  6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
  7. Wall Access: Square, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.
  8. Basis of Design: Watts Model CO-460-RD
- H. Floor Cleanouts for PVC systems: **Type F**
- Application: Floor Cleanout plastic piping Systems
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Sioux Chief Manufacturing Company, Inc.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Size: Same as connected branch.



3. Body Material: PVC.
4. Closure Plug: PVC or PP.
5. Cover: Round
6. Riser: Drainage pipe fitting and riser to clean out of same material as drainage piping.
7. Basis of Design: **Watts 200 R -60 for PVC**

I. Penthouse Industrial Floor Cleanouts for Cast Iron Systems: Type G

1. Application: cast iron pipe horizontal for concrete penthouse floor
2. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. **Smith, Jay R. Mfg. Co.**
  - b. **Watts.**
  - c. **Zurn Industries, LLC.**
  - d. Or Approved Equal.
3. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
4. Size: Same as connected branch.
5. Body or Ferrule Material: Match Piping.
6. Clamping Device: match pipe material
7. Closure: Brass plug with tapered threads
8. Adjustable Housing Material: Cast iron with threads set-screws or another device.
9. Frame and Cover Material and Finish: Stainless steel.
10. Frame and Cover Shape: Round.
11. Top-Loading Classification: Heavy Duty.
12. For Carpeted areas use carpet marker

Basis of Design:

- a. For a membrane floor with surface membrane clamp: **Watts CO-200-R with C option**
- b. For a poured water proof floor: **Watts CO-200-H** with an elastomeric flange

J. Penthouse Industrial Floor Cleanouts for Cast Iron Systems: Type H

1. Application: cast iron pipe horizontal for concrete floor with membrane
2. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. **Smith, Jay R. Mfg. Co.**
  - b. **Watts.**
  - c. **Zurn Industries, LLC.**

- d. Or Approved Equal.
3. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
4. Size: Same as connected branch.
5. Body or Ferrule Material: Match Piping .
6. Clamping Device: match pipe material
7. Closure: Brass plug with tapered threads
8. Adjustable Housing Material: Cast iron with threads set-screws or another device.
9. Frame and Cover Material and Finish: Nickle Bronze or Stainless steel.
10. Frame and Cover Shape: Round.
11. Top-Loading Classification: Heavy Duty.
12. For Carpeted areas use carpet marker
  - a. Basis of Design: for a membrane floor with surface membrane clamp: . Watts CO-200-Rwith C option

## 2.5 BACKWATER VALVES

### A. Cast-Iron, Horizontal Backwater Valves, see drawings for schedule information.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Smith, Jay R. Mfg. Co.
  - b. Watts; a Watts Water Technologies company.
  - c. Zurn Industries, LLC.
  - d. Or Approved Equal.
2. Standard: ASME A112.14.1, for backwater valves.
3. Size: Same as connected piping.
4. Body Material: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: hub and spigot or hubless.
7. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
8. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
9. Basis of Design: Watts Model BV-200

### B. Cast-Iron, Drain-Outlet Backwater Valves, see drawings for schedule information.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.

- a. Smith, Jay R. Mfg. Co.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Size: Same as floor drain outlet.
  3. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
  4. Check Valve: Removable ball float.
  5. Inlet: Threaded.
  6. Outlet: Threaded or spigot.
  7. Basis of Design: Watts Model BV-300
- C. Plastic, Horizontal Backwater Valves
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. IPS Corporation.
    - b. Sioux Chief Manufacturing Company, Inc.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASME A112.14.1, for backwater valves.
  3. Size: Same as connected piping.
  4. Body Material: PVC.
  5. Cover: Same material as body with threaded access to check valve.
  6. Check Valve: Removable swing check.
  7. End Connections: Socket type.
  8. Basis of Design: Sioux Chief Model 869-6P 6" backwater valve

## 2.6 TRENCH DRAINS

- A. Trench Drains: see drawings for schedule information.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Smith, Jay R. Mfg. Co.
    - b. Watts; a Watts Water Technologies company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.

2. Standard: ASME A112.6.3, for trench drains.
3. Body Material: Cast iron.
4. Flange: Anchor with weep holes.
5. Clamping Device
6. Grate Material: Stainless steel.
7. Dimensions of Frame and Grate: 8 inches
8. Top-Loading Classification: Heavy Duty.
9. Basis of Design: Watts Model DEAD LEVEL DX SERIES

## 2.7 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

- A. Through-Penetration Firestop Assemblies for PVC or other thermoplastic piped system conductors:
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. 3M Corporation.
    - b. Hilti, Inc.
    - c. ProSet Systems Inc.
    - d. Or Approved Equal.
  2. Standard: ASTM E 814, for through-penetration firestop assemblies.
  3. Certification and Listing: Insert testing agency acceptable to authorities having jurisdiction for through-penetration firestop assemblies.
  4. Size: Same as connected pipe.
  5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
  6. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
  7. Special Coating: Corrosion resistant on interior of fittings.

## 2.8 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, 12 oz. /sf.
- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.

- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.

### PART 3 - EXECUTION

#### 3.1 SCHEDULE FOR FLOOR CLEANOUTS

- A. All drainage cleanouts to be Buy American Compliant

Service	Piping	Duty	Type	Cleanout Top
Floor cleanouts in finished areas	Cast Iron	Medium	B	See part 2
Floor cleanouts in carpeted finished areas	Cast Iron	Medium	B. Add carpet marker	See -part 2
Floor cleanouts in unfinished areas	Cast Iron	Heavy	B-XH	Round Stainless Steel or Ductile Iron
Floor cleanouts in warehouses and loading docks	Cast Iron	Extra Heavy	B-HX	Round Stainless, Ductile or Durisist
Floor cleanouts in Industrial anywhere forklifts or pallet-jack equipment is used	Cast Iron	Extra Heavy	B-HX	Round Stainless, Ductile or Durisist
Floor cleanouts in kitchen finished areas	Stainless Steel	Medium	C1	For kitchen and finish floor areas
Floor cleanouts in kitchen outside kitchen for mechanical areas or industrial areas	Stainless Steel	Extra Heavy	C2	Non finished areas
Floor cleanouts in unfinished areas	Stainless Steel	Heavy	C	Round Stainless Steel
Floor cleanouts in warehouses and loading docks	Stainless Steel	Extra Heavy	C	Round Stainless Steel Extra Heavy Duty model
Floor cleanouts in Industrial anywhere forklifts or pallet-jack equipment is used	Stainless Steel	Extra Heavy	C	Round Stainless Steel Extra Heavy Duty model
Floor cleanouts in finished areas	PVC	Medium	F	Round
Floor cleanouts in carpeted finished areas	PVC	Medium	F	Round add carpet marker
Floor cleanouts for penthouses	Cast Iron	Heavy	G	Round Stainless Steel
Floors with waterproof membrane	Per Pipe	Heavy	H	Round Stainless Steel or Nickle Chrome

#### 3.2 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.
- B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.
- C. Install downspout boots at grade with top 12 inches above grade. Secure to building wall.
- D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
  1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
  3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  4. Locate cleanouts at base of each vertical soil and waste stack.
- F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- H. Install horizontal backwater valves in floor with cover flush with floor.
- I. Install drain-outlet backwater valves in outlet of drains.
- J. Install test tees in vertical conductors and near floor.
- K. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- L. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- M. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- N. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.
- O. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

### 3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Division 22. Drawings indicate general arrangement of piping, fittings, and specialties.

### 3.4 ROOF DRAIN MARKER INSTALLATION

- A. Install roof drain markers on each roof drain dome in roof area. Install in accordance with manufacturer's instructions.
  - 1. Attach bracket to drain dome using manufacturer-furnished corrosion-resistant fasteners, securely tighten.
  - 2. Thread marker base to threaded stud on marker bracket and tighten securely.
  - 3. Insert flag marker into marker base and secure using set-screw. Coordinate selection of colored flag marker end based upon drain condition.

### 3.5 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
  - 1. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
  - 1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

### 3.6 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

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## SECTION 223400 - FUEL-FIRED, WATER HEATERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Commercial, gas-fired, condensing water heaters – General
  - 2. Multi Duty Commercial Condensing Water Heater
  - 3. Extensive Capacity Commercial Condensing Water Heater.
  - 4. Gas-fired, tankless, condensing water heaters.
  - 5. Residential, gas-fired storage, water heaters
  - 6. Water heater accessories.
  - 7. Floor leak detection system
  - 8. Source Quality Control

#### 1.3 PERFORMANCE REQUIREMENTS

- A. For seismic projects and related performance, commercial water heaters shall withstand the effects of earthquake motions determined according to Division 22 for vibration and seismic isolation.
  - 1. For seismic projects, the term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
  - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."
- C. Shop Drawings:



1. Wiring Diagrams: For power, signal, and control wiring.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For fuel-fired, water heaters, accessories, and components, from manufacturer.
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each type of commercial, gas-fired, gas-fired, tankless, residential, gas-fired, water heater, from manufacturer.
- C. Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Warranty: Sample of special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuel-fired, water heaters to include in emergency, operation, and maintenance manuals.

#### 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, water heaters to comply with ASHRAE/IESNA 90.1.
- C. ASME Compliance:
  1. Where ASME-code construction is indicated, fabricate and label commercial, water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
  2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

#### 1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

## 1.9 WARRANTY

- A. General: periods are stipulated here for this specification section. Generally manufacturers standard warranty applies, however, longer warranty periods, if required, are stipulated in part 2 where each product is specified. The warranty periods stipulated in part 2 take priority over standard manufacturer's warranty periods specified in part 1.
- B. Warranty: Manufacturer's standard warranty – submit a form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within manufacturers standard specified warranty period. Manufacturers standard warranty must include minimum durations below
- C. Minimum Durations and Special Warrantees: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
  - 1. Structural failures including shell.
  - 2. Warranty period shall begin on the date of project substantial completion stipulated by the Architect and/or the Construction Manager
  - 3. Commercial, Storage, Water Heaters:
    - a. Storage Tank: Five years.
    - b. Controls and Other Components: Three years.
  - 4. Residential, , Storage, Domestic-Water Heaters:
    - a. Storage Tank: 5 years.
    - b. Controls and Other Components: Three years.
  - 5. Compression Tanks: Five years.

## PART 2 - PRODUCTS

### 2.1 COMMERCIAL, GAS-FIRED WATER HEATERS GENERAL

- A. Commercial, Gas-Fired, High-Efficiency, Water Heaters:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. A. O. Smith
    - b. Lochinvar, LLC.
    - c. PVI Industries, LLC.
    - d. Or Approved Equal.
  - 2. Standard: ANSI Z21.10.3/CSA 4.3.
  - 3. Description: Manufacturer's proprietary design to provide at least 94% percent thermal efficiency.
  - 4. Storage-Tank Construction: ASME-code steel with 150-psig except for high-rise application minimum working-pressure rating.

## 2.2 MULTI DUTY COMMERCIAL CONDENSING WATER HEATER AND TANK

<b>GAS FIRED CONDENSING WATER HEATER -</b>	
Fuel	Natural or Propane Gas, verify on Schedule Sheet.
Number of Units	See Schedule Sheet
Performance	<p>The water heaters shall be CSA listed as a complete unit. The heater shall satisfy current Federal Energy Policy Act standards for both thermal efficiency and stand-by heat losses as established for gas fired water heaters.</p> <p>Water heaters will operate at a minimum 94 percent thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol (DOE 10 CFR 431).</p> <p>Water heater will meet the thermal efficiency and standby heat loss requirements of ASHRAE 90.1 – 2010.</p>
Construction	<p>Water heaters will be of the BTU input(s) and storage capacity indicated on the equipment schedule.</p> <p>The water heater will be a vertical fire or horizontal water tube design that is constructed and stamped in accordance with Section IV of the ASME code. Water heater will be National Board Registered for a working pressure of 150 psi and will be pressure tested at 1-1/2 times working pressure. Water heater will be coupled with an external storage tank or an internal storage tank. The tank is to be lined with manufacturers lining comparable to seamless cement. Aa Cement lined Storage Vessel shall not require any type of anodic protection.</p> <p>Water Heater heat exchanger shall be constructed of 316L stainless steel, and mounted in a sealed stainless steel combustion chamber. The heat exchanger and combustion chamber assembly shall be of all-welded construction. The heat exchanger shall be rated for 160psi maximum operating pressure. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. All tank connections/fittings will be non-ferrous or stainless steel.</p> <p>Combustion will be provided by a premix, fan-assisted surface burner with a gas train meeting CSA standards for the input specified.</p> <p>Combustion will be provided by a fan-assisted burner with a gas train meeting Massachusetts code requirements for the input specified.</p> <ul style="list-style-type: none"> <li>• Burner will be stainless steel.</li> <li>• Gas train components will capable of self-pro-portionating gas and air to maintain optimum combustion in response to varying vent pressures.</li> <li>• The burner will employ a Variable speed blower utilizing pulse width modulation to vary gas and air.</li> <li>• Burner NOx emissions will be less than 20 ppm when corrected to 3 percent oxygen.</li> </ul> <p>Water heater will be a category IV, condensing appliance and vent through PVC or Polypropylene. Water heater will satisfy requirements for sealed combustion. Vents for inlet air and exhaust can terminate in different pressure zones.</p>
Quality Assurance	<p>Listing: The water heater will be The water heater shall be certified to the ANSI Z21.10.3 / CSA 4.3 Gas Water Heater Standard. ASME Compliance: Water heater shall bear the ASME stamp and be National Board listed. Water heaters will operate at a minimum 94 percent thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol (DOE 10 CFR 431).</p> <p>The water heater will comply with current ASHRAE 90.1 requirements. Water heater manufacturer certified to the ISO 9001 International Quality System.</p>
Water Heater Trim	<p>As a minimum, the heater will be equipped with the following:</p> <ul style="list-style-type: none"> <li>• electronic flame monitoring</li> <li>• electronic low water cutoff</li> <li>• an <i>immersion</i> operating control</li> <li>• an <i>immersion</i> UL listed temperature limiting device</li> <li>• an ASME- rated temperature and pressure relief valve</li> </ul> <p>Operating and safety controls shall meet the requirements of CSD-1/GEGAP and Massachusetts code</p> <p>The water heater shall employ an electronic operating control with digital temperature readout. Operator shall be capable of connecting to a building automation system through serial connection using Modbus RTU protocol.</p>

<b>GAS FIRED CONDENSING WATER HEATER -</b>	
Installation and Communication	<p>Install water heaters level and plumb in accordance with manufacturers written instructions and referenced standards</p> <p>The controller shall have the ability to communicate common field-bus protocols, (BACnet, Modbus, Profibus, and LON or N2), via optional gateway communication expansion card installed inside controller.</p>
Finishing	<p>Base option - The storage and heating sections shall be completely factory packaged on a single skid, requiring only job site hookup to utilities, venting, and plumbing. The system may be shipped in component parts should jobsite access be restricted. The heater shall be insulated to meet current ASHRAE 90.1 standby loss requirements. Pressure vessel shall include a ball-type drain valve. The heater shall fit properly in the space provided and installation shall conform to all local, state, and national codes</p>
Start-Up	<p>Start up on the unit will be performed by factory trained and authorized personnel. A copy of the startup report will be provided to the owner.</p>
Warranty	See part 1
Rated Duty/Capacity	See Drawing Schedule Sheet
Basis of Design	<p>Model NX Hubbell Water Heaters</p> <p>PVI Conquest™ Plus packaged water heater</p>

## 2.3 WATER HEATER ACCESSORIES

### A. Condensate Neutralization for Condensing Heaters

1. Provide a package neutralization pod capable of pH correction of the condensate discharge for each condensing water heater
2. Provide appropriate thermoplastic piping to and from pod to a safe drain location

### B. Water Compression Tanks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. AMTROL, Inc.
  - b. Smith, A. O. Corporation.
  - c. Taco, Inc.
  - d. Or Approved Equal.
2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.
3. Construction:
  - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
  - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
  - c. Air-Charging Valve: Factory installed.
4. Warranty: see part 1

### C. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

### D. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

### E. Heat-Trap Fittings: ASHRAE 90.2.

### F. Manifold Kits: -water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each water heater and calibrated memory-stop balancing valves to provide balanced flow through each water heater.

- G. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Division 22.
  - 1. Comply with requirements for balancing valves specified in Division 22.
- H. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M manually operated. Furnish for installation in piping.
- I. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig, 2-psig or 5-psig pressure rating as required to match gas supply.
- J. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- K. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
  - 1. Gas-Fired, Water Heaters: ANSI Z21.22/CSA 4.4-M.
- L. Pressure Relief Valves: Include pressure setting less than water heater working-pressure rating.
  - 1. Gas-Fired, Water Heaters: ANSI Z21.22/CSA 4.4-M.
- M. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.
- N. Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting water heater and water. Provide dimension that will support bottom of water heater a minimum of 18 inches above the floor.
- O. Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting water heater and water.

#### 2.4 FLOOR LEAK DETECTION

- A. Leak Detection: Provide leak detection for each installation of general water heating equipment including storage tanks per the following:
  - 1. Provide a concrete curb containment that fully encompasses the water heater installation area. If storage tanks are separate provide curb around each unit or package.
  - 2. Provide a full size floor drain or floor sink inside the concrete curbed area
- B. General
  - 1. Furnish and install a complete floor leak detection system around the perimeter of the steam water heater installation.
  - 2. Wireless or hard wired floor sensors are acceptable
  - 3. Position leak detection pucks approximately 10 feet on center around the perimeter of the heater installation
  - 4. Perform all necessary placement of sensors, controllers and valves. Route detector wires, control wire signals to valves and charger wires to result in a full turnkey operation
  - 5. Mount the fixed controller on a wall or column in the immediate area of the water heater
  - 6. Coordinate power with Division 26 Electrical Contractor exact location of power source wire. 120VAC will be provided to a two duplex outlets at the controller location

- C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
1. Pipe Burst Pro.
  2. Floodmaster, Inc.
  3. Pentair
  4. Or Approved Equal.



LEAK DETECTION - FLOOR MONITOR SYSTEM FOR STEAM WATER HEATER AREA		
DESCRIPTION	Water detection alarm system designed to monitor water leak location, and near water systems such as water heating equipment and recirculating pumps. The system shall sequence an alarm when: <ul style="list-style-type: none"><li>- A wireless sensor and/or wired sensor is in contact with any non-flammable conductive liquid (such as water)</li><li>- A water meter, integrated with the system, exceeds a user set quantity within a user defined timer limit</li></ul> The system shall operate as a package and initiate the following: <ul style="list-style-type: none"><li>- Automatically close the electrically actuated water valve on the designated water shut off location via wireless relay switch</li><li>- Sound local audible alarms, send alerts and notifications via text, email and/or phone call</li><li>- Report via dry contacts to a Building Management System (BMS)</li><li>- Report directly to Building Personnel and allow full system monitoring and control via app.ionleaks.com</li></ul>	
PERFORMANCE CONDITIONS	Floor stationed wireless and wired sensors are activated by conductive fluid. Flow detection is activated when a user set quantity is exceeded in a user defined timer limit. <ul style="list-style-type: none"><li>- All communications, audible alarms, alerts, phone calls, communication with BMS and automatic valve closures, are automatically set in motion.</li><li>- Opening of the valve happens slowly in incremental “ticking” stages.</li><li>- Up to one-hundred (100) wireless devices can be added to a single system.</li><li>- Up to twenty-six (26) autonomous zones are available within a single system.</li><li>- Single systems communicate with each other for scalability within a property.</li></ul>	
COMPONENT HARDWARE		
Communication Hub	Description	The primary function of the device is to coordinate incoming signals from system devices and facilitate actions accordingly. Each Communication HUB accommodates up to 100 Wireless Devices distributed, as applicable, across a maximum of 26 autonomous Zones.
	Wireless Range	Up to 900 feet in nominal conditions.
	Internet Connectivity	Connectivity to internet router via RJ45 connection located inside the Valve Interface Panel (VIP).
	Power Requirements	Component Power Adapter Input: 100V – 240V 50/60Hz Component Power Adapter Output: DC 5V @ 1A max
Wireless Relay And Switch	Description	The primary function of the device is enabling wireless operation of equipment wired to it. This device operates as a control module for standard equipment, but is capable of managing any third party device that meets the input/output criteria.
	Wireless Range	Up to 900 feet in nominal conditions.
	Power Requirements	Component Power Adapter Input: 100V – 240V 50/60Hz Component Power Adapter Output: DC 5V @ 1A max
Wireless Water And Temperature Sensor	Description	The primary function of the device is to detect the physical presence of water or when the ambient temperature drops below the standard threshold. When water is detected or the standard temperature threshold is reached, the regular operation of this device is to sound an audible alarm in the device itself, and alarm the System Zone it is assigned to.
	Wireless Range	Up to 900 feet in nominal conditions.
	Power Requirements	Component Power Adapter Input: 100V – 240V 50/60Hz Component Power Adapter Output: DC 5V @ 1A max Battery Power: Two (2) standard Double A (AA) batteries
Wireless Signal Repeater	Description	The primary function of the device is to extend the coverage area between the Communication HUB and end devices. The secondary function of the device is to detect the physical presence of water or when the ambient temperature drops below the standard threshold. When water is detected or the standard temperature threshold is reached, the regular operation of the RP Device is to sound an audible alarm in the device itself, and alarm the System Zone it is assigned to.
	Wireless Range	Up to 900 feet in nominal conditions.
	Power Requirements	Component Power Adapter Input: 100V – 240V 50/60Hz Component Power Adapter Output: DC 5V @ 1A max Battery Backup: Two (2) standard Double A (AA) batteries
Wireless Remote	Description	The primary function of the device is to change the state of, or mute an alarm

LEAK DETECTION - FLOOR MONITOR SYSTEM FOR STEAM WATER HEATER AREA		
Control		for, the Zone it is assigned to. The secondary function of this device is to detect the physical presence of water or when the ambient temperature drops below the standard threshold. When water is detected or the standard temperature threshold is reached, the regular operation of this device is to sound an audible alarm in the device itself, and alarm the Zone it is assigned to.
	Wireless Range	Up to 900 feet in nominal conditions.
	Power Requirements	Component Power Adapter Input: 100V – 240V -50/60Hz Component Power Adapter Output: DC 5V @ 1A max Battery Backup: Two (2) standard Double A (AA) batteries
WIRELESS FREQUENCY	915MHz	
WIRED SENSORS	Stainless Steel and ABS Wired sensors placed at a ratio of one sensor per 100sqft with wires extended and connected to a wireless sensor. Test all sensor locations, wired and/or wireless.	
ACCESSORIES	Provide all manufacturers approved and recommended connectors, extension cables, junction boxes and tags to provide a complete, functional system	
WATER INLET AND OUTLET CONTROL SHUTOFF VALVES FLDV-101	<p>All Actuators are rated:</p> <ul style="list-style-type: none"> <li>• NEMA 6P</li> <li>• NEMA 7D</li> </ul> <p>All Valves are rated:</p> <ul style="list-style-type: none"> <li>• UPC</li> <li>• NSF/ANSI 61 – Annex G</li> <li>• No Lead</li> </ul> <p>Available valve sizes (<i>model numbers listed</i>) are:</p> <ul style="list-style-type: none"> <li>• ¾" – WVEZ3-T</li> <li>• 1" – WVFS3-T</li> <li>• 1½" – WVHS2-T</li> <li>• 2" – WVIS2-T</li> <li>• 3" – WVK5-T (WVKS(five)-T)</li> </ul> <p>316 Stainless Steel Full Port Ball Valve Lead Free Brass Standard Port Ball Valve Manual Handle for Emergency Override WV Series, Electrically Actuated Valves Run control wiring from wireless relay to each Water Valve location, maximum distance between Water Valve and wireless relay is 100'.</p>	
REMOTE ALARM	BMS or Security systems interface via dry contacts	
ELECTRICAL	<p>Wireless Component with Battery: Two (2) standard Double A (AA) batteries Wireless Component Power Adapter Input: 100V – 240V -50/60Hz Wireless Component Power Adapter Output: DC 5V @ 1A max Water Valve Power Adapter Input: 100V – 240V @ 1.5A Water Valve Power Adapter Output: 15V @ 3A max</p>	
BASIS OF DESIGN	PipeBurst Pro 4 series VP415-CP), app.ionleaks.com, SK220B wired sensors, WT400 wireless sensors, Series WV Electrically Actuated Valves, ( <i>see above for WV model numbers.</i> )	

## 2.5 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.
- C. Water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 for retesting and re-inspecting requirements and Division 01 for requirements for correcting the Work.

- D. Prepare test and inspection reports.

### PART 3 - EXECUTION

#### 3.1 INDEX OF FUEL FIRED WATER HEATERS-

Equipment Tag	Type	Application	Tank size range
Refer to Schedule Sheet	Gas Fired Condensing with Tank	Multi-Residential or Commercial mid-range to large load profile	100 to 300 gallons Multipurpose
Refer to Schedule Sheet	Gas Fired Condensing Very Large Application	Extensive Load, Small Storage, Large Recovery	100 to 300 gallons
Refer to Schedule Sheet	Gas Fired Condensing Tankless	Instantaneous Residential Style	none
Refer to Schedule Sheet	Residential Gas Fired Storage Water Heater	Standard Atmospheric Gas fired Residential Style Water Heater	10 - 66 gallons

#### 3.2 WATER HEATER INSTALLATION

- A. Commercial, Water Heater Mounting: Install commercial water heaters on concrete base. Comply with requirements for concrete base specified in Division 03.
- Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
  - Maintain manufacturer's recommended clearances.
  - Arrange units so controls and devices that require servicing are accessible.
  - Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - Install anchor bolts to elevations required for proper attachment to supported equipment.
  - Anchor water heaters to substrate.
- B. Residential, Water Heater Mounting: Install residential water heaters on floor.
- Maintain manufacturer's recommended clearances.
  - Arrange units so controls and devices that require servicing are accessible.
  - Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - Install anchor bolts to elevations required for proper attachment to supported equipment.
  - Anchor water heaters to substrate.
- C. Tankless, Water Heater Mounting: Install tankless, water heaters at least 18 inches above floor on wall bracket.

1. Maintain manufacturer's recommended clearances.
  2. Arrange units so controls and devices that require servicing are accessible.
  3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  4. Install anchor bolts to elevations required for proper attachment to supported equipment.
  5. Anchor water heaters to substrate.
- D. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on water-supply piping to water heaters and on hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22. Install gas-fired, water heaters according to NFPA 54.
  2. Install gas shutoff valves on gas supply piping to gas-fired, water heaters without shutoff valves.
  3. Install gas pressure regulators on gas supplies to gas-fired, water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
  4. Install automatic gas valves on gas supplies to gas-fired, water heaters if required for operation of safety control.
  5. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Divisions 22 and 23.
- E. Install commercial water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Division 22.
- F. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- G. Install combination temperature-and-pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- H. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22.
- I. Install thermometer on outlet piping of water heaters. Comply with requirements for thermometers specified in Division 22.
- J. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Comply with requirements for valves specified in Division 22 and comply with requirements for thermometers specified in Division 22.

- K. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
- L. Fill water heaters with water.
- M. Charge water compression tanks with air.

### 3.3 CONNECTIONS

- A. Comply with requirements for water piping specified in Division 22.
- B. Comply with requirements for fuel-oil piping specified in Division 23.
- C. Comply with requirements for gas piping specified in Divisions 22 and 23.
- D. Drawings indicate general arrangement of piping, fittings, and specialties.
- E. Where installing piping adjacent to fuel-fired, water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of water heaters.

### 3.4 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Division 22.

### 3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
  - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 for retesting and re-inspecting requirements and Division 01 for requirements for correcting the Work.
- C. Prepare test and inspection reports.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, gas-fired, tankless commercial, gas- and oil-fired, water heaters.

END OF SECTION

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## **SECTION 224200 - COMMERCIAL PLUMBING FIXTURES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Plumbing Fixtures General
  - 2. Water Closets
  - 3. Water Closet Flushometer Valves
  - 4. Closet Toilet Seat
  - 5. Water Closet Supports
  - 6. Urinals
  - 7. Urinal Flushometer Valves
  - 8. Urinal Supports
  - 9. Lavatories
  - 10. Lavatory Support
  - 11. Lavatory Faucets
  - 12. Commercial Janitor Sinks
  - 13. Service Sink Faucets
  - 14. Utility Sinks
  - 15. Utility Sink Faucets
  - 16. Handwash Sinks
  - 17. Handwash Sink Supports
  - 18. Handwash Sink Faucets
  - 19. Showers
  - 20. Individual Shower Faucets for Single Shower
  - 21. Group Wall Mounted Showers
  - 22. Drinking Fountains stainless steel or vitreous china wall mount semi recessed

- 23. Supply Fittings
- 24. Risers
- 25. Source quality control
- 26. Grout

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
  - 1. Product Data for Prerequisites WE 1, Credit WE 2, and/or Credit WE 3: Documentation indicating flow and water consumption requirements.
  - 2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
  - 3. Product Data for Prerequisite WE 1 and/or Credit WE 2: Documentation indicating flow and water consumption requirements.
- C. Shop Drawings: Include diagrams for power, signal, and control wiring.

### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For all plumbing fixtures including faucets, fittings, valves, flushometer valves and electronic sensors to be included in operation and maintenance manuals.

### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no less than one of each type.

## PART 2 - PRODUCTS

### 2.1 PLUMBING FIXTURES - GENERAL

- A. Plumbing Fixtures Models are scheduled on the drawings, specifically on the plumbing drawing schedule sheet. Below are requirements that establish the level of quality.
- B. Quality
  - 1. Grade 1, type 1 plumbing fixtures only are acceptable.
- C. See Drawings for exact models and types.
- D. General



1. All plumbing fixtures shall be furnished from the same manufacturer for all commodity and china product castings. Specialties only may be furnished from exclusive manufacturers.
2. All fixtures shall comply with the latest water conservation standards.
3. Refer to Architectural and Plumbing Drawings for quantities, locations and mounting heights of fixtures provided under this Section.
4. Fixture trim, traps, faucets, escutcheons, and waste pipes exposed to view in finished spaces shall be IPS brass with chrome plating over nickel finish. Refer to schedules for specific applications, such as commercial kitchens, or institutional facilities, etc.
5. Vitreous china fixtures shall be regular selection fused and vitrified to produce homogeneous material with close grain without pores. Surfaces that contact walls, floors and other fixtures shall be set true.
6. Enameled surfaces on cast iron fixtures shall be of suitable thickness to provide the highest commercial grade. Exterior exposed surfaces not enameled shall be treated at factory with one coat of filler.
7. Affix manufacturer's guarantee label or trademark to fixture to indicate first quality. Acid-resisting enameled fixture shall bear manufacturer's symbol signifying resistance to acid.
8. Set fixtures with wall outlet flanges at proper distance from floors and walls with closet setting compound or gasket.
9. Vitreous china and enameled cast-iron fixtures shall be scheduled on the drawings unless specified otherwise.
  - a. Fixture colors: White, unless scheduled otherwise.

## 2.2 WATER CLOSETS

### A. Water Closets: Wall mounted, top spud.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. American Standard.
  - b. Eljer Company.
  - c. Kohler Co.
  - d. Sloan Valve Company.
  - e. TOTO USA, INC.
  - f. Zurn Industries LLC.
  - g. Or Approved Equal.
2. **Bowl:**
  - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
  - b. Material: Vitreous china.
  - c. Type: Siphon jet.

- d. Style: Flushometer valve.
- e. Height: Standard.
- f. Rim Contour: Elongated.
- g. Water Consumption: 1.28 gal. per flush.
- h. Water Consumption: 1.6 gal. for all private use water closets greater than 50 feet from a vertical stack
- i. Spud Size and Location: NPS 1-1/2; top.

## 2.3 WATER CLOSET FLUSHOMETER VALVES

### A. Lever-Handle, Flushometer Valves:

- 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. **Advanced Modern Technologies Corporation - AMTC.**
  - b. **Delany Products.**
  - c. **Sloan Valve Company.**
  - d. **Zurn Industries, LLC.**
  - e. Or Approved Equal.
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig.
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
  - a. Style: Exposed or concealed, as indicated on drawing schedules.
    - 1) Exposed Flushometer-Valve Finish: Chrome plated.
    - 2) For concealed valves - Panel Finish: Chrome plated or stainless steel.
  - b. Consumption: 1.28 gal. 1.6 gal. per flush for remote.
  - c. Minimum Inlet: NPS 1.
  - d. Minimum Outlet: NPS 1-1/4.

### B. Solenoid-Actuator, Flushometer Valves

- 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. **Delany Products.**
  - b. **Sloan Valve Company.**
  - c. **Zurn Industries, LLC.**
  - d. Or Approved Equal.
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig.

4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed or concealed as indicated on drawing schedules.
9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Trip Mechanism: see schedule: Battery-powered or Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. Consumption: Refer to drawing schedules.
12. Minimum Inlet: NPS 1.
13. Minimum Outlet: NPS 1-1/4.

#### 2.4 CLOSET TOILET SEAT:

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
1. **American Standard.**
    - a. Bemis Manufacturing Company.
    - b. Church Seats; Bemis Manufacturing Company.
    - c. Kohler Co.
    - d. Olsonite Seat Co.
    - e. TOTO USA, INC.
    - f. Zurn Industries, LLC.
    - g. Or Approved Equal.
  2. Standard: IAPMO/ANSI Z124.5.
  3. Material: Plastic.
  4. Type: Commercial (Heavy duty).
  5. Shape: Elongated rim, open front.
  6. Hinge: Self-sustaining, check.
  7. Hinge Material: Noncorroding metal.
  8. Seat Cover: Refer to drawing schedules.
  9. Color: Match fixture color, unless otherwise indicated on drawings.

#### 2.5 WATER CLOSET SUPPORTS

- A. Water Closet Carrier:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. Josam Company.
  - b. Smith Industries.
  - c. Wade Company.
  - d. Watts.
  - e. Zurn Industries, LLC.
  - f. Or Approved Equal.
2. Standard: ASME A112.6.1M.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
4. Water-Closet Mounting Height: Standard, Child, or Handicapped/elderly according to ICC/ANSI A117.1. See drawing schedules.

## 2.6 URINALS

### A. Urinals: Wall hung, back outlet, blowout.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. American Standard.
  - b. Eljer Inc.
  - c. Kohler Co.
  - d. Sloan Company.
  - e. TOTO of America.
  - f. Zurn Industries LLC
  - g. Or Approved Equal.
2. Fixture:
  - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
  - b. Material: Vitreous china.
  - c. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
  - d. Water Consumption: Water saving.
  - e. Spud Size and Location: NPS 1-1/4.
  - f. Outlet Size and Location: NPS 2; back.
  - g. Color: White.
3. Waste Fitting:
  - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.

- b. Size: NPS 2.
- 4. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.
- 5. Urinal Mounting Height: Standard Child Handicapped/elderly according to ICC A117.1.
- B. Urinals: Wall hung, back outlet, siphon jet, standard or accessible.
  - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. American Standard.
    - b. Kohler Co.
    - c. Sloan Company.
    - d. Zurn Industries, LLC.
    - e. Or Approved Equal.
  - 2. Fixture:
    - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
    - b. Material: Vitreous china.
    - c. Type: Siphon jet with extended shields.
    - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
    - e. Water Consumption: Water saving Low.
    - f. Spud Size and Location: NPS 3/4.
    - g. Outlet Size and Location: NPS 2; back.
    - h. Color: White.
  - 3. Waste Fitting:
    - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
    - b. Size: NPS 2.
  - 4. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.
  - 5. Urinal Mounting Height: Refer to drawing schedules.
- C. Urinals: Wall-hung, back outlet, washout, standard or accessible.
  - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. American Standard.
    - b. Kohler Co.
    - c. Sloan Company.
    - d. TOTO USA, INC.
    - e. Zurn Industries, LLC.
    - f. Or Approved Equal.

2. Fixture:
  - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
  - b. Material: Vitreous china.
  - c. Type: Washout with extended shields.
  - d. Strainer or Trap-way: Manufacturer's standard strainer with integral trap.
  - e. Water Consumption: Water saving Low.
  - f. Spud Size and Location: NPS 3/4.
  - g. Outlet Size and Location: NPS 2, back.
  - h. Color: White.
3. Waste Fitting:
  - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
  - b. Size: NPS 2.
4. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.
5. Urinal Mounting Height: Refer to drawing schedules.

## 2.7 URINAL FLUSHOMETER VALVES

- A. Styles: Refer to drawing schedules for model types.
- B. Lever-Handle, Flushometer Valves:
  1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. Delany Products.
    - b. Sloan Valve Company.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASSE 1037.
  3. Minimum Pressure Rating: 125 psig.
  4. Features: Include integral check stop and backflow-prevention device.
  5. Material: Brass body with corrosion-resistant components.
  6. Exposed Flushometer-Valve Finish: Chrome plated.
  7. Panel Finish: Chrome plated or stainless steel.
  8. Style: Refer to drawing schedules.
  9. Consumption: Refer to drawing schedules.
  10. Minimum Inlet: Refer to drawing schedules.
  11. Minimum Outlet: Refer to drawing schedules.
- C. Hard-Wired, Solenoid-Actuator, Flushometer Valves:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. Sloan Valve Company.
    - b. TOTO USA, INC.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Standard: ASSE 1037.
  3. Minimum Pressure Rating: 125 psig.
  4. Features: Include integral check stop and backflow-prevention device.
  5. Material: Brass body with corrosion-resistant components.
  6. Exposed Flushometer-Valve Finish: Chrome plated.
  7. Panel Finish: Chrome plated or stainless steel.
  8. Style: Refer to drawing schedules.
  9. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
  10. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
  11. Consumption: Refer to drawing schedules.
  12. Minimum Inlet: Refer to drawing schedules.
  13. Minimum Outlet: Refer to drawing schedules.
- D. Battery-Powered, Solenoid-Actuator, Flushometer Valves:
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. American Standard.
    - b. Delany Products.
    - c. Kohler Co.
    - d. Sloan Valve Company.
    - e. TOTO USA, INC.
    - f. Zurn Industries, LLC.
    - g. Or Approved Equal.
  2. Standard: ASSE 1037.
  3. Minimum Pressure Rating: 125 psig.
  4. Features: Include integral check stop and backflow-prevention device.
  5. Material: Brass body with corrosion-resistant components.
  6. Exposed Flushometer-Valve Finish: Chrome plated.

7. Panel Finish: Chrome plated or stainless steel.
8. Style: Refer to drawing schedules.
9. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
11. Consumption: Refer to drawing schedules.
12. Minimum Inlet: Refer to drawing schedules.
13. Minimum Outlet: Refer to drawing schedules.

## 2.8 URINAL SUPPORTS

### A. Urinal Carriers:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. Jay R. Smith Mfg. Co; a division of Morris Group International.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Wade Drains.
  - e. WATTS.
  - f. Zurn Industries, LLC.
  - g. Or Approved Equal.
2. Standard: ASME A112.6.1M.

## 2.9 LAVATORIES

### A. Lavatory: Oval, Vitreous China, Undercounter Mounted.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. American Standard.
  - b. Kohler Co.
  - c. Sloan Valve Company.
  - d. TOTO USA, INC.
  - e. Zurn Industries, LLC.
  - f. Or Approved Equal.
2. Fixture:
  - a. Standard: ASME A112.19.2/CSA B45.1.
  - b. Type: For undercounter mounting.



- c. Nominal Size: Refer to drawing plans and schedules.
    - d. Faucet-Hole Punching: No holes.
    - e. Faucet-Hole Location: On countertop.
    - f. Mounting Material: Sealant and undercounter mounting kit.
  - 3. Faucet: scheduled.
- B. Lavatory: Rectangular, Vitreous China, Wall Mounted.
- 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. American Standard.
    - b. Kohler Co.
    - c. Sloan Valve Company.
    - d. TOTO.
    - e. Zurn Industries, LLC.
    - f. Or Approved Equal.
  - 2. Fixture:
    - a. Standard: ASME A112.19.1/CSA B45.2.
    - b. Type: Straight-front apron with straight back.
    - c. Nominal Size: Rectangular, Scheduled
    - d. Faucet-Hole Punching: scheduled.
    - e. Faucet-Hole Location: Top.
    - f. Mounting Material: Wall bracket.
  - 3. Faucet: Refer to drawing schedules.
- C. Lavatory: Wheelchair, Vitreous China, Wall Mounted.
- 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. American Standard.
    - b. Kohler Co.
    - c. Sloan Valve Company.
    - d. TOTO of America.
    - e. Zurn Industries, LLC.
    - f. Or Approved Equal.
  - 2. Fixture:
    - a. Standard: ASME A112.19.2/CSA B45.1.
    - b. Type: Slab or wheelchair.
    - c. Nominal Size: Rectangular, 27 by 20 inches.

- d. Faucet-Hole Punching: Three holes, centers. Coordinate with scheduled faucet
  - e. Faucet-Hole Location: Top.
  - f. Mounting: For concealed-arm carrier.
3. Faucet: Refer to drawing schedules.

2.10 LAVATORY SUPPORT:

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
- 1. Jay R. Smith Mfg. Co; a division of Morris Group International.
  - 2. Josam Company.
  - 3. MIFAB, Inc.
  - 4. Wade Drains.
  - 5. WATTS.
  - 6. Zurn Industries, LLC.
  - 7. Or Approved Equal.
- B. Standard: ASME A112.6.1M.
- C. Lavatory Mounting Height: Refer to schedules.
- 1. Standard Child or Handicapped/elderly according to ICC A117.1.

2.11 LAVATORY FAUCETS:

- A. Manual-type, Mixing, commercial, solid-brass valve.
- 1. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.
    - a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - b. American Standard.
    - c. Chicago Faucets; Geberit Company.
    - d. GROHE America, Inc.
    - e. Kohler Co.
    - f. Speakman Company.
    - g. T&S Brass and Bronze Works, Inc.
    - h. Zurn Industries, LLC.
    - i. Or Approved Equal.
  - 2. Standard: ASME A112.18.1/CSA B125.1.
  - 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole penetrations; coordinate outlet with spout and fixture receptor.
  - 4. Body Type: Refer to schedules for centerset, widespread or single hole.

5. Body Material: Commercial, solid brass.
  6. Finish: Polished chrome plate.
  7. Maximum Flow Rate: Refer to drawing schedules.
  8. Maximum Flow: Refer to drawing schedules for metering cycle.
  9. Mounting Type, Valve Handle(s), Spout, Spout Outlet, Operation - scheduled.
  10. Drain: Grid.
- B. Lavatory Faucets: Automatic-type, electronic-sensor-operated, solid-brass valve. Refer to drawing schedules for hard-wired, battery, or solar power option.
1. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.
  2. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. American Standard.
    - b. Bradley Corporation.
    - c. Chicago Faucets; Geberit Company.
    - d. GROHE America, Inc.
    - e. Kohler Co.
    - f. Sloan Valve Company.
    - g. Speakman Company.
    - h. T&S Brass and Bronze Works, Inc.
    - i. TOTO USA, INC.
    - j. Zurn Industries, LLC.
    - k. Or Approved Equal.
  3. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
  4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  5. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
  6. Body Type: Refer to drawing schedules.
  7. Body Material: Commercial, solid brass.
  8. Finish: Polished chrome plate.
  9. Maximum Flow Rate: 0.5 gpm.
  10. Mounting Type, Valve Handle(s), Spout, Spout Outlet, Operation: As scheduled.
  11. Drain: Grid. Finish same as faucet.
- C. Laminar-Flow, Faucet-Spout Outlets

1. NSF Standard: Comply with NSF 372 for faucet-spout-outlet materials that will be in contact with potable water.
2. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. AM Conservation Group, Inc.
  - b. Chronomite Laboratories, Inc; a division of Morris Group International.
  - c. NEOPERL, Inc.
  - d. T&S Brass and Bronze Works, Inc.
  - e. Or Approved Equal.
3. **Description:** Chrome-plated-brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

## 2.12 COMMERCIAL JANITOR SINKS

### A. Service Basins: Terrazzo, floor mounted.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. Acorn Engineering Company; a Division of Morris Group International.
  - b. Florestone Products Co., Inc.
  - c. Stern-Williams Co., Inc.
  - d. Or Approved Equal.
2. **Fixture:**
  - a. Standard: IAPMO PS 99.
  - b. Tiling Flange: On three sides.
  - c. Rim Guard: On all top surfaces.
  - d. Color: Not applicable.
  - e. Drain: Grid with NPS 3 outlet.
3. **Mounting:** On floor and flush to wall.

### B. Service Sinks: Enameled, cast iron, trap standard mounted.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. American Standard.
  - b. Commercial Enameling Company.
  - c. Kohler Co.
  - d. Zurn Industries, LLC.
  - e. Or Approved Equal.
2. **Fixture:**

- a. Standard: ASME A112.19.1/CSA B45.2.
    - b. Type: Service sink with back.
    - c. Nominal Size: Refer to drawing schedules.
    - d. Color: White.
    - e. Mounting: NPS 3 P-trap standard with grid strainer inlet, cleanout, and floor flange.
    - f. Rim Guard: On front and sides.
  3. Support: sink carrier.
- C. Service Sinks: Enameled, cast iron, floor mounted.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. American Standard.
    - b. Kohler.
    - c. Zurn Industries, LLC.
    - d. Or Approved Equal.
  2. Fixture:
    - a. Standard: ASME A112.19.1/CSA B45.2.
    - b. Style: With front apron and raised back.
    - c. Nominal Size: 28 by 28 inches.
    - d. Color: White.
    - e. Drain: Grid with NPS 3 outlet.
    - f. Rim Guard: Coated wire.

2.13 SERVICE SINK FAUCETS:

- A. Manual type, two lever handle mixing valve.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. American Standard.
    - b. Bradley Corporation.
    - c. Chicago Faucets; Geberit Company.
    - d. Kohler Co.
    - e. Sloan Valve Company.
    - f. Speakman Company.
    - g. T&S Brass and Bronze Works, Inc.
    - h. Zurn Industries, LLC.
    - i. Or Approved Equal.

2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets
  - a. Coordinate with supplies and fixture hole penetrations
  - b. coordinate outlet with spout and sink receptor.
4. Body Type: Widespread.
5. Body Material: Commercial, solid brass.
6. Finish: Chrome plated.
7. Maximum Flow Rate: 4.0 gpm.
8. Handle(s): Refer to drawing schedules.
9. Mounting Type: Refer to drawing schedules.
10. Spout Type: Rigid, solid brass with wall brace and pail hook.
11. Vacuum Breaker: Required for hose outlet.
12. Spout Outlet: Hose thread according to ASME B1.20.7. furnish and install hose.
13. Mop service hanger furnish and install.

## 2.14 UTILITY SINKS

### A. Utility Sinks: Stainless steel, counter mounted.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. Advance Tabco.
  - b. Eagle Group.
  - c. Elkay Manufacturing Co.
  - d. Griffin Products, Inc.
  - e. Just Manufacturing.
  - f. Or Approved Equal.
2. Fixture:
  - a. Standard: ASME A112.19.3/CSA B45.4.
  - b. Type: Ledge back.
  - c. Number of Compartments: Refer to drawing schedules.
  - d. Metal Thickness: 0.050 inch.
  - e. Drains: Grid with NPS 1-1/2 tailpiece and twist drain.
3. Faucet(s): Refer to drawing schedules.
4. Supply Fittings:
  - a. Standard: ASME A112.18.1/CSA B125.1.
  - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.

- 1) Operation: Wheel handle.
    - 2) Risers: NPS 1/2, ASME A112.18.6, braided or corrugated stainless-steel flexible hose.
  5. Waste Fittings:
    - a. Standard: ASME A112.18.2/CSA B125.2.
      - 1) Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.
    - b. Continuous Waste:
      - 1) Material: Chrome-plated, 0.032-inch-thick brass tube.
  6. Mounting: On counter kit with sealant.
- B. Utility Sinks: Stainless steel, freestanding.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. Advance Tabco.
    - b. AERO Manufacturing Company.
    - c. Amtekco Industries, Inc; a Wasserstrom Company.
    - d. Eagle Group.
    - e. Elkay Manufacturing Co.
    - f. Griffin Products, Inc.
    - g. Just Manufacturing.
    - h. Or Approved Equal.
  2. Fixture:
    - a. Standard: ASME A112.19.3/CSA B45.4.
    - b. Type: With backsplash.
    - c. Number of Compartments: scheduled.
    - d. Overall Dimensions: . scheduled.
    - e. Metal Thickness: 0.063 inch.
    - f. Compartments:
      - 1) Drain: Grid with NPS 2 tailpiece and twist drain.
      - 2) Drain Location: Near back of compartment.
    - g. Number of Compartments: scheduled:
    - h. Drainboard(s): Refer to drawing plans and schedules.
      - 1) Dimensions Each: Refer to drawing schedules.
  3. Supports: Adjustable-length steel legs.
  4. Faucet(s): Refer to drawing schedules.

- a. Number Required: One for single compartment. Two for multiple compartment.
- b. Mounting: On backsplash.
- 5. Supply Fittings:
  - a. Standard: ASME A112.18.1/CSA B125.1.
  - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
    - 1) Operation: Wheel handle.
    - 2) Risers: NPS 1/2, ASME A112.18.6, braided or corrugated stainless-steel flexible hose.
- 6. Waste Fittings:
  - a. Standard: ASME A112.18.2/CSA B125.2.
  - b. Trap(s):
    - 1) Size: NPS 2.
    - 2) Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated brass or steel wall flange.
    - 3) Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.
  - c. Continuous Waste:
    - 1) Size: NPS 2.
    - 2) Material: Chrome-plated, 0.032-inch- thick brass tube.

## 2.15 UTILITY SINK FAUCETS

- A. NSF Standard: Comply with NSF 372 for faucet-spout materials that will be in contact with potable water.
- B. Sink Faucets: Manual type, mixing valve. Refer to drawing schedules.
- C. Commercial, Solid-Brass Faucets:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. American Standard.
    - b. Bradley Corporation.
    - c. Chicago Faucets; Geberit Company.
    - d. Just Manufacturing.
    - e. Kohler Co.
    - f. Sloan Valve Company.
    - g. Speakman Company.
    - h. T&S Brass and Bronze Works, Inc.



- i. Zurn Industries, LLC.
  - j. Or Approved Equal.
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Material: Commercial, solid brass.
5. Finish: Polished chrome plate.
6. Maximum Flow Rate: 2.2 gpm.
7. Handle(s): Wrist blade, 4 inches Elbow, or 6 inches. (see schedule)
8. Mounting Type: per sink opening
9. Spout Type: Swing, solid brass or Swivel gooseneck. (see schedule)
10. Vacuum Breaker: Refer to drawing schedules. Required for threaded outlet.
11. Spout Outlet: Aerator Laminar flow, Hose thread according to ASME B1.20.7, Plain end Spray (see schedule)

## 2.16 HANDWASH SINKS

### A. Handwash Sinks: Stainless steel, wall mounted.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - a. Advance Tabco.
  - b. AERO Manufacturing Company.
  - c. Amtekco Industries, Inc; a Wasserstrom Company.
  - d. Eagle Group.
  - e. Elkay Manufacturing Co.
  - f. Griffin Products, Inc.
  - g. Just Manufacturing.
  - h. Sloan Valve Company.
  - i. Or Approved Equal.
2. Fixture:
  - a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
  - b. Type: Basin with radius corners, back for faucet, and support brackets.
  - c. Nominal Size: 17 by 16 by 5 inches.
3. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
4. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
5. Support: Type II sink carrier.

6. Lavatory Mounting Height: Standard Child Handicapped/elderly according to ICC A117.1.

## 2.17 HANDWASH SINK SUPPORTS

- A. Type II Sink Carrier:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
  1. Jay R. Smith Mfg. Co.
  2. Josam Company.
  3. MIFAB, Inc.
  4. Wade Drains.
  5. WATTS
  6. Or Approved Equal.
- C. Standard: ASME A112.6.1M.

## 2.18 HANDWASH SINK FAUCETS

- A. Automatic, sensor-operated type, 120 V ac hard-wired or battery-powered. Refer to drawing schedules.
  1. Commercial, Solid-Brass Faucets:
    - a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
      - 1) American Standard.
      - 2) Bradley Corporation.
      - 3) Chicago Faucets; Geberit Company.
      - 4) Elkay Manufacturing Co.
      - 5) GROHE America, Inc.
      - 6) Just Manufacturing.
      - 7) Kohler Co.
      - 8) Sloan Valve Company.
      - 9) Speakman Company.
      - 10) T&S Brass and Bronze Works, Inc.
      - 11) Zurn Industries, LLC.
      - 12) Or Approved Equal.
  2. Standard: ASME A112.18.1/CSA B125.1.
  3. General: Coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.

4. Body Type: Refer to drawing schedules.
5. Body Material: Commercial, solid brass.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 0.5 gpm.
8. Mounting Type: per sink opening
9. Spout Type: Rigid gooseneck or as scheduled on drawings.
10. Spout Outlet: Aerator.
11. Thermostatic Mixing Valve: Use ASSE 1070 point-of-use thermostatic mixing valve. Refer to drawing schedules.
12. Control module: Water-resistant module with internal flow setting switches.

## 2.19 SHOWERS

### A. Shower Basins

1. Cast-Polymer Shower Basins:
  - a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - 1) Crane Plumbing, L.L.C.
    - 2) Florestone Products Co., Inc.
    - 3) Inpro Corporation.
    - 4) Or Approved Equal.
2. FRP Shower Basins:
  - a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - 1) Crane Plumbing, L.L.C.
    - 2) Florestone Products Co., Inc.
    - 3) LASCO Bathware.
    - 4) MAAX.
    - 5) Sterling.
    - 6) Swan Corporation (The).
    - 7) Or Approved Equal.
3. PMMA (Acrylic) Shower Basins:
  - a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - 1) American Standard.
    - 2) Crane Plumbing, L.L.C.
    - 3) Florestone Products Co., Inc.

- 4) Jason International, Inc.
  - 5) Kohler Co.
  - 6) LASCO Bathware.
  - 7) MAAX.
  - 8) Royal Baths Manufacturing Co.
  - 9) Or Approved Equal.
4. Precast-Terrazzo Shower Basins:
- a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - 1) Acorn Engineering Company; a Division of Morris Group International.
    - 2) Crane Plumbing, L.L.C.
    - 3) Florestone Products Co., Inc.
    - 4) Stern-Williams Co., Inc.
    - 5) Or Approved Equal.
5. Solid-Surface Shower Basins:
- a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - 1) American Standard.
    - 2) Swan Corporation (The).
    - 3) Tower Industries.
    - 4) Or Approved Equal.
6. General:
- a. Cast-polymer FRP PMMA Precast-terrazzo or Solid-surface base for built-up-type shower fixture. See schedule sheet for designation and type for each shower area.
  - b. Control: Thermostatic valve with individual hot- and cold-water mixing-valve operation.
  - c. Flow-Control Fitting: 2.0 gpm shower head maximum.
  - d. EPA WaterSense: Required.
  - e. Liquid Soap Dispenser: Required for each shower head.
  - f. Soap Dish: Required for each shower head.
  - g. Standard: ANSI Z124.1.3 for cast-polymer FRPPMMA bases.
  - h. Standard: IAPMO PS 99 for precast-terrazzo material.
  - i. Standard: ANSI/ICPA SS-1 for solid-surface material.
  - j. Type: Handicapped/wheelchair.
  - k. Nominal Size and Shape: Refer to drawing schedules.
  - l. Color: White, unless schedules otherwise.

- m. Outlet: Drain with NPS 2 outlet.
- n. Bathing Surface: Slip resistant according to ASTM F462.

2.20 INDIVIDUAL SHOWER FAUCETS FOR SINGLE SHOWER:

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - 1. Acorn Engineering Company; a Division of Morris Group International.
  - 2. Chicago Faucets; Geberit Company.
  - 3. Lawler Manufacturing Company, Inc.
  - 4. Leonard Valve Company.
  - 5. POWERS; A WATTS Brand.
  - 6. Or Approved Equal.
- B. **Description:** Single-handle, thermostatic mixing valve with hot- and cold-water indicators; check stops; and shower head.
- C. **Faucet:**
  - 1. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
  - 2. Body Material: Solid brass.
  - 3. Finish: Polished chrome plate.
    - a. Shower-Arm, Flow-Control Fitting: 2.0 gpm.
  - 4. EPA WaterSense: Required.
  - 5. Mounting: Concealed.
  - 6. Operation: Single-handle control. Refer to drawing schedules.
  - 7. Antiscald Device: Integral with mixing valve.
  - 8. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
  - 9. Supply Connections: NPS 1/2.
- D. **Shower Head:**
  - 1. Standard: ASME A112.18.1/CSA B125.1.
  - 2. Type: scheduled.
  - 3. Shower Head Material: Metallic with chrome-plated finish.
  - 4. Spray Pattern: Adjustable.
  - 5. Integral Volume Control: Required.
  - 6. Shower-Arm, Flow-Control Fitting: 2.0 gpm maximum.
- E. **Temperature Indicator:** Integral with faucet.

2.21 GROUP WALL-MOUNTED SHOWERS:

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
  - 1. Acorn Engineering Company; a Division of Morris Group International.
  - 2. Bradley Corporation.
  - 3. Willoughby Industries.
  - 4. Zurn Industries, LLC.
  - 5. Or Approved Equal.
- B. **Description:** Stainless-steel, wall-mounted, surface-enclosure shower fixture with individual nozzles.
- C. **Standards:** ASME A112.18.1/CSA B125.1 and ASSE 1016.
- D. **Metal Nominal Thickness:** 0.063 inch.
- E. **Number of Shower Nozzles:** Refer to plans and drawing schedules.
- F. **Height to Nozzles:** Refer to drawing plans, elevations, and schedules.
- G. **Control:** Thermostatic valve with individual hot- and cold-water mixing-valve operation.
- H. **Flow-Control Fitting:** 2.0 gpm maximum for each shower head.
- I. **EPA WaterSense:** Required.
- J. **Liquid Soap Dispenser:** Required for each shower head.
- K. **Soap Dish:** Required for each shower head.
- L. **Mounting:** Wall bracket.
- M. **Supplies:** NPS 3/4 copper tubing with valves.

2.22 DRINKING FOUNTAINS: STAINLESS STEEL AND VITREOUS CHINA, WALL MOUNTED, SEMIRECESSED.

- A. **Stainless-Steel Drinking Fountains:**
  - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:
    - a. Elkay
    - b. Filtrine
    - c. Halsey Taylor
    - d. Haws
    - e. Oasis
    - f. Or Approved Equal.
- B. **Vitreous-China Drinking Fountains:**
  - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equal:

- a. Kohler
  - b. American Standard
  - c. Eljer
  - d. Crane
  - e. Or Approved Equal.
- C. Standards:
- 1. ASME A112.19.3/CSA B45.4.
  - 2. ASME A112.19.2/CSA B45.1.
  - 3. NSF 61 and NSF 372.
  - 4. ICC A117.1.
- D. Receptor Shape: Concave with projecting bowl.
- E. Bubbler: One, with adjustable stream regulator, located on deck.
- F. Maximum Water Flow: 0.15 gpm.
- G. Control: Refer to drawing schedules.
- H. Drain: Grid type with NPS 1-1/4 tailpiece.
- I. Supply: NPS 3/8 with shutoff valve.
- J. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
- K. Support: Mounting frame or brackets for attaching to wood blocking or substrate.

## 2.23 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 61 Annex G or NSF 372 or NSF 372 (NSF 372), "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type, or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.

## 2.24 RISERS

- A. NPS 1/2 chrome-plated, soft-copper flexible tube or ASME A112.18.6, braided or corrugated stainless-steel, flexible hose waste fittings.
- B. Standard: ASME A112.18.2/CSA B125.2.
- C. Drain: Grid with NPS 1-1/2 DN 40 tailpiece.
- D. Trap:
  - 1. Size: NPS 1-1/2.

2. Note: All trap trim shall match the finish selected by the Architect. See architectural requirements for finished material.
3. Material: two-piece, cast-brass trap, and swivel elbow with 0.032-inch- thick brass tube to wall; and finish -plated brass or steel wall flange.
4. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- thick stainless-steel tube to wall; and stainless-steel wall flange.
  - a. Supply Connections: For hot and cold water.

#### 2.25 SOURCE QUALITY CONTROL

- A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

#### 2.26 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine walls and floors for suitable conditions where closet plumbing fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

#### 3.3 WATER-CLOSET INSTALLATION:

- A. Install level and plumb according to roughing-in drawings.
- B. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
- C. Install toilet seats on water closets.

#### 3.4 URINAL INSTALLATION:

- A. Install urinals level and plumb according to roughing-in drawings.
- B. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.



- C. Install Wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
- D. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
- E. Install trap-seal liquid in waterless urinals.

### 3.5 LAVATORY INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Division 22.
- E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07.
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Division 22 for plumbing piping insulation.

### 3.6 SINK INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
  - 1. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Division 22.
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07.
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Division 22 for plumbing piping insulation.

### 3.7 SHOWER INSTALLATION

- A. Assemble shower components according to manufacturers' written instructions.
- B. Install showers level and plumb according to roughing-in drawings.
- C. Install water-supply piping with stop on each supply to each shower faucet.

1. Exception: Use ball or gate valves if supply stops are not specified with shower.
  2. Install stops in locations where they can be easily reached for operation.
- D. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- E. Set shower receptors and shower basins in leveling bed of cement grout.

### 3.8 WASH-FOUNTAIN INSTALLATION

- A. Install wash fountains level and plumb according to roughing-in drawings.
- B. Set freestanding wash fountains on floor.
- C. Install off-floor carrier supports, affixed to building substrate, for wall-mounted wash fountains.
- D. Install accessible, wall-mounted wash fountains at mounting height for handicapped/elderly according to ICC A117.1.
- E. Install water-supply piping with shutoff valve on each supply to each wash fountain to be connected to domestic-water distribution piping.
- F. Use ball or gate valve. Install valves in locations where they can be easily reached for operation.
- G. Install trap and waste piping on each drain outlet of each wash fountain to be connected to sanitary drainage system.
- H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07.

### 3.9 SUPPORT INSTALLATION:

- A. Install supports, affixed to building substrate, for wall-hung urinals.
- B. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
- C. Use carriers without waste fitting for urinals with tubular waste piping.
- D. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
- E. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
- F. Use carrier supports with waste-fitting assembly and seal.
- G. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
- H. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

### 3.10 DRINKING FOUNTAIN INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Set pedestal drinking fountains on the floor.
- C. Install recessed drinking fountains secured to wood blocking in wall construction.
- D. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

- E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation.

### 3.11 SHOWER INSTALLATION

- A. Assemble shower components according to manufacturers' written instructions.
- B. Install showers level and plumb according to roughing-in drawings.
- C. Install water-supply piping with stop on each supply to each shower faucet.
  - 1. Install stops in locations where they can be easily reached for operation.
- D. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- E. Set shower receptors and shower basins in leveling bed of cement grout.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Division 22.
- G. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07.

### 3.12 FLUSHOMETER-VALVE INSTALLATION:

- A. Install flushometer-valve, water-supply fitting on each supply to each water closet.
- B. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
- C. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
- D. Install actuators in locations that are easy for people with disabilities to reach.
- E. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

### 3.13 WALL FLANGE AND ESCUTCHEON INSTALLATION:

- A. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
- B. Install deep-pattern escutcheons if required to conceal protruding fittings.
- C. Comply with escutcheon requirements specified in Division 22.

### 3.14 JOINT SEALING:

- A. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
- B. Match sealant color to water-closet color.
- C. Comply with sealant requirements specified in Division 07.
- D. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Division 22.

- E. Fill self-contained fixtures with flushing fluid.

### 3.15 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Where installing piping adjacent to water closets allow space for service and maintenance.

### 3.16 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- C. Adjust water pressure at flushometer valves to produce proper flow.
- D. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

### 3.17 CLEANING AND PROTECTION

- A. Clean all plumbing fixtures and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for fixtures and fittings.
- C. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by the Owner.
- D. Verify all fixtures are clear of debris and clogs and all aerators are clean after cleaning.

END OF SECTION

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## SECTION 224500 - EMERGENCY PLUMBING FIXTURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Standard Wall Mount Eye/face Wash Unit.
  - 2. Accessible Wall Mount Eye/face Wash Unit.
  - 3. Barrier Free Recessed Wall Mount Combination Unit
  - 4. Water Tempering Equipment
  - 5. High Temperature Reject Valves
  - 6. Source Quality Control.

#### 1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
- D. Tepid: Moderately warm.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.

- B. Field quality-control test reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. Flushing-Fluid Solution: Separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

#### 1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- C. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
- D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. For all identification, part, or tag numbers see the schedule sheet for Division 22.
- B. For all electrical requirements see schedule.
- C. State Plumbing code requirements for flow, pressure and temperature shall be followed for all installations.
- D. Finishes: Match finishes defined by Architect for each location unless otherwise stipulated in this section.

#### 2.2 STANDARD, WALL-MOUNTED, EYE/FACE WASH UNITS

- A. Plumbed Eyewash Only
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Acorn Safety.
    - b. Guardian Equipment Co.

- c. Haws Corporation.
  - d. Speakman Company.
  - e. Water Saver Faucet Co.
  - f. Or Approved Equal.
- 2. Capacity: Not less than 3.0 gpm for at least 15 minutes.
- 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
- 4. Furnish flip top dust cover, internal flow controls and filter.
- 5. Control-Valve Actuator: Paddle.
- 6. Spray-Head Assembly: Two or four receptor-mounted spray heads.
- 7. Receptor: stainless-steel bowl.
- 8. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.
- 9. Mounting: Wall bracket.
- 10. Basis of Design
  - a. Stainless Steel: Guardian G-1724

## **2.3 ACCESSIBLE, WALL-MOUNTED, PLUMBED, EYE/FACE WASH UNITS**

### **A. Plumbed Eyewash Only**

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Acorn Safety.
  - b. Guardian Equipment Co.
  - c. Haws Corporation.
  - d. Speakman Company.
  - e. Water Saver Faucet Co.
  - f. Or Approved Equal.
- 2. Capacity: Not less than 3.0 gpm for at least 15 minutes.
- 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
- 4. Control-Valve Actuator: Paddle.

5. Spray-Head Assembly: Four receptor-mounted spray heads.
6. Furnish flip top dust cover, internal flow controls and filter.
7. Receptor: stainless-steel bowl.
8. Mounting: Wall bracket.
9. Special Construction: Comply with ICC/ANSI A117.1.
10. Basis of Design
  - a. Stainless Steel: Guardian

**2.4 BARRIER FREE, RECESSED, WALL MOUNTED COMBINATION**

**A. Eye/face wash and shower safety station with ceiling mounted exposed shower head,**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Acorn Safety.
  - b. Guardian Equipment Co.
  - c. Haws Corporation.
  - d. Speakman Company.
  - e. Water Saver Faucet Co.
  - f. Or Approved Equal.
2. ADA Compliance:
  - a. When installed at recommended mounting heights, unit complies with ADA requirements for accessibility by handicapped persons.
3. Piping:
  - a. Material: Exposed pipe and escutcheon are brushed stainless steel.
  - b. Unit Supply: NPS 1-1/4
  - c. Unit Drain: Outlet at bottom.
4. Shower:
  - a. Capacity: Not less than 20 gpm
  - b. Supply Piping: NPS with flow regulator and stay-open control valve.
  - c. Provide flow restrictor on each shower head, Guardian FC-20
  - d. Control-Valve Actuator: Panic bar actuator
  - e. Shower Head: 10-inch stainless steel.
5. Eye/Face Wash Unit:



- a. Capacity: Not less than 3 gpm for at least 15 minutes.
- b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
- c. Control-Valve Actuator: 1/2-inch IPS brass plug-type valve with O-ring seals. Furnished with in-line strainer to protect valve from debris and foreign matter.
- d. Spray-Head Assembly: Two receptor-mounted spray heads.
- e. Receptor: 16-gauge stainless steel combination cover and drain pan. Grasping "panic bar" handle and opening cover pulls spray head assembly down from vertical to horizontal position, activating water flow.
- f. Waste: 2-inch NPT female outlet
- g. Mounting: Recessed mounting in wall. Unit fits in standard 3-5/8 inch deep wall.
- h. Basis of Design
  - 1) Galvanized Steel Pipe with Plastic Head: Guardian GBF2150

## 2.5 WATER-TEMPERING EQUIPMENT

### A. Hot- and Cold-Water, Water-Tempering Equipment,:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal.
  - a. Guardian Equipment Co.
  - b. Haws Corporation.
  - c. Lawler Manufacturing Company, Inc.
  - d. Leonard Valve Company.
  - e. Powers.
  - f. Or Approved Equal.
- 2. Description: Factory-fabricated equipment with thermostatic mixing valve.
  - a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
  - b. Supply Connections: For hot and cold water.

### B. Electric Water-Tempering Equipment

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
  - a. Guardian
  - b. A.O. Smith
  - c. Lochinvar

- d. Chromolox.
  - e. Or Approved Equal.
2. Description: Factory-fabricated equipment with electric heating.
- a. Heating System: Electric, designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, heating coils, high-temperature-limit device, metal piping, and corrosion-resistant enclosure.
    - 1) Electrical Characteristics: see schedule sheet for voltage at single phase, 60 Hz.
  - b. Basis of Design: Guardian skid mounted system with tanks, heaters, recirculation pump, UV sterilizer, and Tempering Valve model number G-4110.

## 2.6 TEMPERATURE REJECT VALVE

- A. Install temperature safety dump valve where indicated. Allow rejected water to be discharged to safe location
- B. When installing the valve on the loop, use a tee and close coupler to the valve. Allow no more than 6D from main circulation line. The 6D is measured on the outlet tee diameter of the pipe (normally 3/4 inch, therefore about 4-1/2 inches.
- C. Manufacturers
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide temperature dump valve indicated as BOD below or a comparable product by one of the following or approved equal:
    - a. Basis of Design: ThermOmega HAT/SP
    - b. Kobold Instrument Co
    - c. Dwyer Instrument Co
- D. Valve:
  - 1. Therm-Omega HAT/SPanti scald device.
  - 2. Set point = 95 deg F.
  - 3. Comply with ANSI Z358.1 standards.
  - 4. Self-operating, no power or signal required.
  - 5. Provide temperature gauges on both the supply and return of the loop system.

## 2.7 •SOURCE QUALITY CONTROL

- A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.
  - 1. Exception: .

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION**

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Division 22.
  - 1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
  - 2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Division 22.
- F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Division 22.
- G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Division 22.
- H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Division 22.
- I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Division 22.
- J. Fill self-contained fixtures with flushing fluid.

### **3.3 CONNECTIONS**

- A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Division 22 for domestic water piping."

- B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Division 22 for domestic water piping.
- C. Connect steam and cold-water-supply and condensate return piping to steam and cold water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for cold-water piping specified in Division 22 for domestic water piping and comply with requirements for steam and condensate piping specified in Division 23.
- D. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Division 22 for domestic water piping."
- E. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Division 22.
- F. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.
- G. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

### 3.4 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Division 22.

### 3.5 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection.
  - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.6 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION

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## SECTION 224700 - WATER COOLERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- C. This project is required to achieve minimum LEED v4 NC BD+C Silver Certification. Refer to Sustainable Design Specification Section 018111, as well as Specification Section 017410 Construction Indoor Air Quality and Specification Section 017419 Construction Nonhazardous Waste Management Plan for requirements to achieve this certification.

#### 1.2 SUMMARY

- A. Section includes
  - 1. Pressure water coolers

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of remote water coolers.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
  - 1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
  - 2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Shop Drawings: Include diagrams for power, signal, and control wiring.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For remote water coolers to include in maintenance manuals.

## 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filter Cartridges: No fewer than two (2) of each.

## PART 2 - PRODUCTS

### 2.1 PRESSURE WATER COOLERS

- A. Pressure Water Coolers: EWC-1
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work, provide products by one of the following, or approved equal.
    - a. Oasis Coolers
    - b. Elkay Manufacturing Co.
    - c. Halsey Taylor.
    - d. Haws Corporation.
    - e. Or Approved Equal.
  - 2. Standards:
    - a. Comply with NSF 61 Annex G.
    - b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
  - 3. Cabinet: All stainless steel.
  - 4. Bubbler: One, with adjustable stream regulator, located on deck.
  - 5. Control: Push bar.
  - 6. Drain: Grid with NPS 1-1/4 tailpiece.
  - 7. Supply: NPS 3/8 with shutoff valve.
  - 8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
  - 9. Limited 5-year warranty
  - 10. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
  - 11. Cooling System: Electric, with **precooler**, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
    - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 12. Capacities and Characteristics:

- a. Cooled Water: 8 gph.
- b. Ambient-Air Temperature: 90 deg F.
- c. Inlet-Water Temperature: 80 deg F
- d. Cooled-Water Temperature: 50 deg F.
- e. Electrical Characteristics:
  - 1) Motor Horsepower: 390 watts.
  - 2) Volts: 120-V ac.
  - 3) Phase: Single.
  - 4) Hertz: 60.
  - 5) Full-Load Amperes:
  - 6) Minimum Circuit Ampacity: One (1)
- 13. Ventilation Grille: Stainless steel, located below water cooler.
- 14. Support: Mounting frame for attaching to substrate.
- 15. Basis of Design
  - a. Halsey Taylor Model: HTHBWF-OVLSER-1

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine roughing-in for water-supply and sanitary drainage piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where remote water coolers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Set freestanding pressure water coolers on floor.
- C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- D. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.
- E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation.
- F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.



- G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Division 22.
- H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.
- I. Install remote water coolers level and plumb according to roughing-in drawings.
- J. Install water-supply piping with shutoff valve on supply to each remote water cooler to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Set remote water coolers on floor unless otherwise indicated.
- K. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Division 22.

### 3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Division 22.
- C. Install ball or gate shutoff valve on water supply to each fixture. **Install valve upstream from filter for water cooler.**
- D. Comply with soil and waste piping requirements specified in Division 22.

### 3.4 ADJUSTING

- A. Adjust water-cooler temperature settings.
- B. Adjust fixture flow regulators for proper flow and stream height.
- C. Adjust pressure water-cooler temperature settings.

### 3.5 CLEANING

- A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.
- E. After installing remote water cooler, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

END OF SECTION

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**SECTION 230130.51 - HVAC AIR-DISTRIBUTION SYSTEM CLEANING-EXISTING  
SYSTEMS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section includes cleaning HVAC air-distribution equipment, ducts, plenums, and system components.

**1.3 DEFINITIONS**

- A. ASCS: Air systems cleaning specialist.
- B. NADCA: National Air Duct Cleaners Association.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For an ASCS.
- B. Strategies and procedures plan.
- C. Cleanliness verification report.

**1.5 QUALITY ASSURANCE**

- A. ASCS Qualifications: A certified member of NADCA.
  - 1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
  - 2. Supervisor Qualifications: Certified as an ASCS by NADCA.
- B. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.
- B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.
- C. Prepare written report listing conditions detrimental to performance of the Work.
- D. Proceed with work only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:
  - 1. Supervisor contact information.
  - 2. Work schedule including location, times, and impact on occupied areas.
  - 3. Methods and materials planned for each HVAC component type.
  - 4. Required support from other trades.
  - 5. Equipment and material storage requirements.
  - 6. Exhaust equipment setup locations.
- B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.
- C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

3.3 CLEANING

- A. Comply with NADCA ACR 2006.
- B. Remove visible surface contaminants and deposits from within the HVAC system.
- C. Systems and Components to Be Cleaned:
  - 1. Air devices for supply and return air.
  - 2. Air-terminal units.
  - 3. Ductwork:
    - a. Supply-air ducts, including turning vanes, to the air-handling unit.
    - b. Return-air ducts to the air-handling unit.
    - c. Exhaust-air ducts.
  - 4. Air-Handling Units:

- a. Interior surfaces of the unit casing.
  - b. Coil surfaces compartment.
  - c. Condensate drain pans.
  - d. Fans, fan blades, and fan housings.
5. Filters and filter housings.
- D. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
- E. Particulate Collection:
  1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
  2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
- F. Control odors and mist vapors during the cleaning and restoration process.
- G. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
- H. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.
- I. Clean all air-distribution devices, registers, grilles, and diffusers.
- J. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:
  1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
  2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
  3. Clean evaporator coils, reheat coils, and other airstream components.
- K. Duct Systems:
  1. Create service openings in the HVAC system as necessary to accommodate cleaning.
  2. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
- L. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.
- M. Mechanical Cleaning Methodology:
  1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning

method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.

- a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
  - b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.
2. Cleaning Mineral-Fiber Insulation Components:
- a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.
  - b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
  - c. Fibrous materials that become wet shall be discarded and replaced.

N. Coil Cleaning:

1. Measure static-pressure differential across each coil.
2. See NADCA ACR 2006, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing Coil Cleaning Verification (see applicable NADCA ACR 2006).
3. Coil drain pans shall be subject to NADCA ACR 2006, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
4. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
5. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations when available.
6. Rinse thoroughly with clean water to remove any latent residues.

O. Antimicrobial Agents and Coatings:

1. Apply antimicrobial agents and coatings if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
2. When used, antimicrobial treatments and coatings shall be applied after the system is rendered clean.
3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
4. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.

### 3.4 CLEANLINESS VERIFICATION

- A. Maintain ductwork in accordance with SMACNA "Duct Cleanliness for New Construction Guidelines." Maintain "Advanced Cleanliness Level" as defined in the guideline.
- B. Verify cleanliness according to NADCA ACR 2013, "Verification of HVAC System Cleanliness" Section.
- C. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.
- D. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to cleanliness testing identified in "Additional Verification" paragraph below.
- E. Verification of Coil Cleaning:
  - 1. Measure static-pressure differential across each coil.
  - 2. Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

### 3.5 RESTORATION

- A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.
- B. Restore service openings capable of future reopening. Comply with requirements in Division 23 for metal ducts. Include location of service openings in Project closeout report.
- C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Division 23 for metal ducts and non-metal ducts.
- D. Replace damaged insulation according to Division 23 for duct insulation.
- E. Ensure that closures do not hinder or alter airflow.
- F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.
- G. Reseal fibrous-glass ducts. Comply with requirements in Division 23 for nonmetal ducts.

END OF SECTION

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## SECTION 230500 - COMMON WORK RESULTS FOR HVAC

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
  - 1. For example, prior to requesting an occupancy permit, the MEP documentation listed in Part 3 of Division 20 (in paragraph "MEP and Fire Protection Completion Requirements", subparagraph "Occupancy Permit" must be submitted and approved so the Engineer can certify that the MEP systems and life safety provisions are completed.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. HVAC demolition.
  - 2. Equipment installation requirements common to equipment sections.
  - 3. Painting and finishing.
  - 4. Concrete bases.
  - 5. Supports and anchorages.
  - 6. Rated fire penetration sealants.
  - 7. Material and workmanship.
  - 8. Access panels.

#### 1.3 REFERENCES

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form part of this specification to the extent referenced. Publications are referenced in the text by the basic designations only.
  - 1. American Iron and Steel Institute (ASI)
  - 2. National Fire Protection Association (NFPA)
    - a. NFPA 70            National Electric Code
  - 3. American Society for Testing and Materials (ASTM)
    - a. ASTM A36            Standard Specification for Carbon Structural Steel
    - b. ASTM A53            Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
    - c. ASTM A109           Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled

- d. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- e. ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- f. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- g. ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
- h. ASTM A633 Standard Specification for Normalized High-Strength Low-Alloy Structural Steel Plates
- i. ASTM A635 Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Commercial Steel, Drawing Steel, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, Hot-Rolled
- j. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- k. ASTM A682 Standard Specification for Steel, Strip, High-Carbon, Cold-Rolled
- l. ASTM A924 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
- m. ASTM A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
- n. ASTM A1018 Standard Specification for Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Carbon, Structural, High-Strength Low-Alloy, Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability
- o. ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus
- p. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- q. ASTM C920 Standard Specification for Elastomeric Joint Sealants
- r. ASTM C1193 Standard Guide for Use of Joint Sealants
- s. ASTM D522 Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
- t. ASTM D523 Standard Test Method for Specular Gloss
- u. ASTM D610 Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces.
- v. ASTM D2247 Standard Practice for Testing Water Resistance of Coatings in 100 per Relative Humidity



- w. ASTM D3451 Standard Guide for Testing Coating Powders and Powder Coatings
- x. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
- y. ASTM F1136 Standard Specification for Chromium/Zinc Corrosion Protective Coatings for Fasteners
- 4. American Wood-Preservers' Association (AWPA)
  - a. AWPA C2 Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
  - b. AWPA C9 Plywood - Preservative Treatment by Pressure Process
  - c. AWPA C20 Structural Lumber - Fire-Retardant Treatment by Pressure Processes
  - d. AWPA C22 Lumber and Plywood for Permanent Wood Foundations- Preservative Treatment by Pressure Processes
  - e. AWPA C27 Plywood-Fire-Retardant Treatment by Pressure Processes
- 5. American Welding Society (AWS)
- 6. Code of Federal Regulations (CFR)
- 7. Metal Framing Manufacturers Association (MFMA)
  - a. MFMA Metal Framing Standards Publication
- 8. Underwriters Laboratories (UL)
  - a. UL 723 Test for Surface Burning Characteristics of Building Materials

#### 1.4 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
  - 1. CPVC: Chlorinated polyvinyl chloride plastic.
  - 2. PE: Polyethylene plastic.
  - 3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

#### 1.5 SUBMITTALS

A. Product Data: For the following:

- 1.
2. Rated fire construction penetration sealants.

#### 1.6 QUALITY ASSURANCE

A. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect and cover equipment (VAV boxes, coils, fans, pumps, control valves, etc) and ductwork components with plastic when stored on site to prevent entrance of dirt, debris and moisture.

#### 1.8 COORDINATION

A. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the manufacturers specified, or approved equal.

#### 2.2 FIRE RATED CONSTRUCTION PENETRATION SEALANTS

A. Description: Sealants for interior fire rated assembly penetrations:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - a. 3M,
  - b. Hilti,
  - c. Firespec,
  - d. Or approved equal.

- B. Sealants, caulking and devices shall be rated the same as the wall rating they are used in.
- C. Refer to Division 07 for materials and architectural drawings for listed penetration details.

### **PART 3 - EXECUTION**

#### **3.1 HVAC DEMOLITION**

- A. Refer to Division 01 and Division 02 for general demolition requirements and procedures.
- B. Refer to drawings for general description of areas requiring demolition.
- C. Refer to General Contractor's/Construction Manager's Instructions for existing equipment and materials that shall remain the property of the Owner.
- D. Where it is noted that items of value are not to be returned to the Owner, the items shall become the property of the Contractor. Storage or sale of items on the project site is prohibited. Items shall be removed from site and legally disposed of.
- E. Protection: Ensure the safe passage of persons in and around the building/site during demolition. Prevent injury to persons and damage to property. Provide adequate shoring and bracing to prevent collapse. Immediately repair damage to the condition before being damaged to the satisfaction of the architect and Owner. Take effective measures to prevent windblown dust.
- F. Utilities: Maintain utilities except those requiring removal or relocation. Keep utilities in service and protect from damage. Do not interrupt utilities serving in-use areas without first obtaining permission from the utility company and the Owner. Provide temporary services as required.
- G. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
  - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap remaining piping with same or compatible piping material.
  - 2. Piping to Be Abandoned in Place: Drain piping and cap piping with same or compatible piping material.
  - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap remaining ducts with same or compatible ductwork material.
  - 4. Ducts to Be Abandoned in Place: Cap ducts with same or compatible ductwork material.
  - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- H. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

### 3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.
- E. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to satisfaction of Architect and in accordance with code requirements.
- F. Distribute equipment loads on building structural members provided for equipment support. Roof-mounted equipment shall be installed and supported on structural steel.
- G. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs for floor, wall or ceiling mounting of equipment.
- H. Provide steel supports and hardware for proper installation of hangers, anchors and guides.
- I. Provide cuts, weights, and other pertinent data required for proper coordination of equipment support provisions and installation.
- J. Structural steel and hardware shall conform to Standard Specifications of ASTM; use of steel and hardware shall conform to requirements of Section Five of Code of Practice of American Institute of Steel Construction.
- K. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly that will void warrantee. Report in writing to Architect, prior to purchase or shipment of equipment involved, on conditions that may prevent proper installation.
- L. For all equipment installed external to the building; whether on roofs, supports, grade, etc., the installation shall comply with wind loading and impact requirements of the applicable codes for this project site. All equipment provided for this project shall be certified by the manufacturer that the equipment meets the applicable seismic, wind, earthquake, and hurricane impact requirements as set forth by the Authority Having Jurisdiction.

### 3.3 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Equipment installed shall have shop coat of non-lead gray paint. Hangers and supports shall have one coat of non-lead red primer. Machinery (e.g. pumps, fans and air handling units) shall be stenciled with equipment name. Stencil shall be at least 6 inches high for large equipment, 2 inches high for small equipment.
- D. Note requirement for Architect's approval invoked under paragraph MATERIALS AND WORKMANSHIP regarding finish of material and equipment that is visible or subject to corrosive or atmospheric conditions.

### 3.4 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 7. Use 3000 psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03.

### 3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

### 3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

### 3.7 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.

- H. Cure placed grout.

### 3.8 ACCESS AND ACCESS PANELS

- A. Refer to air distribution system specification section for duct access doors and panels.
- B. Access panels in walls, ceilings and floors are generally not shown on the drawings, but shall be provided to maintain proper access to materials and equipment that require inspection, replacement, repair or service. Provide access doors or panels and coordinate their delivery with Division 08. If proper access cannot be provided, confer with Architect as to best method of approach for minimizing effect of reduced access that may result.
- C. Coordinate and prepare a location, size, and function schedule of access panels required to fully service equipment and deliver to Division 08. Furnish and install distinctively colored buttons (color as selected by Architect) in finished ceiling to identify access panels.
- D. Furnish access panels for installation under other Sections where fire dampers, smoke dampers, volume dampers, smoke detectors, controls, shut-off valves, control valves, check valves, or other items installed under this Section require access and are concealed in floor, wall, furred space or above ceiling.
- E. Ceilings consisting of lay-in or removable splined tiles do not require access panels and dampers, splitters, or test hole openings above ceiling shall have location marked with thumbtack on finished ceiling panel. Location shall be noted on record drawings.
- F. Access panels shall be at least large enough to remove the component requiring access.
  - 1. Minimum Access Door Sizes:
    - a. One-Hand or Inspection Access: 8 inches by 5 inches.
    - b. Two-Hand Access: 12 inches by 6 inches.
    - c. Head and Hand Access: 18 inches by 10 inches.
    - d. Head and Shoulders Access: 21 inches by 14 inches.
    - e. Body Access: 25 inches by 14 inches.
    - f. Body Plus Ladder Access: 25 inches by 17 inches.

### 3.9 MATERIALS AND WORKMANSHIP

- A. Work shall be neat and rectilinear. Ductwork, piping, and conduit shall run concealed except in mechanical rooms and areas where no hung ceiling exists. Install material and equipment in accordance with manufacturers written instructions. Installation shall operate safely and without leakage, undue wear, noise, vibration, corrosion or water hammer. Work shall be properly and effectively protected, and pipe and duct openings shall be temporarily closed to prevent obstruction and damage before completion.
- B. Except as specified otherwise, material and equipment shall be new. Provide supplies, appliances and connections necessary for complete and operational installation. Provide components required or recommended by OSHA and applicable NFPA documents.
- C. Owner will not be responsible for material and equipment before testing, commissioning, and acceptance.

END OF SECTION

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## **SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

#### **1.3 COORDINATION**

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.
  - 5. Variable-speed drive controllers.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL MOTOR REQUIREMENTS**

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Motors under 1/2 HP shall be designed for 120V, 60 Hz, single phase, unless otherwise specified.
- D. Motors 1/2 HP and over shall be voltages as indicated in schedules on drawings.
- E. Individual pumps serving variable flow systems and VAV fans with a motor horsepower of 5 hp or larger shall be provided with variable speed drives that will result in pump or fan motor demand of no more than 30 percent of design wattage at 50 percent of design flow.



## 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

## 2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: All motors shall be premium efficiency type as defined in NEMA MG 1 and shall have their efficiencies determined in accordance with IEEE Standard 112 Method B. The NEMA nominal efficiency shall be listed on the motor nameplate.
- C. Minimum nominal efficiencies shall be as follows:

Premium Efficiency Motor Totally Enclosed Fan-Cooled (TEFC)				Premium Efficiency Motor Open Drip-Proof (ODP)			
Size HP	Speed (rpm)			Size HP	Speed (rpm)		
	1200	1800	3600		1200	1800	3600
	NEMA Nominal Efficiency				NEMA Nominal Efficiency		
1	82.5	85.5	78.5	1	82.5	85.5	80.0
1.5	87.5	86.5	85.5	1.5	86.5	86.5	85.5
2	88.5	86.5	86.5	2	87.5	86.5	86.5
3	89.5	89.5	88.5	3	89.5	89.5	86.5
5	89.5	89.5	89.5	5	89.5	89.5	89.5
7.5	91.7	91.7	91.0	7.5	91.7	91.0	89.5
10	91.7	91.7	91.7	10	91.7	91.7	90.2
15	92.4	92.4	91.7	15	92.4	93.0	91.0
20	92.4	93.0	92.4	20	92.4	93.0	92.4
25	93.0	93.6	93.0	25	93.0	93.6	93.0
30	93.6	93.6	93.0	30	93.6	94.1	93.0
40	94.1	94.1	93.6	40	94.1	94.1	93.6
50	94.1	94.5	94.1	50	94.1	94.5	93.6
60	94.5	95.0	94.1	60	95.0	95.0	94.1
75	95.0	95.4	94.5	75	95.0	95.0	94.5
100	95.4	95.4	95.0	100	95.0	95.4	94.5
125	95.4	95.4	95.4	125	95.4	95.4	95.0
150	95.8	95.8	95.4	150	95.8	95.8	95.4
200+	95.8	96.2	95.8	200+	95.4	95.8	95.4

- D. Multispeed Motors: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: One class below insulation rating. Example: Class B temperature rise for Class F insulation.

- H. Insulation: Class F or Class H as noted below.
- I. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

## 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Premium Efficiency Motors (non-VFD): Class B temperature rise; Class F insulation.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer. Motors shall be premium efficiency "inverter-duty" or "drive duty" motors, compatible with the drive to which it is connected. Use of the motor with a VFD shall not adversely affect the operation, useful life or warranty of the motor.
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
  - 2. Premium-Efficient Motors: Class F temperature rise; Class H insulation.
  - 3. Motor windings shall be spike resistant to withstand 1,600 peak volts. Motors shall have shaft grounding system to protect bearings from induced voltage. Shaft grounding system shall have very low drag, less than 1/2 percent of motor HP, and shall operate for a minimum of three (3) years without periodic adjustments. All consumables of the shaft grounding system shall be replaceable without a shutdown of the motor or VFD. System shall be as manufactured by SGS (Albany, Oregon) or approved equal.
  - 4. Motors used with VFD shall have a minimum three (3) year manufacturer warranty.
- C. Thermal Protection (all polyphase motors): Comply with NEMA MG 1 requirements for thermally protected motors.

## 2.5 SINGLE-PHASE MOTORS

- A. Except where specified as part of terminal equipment (i.e. ECM motors in fan coil units), motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application and shall be premium efficiency type:
  - 1. Permanent-split capacitor.
  - 2. Split phase.
  - 3. Capacitor start, inductor run.
  - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.

- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- F. Electronically Commutated Motors (ECM): Motors shall be an electronic commutation (EC) motor specifically designed for HVAC applications. AC induction type motors are not acceptable. Motors shall be permanently lubricated with heavy-duty ball bearings to match the load, and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the equipment to DC power to operate the motor. Motor shall be speed controllable down to 20 percent of full speed (5:1 turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC control signal. Motor shall be a minimum of 85 percent efficient at all speeds.

## 2.6 ELECTRONICALLY COMMUTATED MOTOR (ECM)

- A. For equipment specified with ECM motors, provide the following.
  - 1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
  - 2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
  - 3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
  - 4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
  - 5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
  - 6. Integrated motor protection verified by UL to protect the pump against over and under voltage, over temperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

## 2.7 STARTERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit,
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution,
  - 3. Rockwell Automation, Inc.; Allen-Bradley brand,
  - 4. Siemens Energy & Automation, Inc,
  - 5. Square D; a brand of Schneider Electric,
  - 6. Cutler-Hammer,
  - 7. Clark,
  - 8. Arrow Hart,
  - 9. Or approved equal

- B. Furnish starters for HVAC equipment, except units served by variable frequency drives. Provide control and other related wiring including interlocks. Power wiring (to panelboards, disconnect switches, starters, and motors) will be provided under Division 26. Starters that are not integral to equipment will be installed and wired under Division 26, Electrical, and furnished under this Section.
- C. Starters that require interlocks or remote control shall be magnetic with HAND-OFF-AUTOMATIC switch (fast-slow-off-auto for two speed motors) in cover. Provide magnetic starters with auxiliary contacts, buttons and switches. Refer to other Division 23 sections and control drawings for interlock requirements. Starters shall be by single manufacturer.
  - 1. Each 3-phase, 60 Hz motor shall be provided with magnetic starter with hand-off-automatic switch.
  - 2. Other motors shall be provided with a manual starter with ON-OFF switch.
  - 3. Control relay for each starter shall be for operation on 120V, single phase. Provide transformer of sufficient capacity within starter case.
  - 4. Provide inverse time limit overload and under voltage protection in each leg and with pilot lights.
  - 5. Provide red and green On-Off pilot lights.
  - 6. Provide nameplates with engraved white lettering to designate area and equipment served.
  - 7. Starters for refrigeration machines shall be furnished by unit manufacturer.
  - 8. Furnish for all single speed motors, 25 HP and above, 95 percent power factor correction capacitors. Capacitors shall be in NEMA enclosure of the same rating as the motor's starter.

## 2.8 DRIVES

- A. Refer to requirements in Division 26.

## PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION

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## SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
  - Steel pipe hangers and supports.
  - Trapeze pipe hangers.
  - Metal framing systems.
  - Thermal-hanger shield inserts.
  - Fastener systems.
  - Pipe stands.
  - Equipment supports.
- B. Related Sections include the following:
  - Division 05 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

#### 1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.
- B. MSS SP-58-2018, "Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation"

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For the following:

Steel pipe hangers and supports.

Thermal-hanger shield inserts.

Components of trapeze pipe hangers and metal framing systems.

Pipe stands.

**B. Shop Drawings: Show fabrication and installation details for the following:**

Trapeze pipe hangers.

Metal framing systems.

Pipe stands.

Equipment supports.

**C. Delegated-Design Submittal: For trapeze hangers, metal framing systems and equipment supports provide analysis data verifying submitted supports meet performance requirements and design criteria, signed and sealed by the qualified professional engineer responsible for their preparation.**

Design calculations for designing trapeze hangers, metal framing systems and equipment supports based on approved piping and equipment submittal data.

Wind-Restraint Details:

- a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
- b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during design wind speed. Indicate association with vibration isolation devices.
- c. Comply with requirements in other Sections for equipment mounted outdoors.

## **1.6 INFORMATIONAL SUBMITTALS**

**A. Welding certificates.**

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

**A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:**

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include manufacturers specified, or approved equal.

### **2.2 PERFORMANCE REQUIREMENTS**

**A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 "Quality Requirements," to design trapeze pipe hangers and equipment supports.**

- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

Wind-Restraint Loading for Outdoor Equipment and Piping:

- a. Basic Wind Speed: 125 MPH.
- b. Building Classification Category: III.
- c. Minimum 10 lb/sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.

- C. Structural Connection Design Criteria

Upper attachments to structure shall have an allowable gravity load of 25% of the failure load (proof test).

Maximum load from hangers attached to the underside of the slabs shall be 250 pounds. If higher loads are required due to space or coordination constraints, submit formal request for interpretation (RFI) to structural design professional of record for review before work commences.

Do not cut any notches or drill or cut any holes on structural members without the expressed approval of the structural design professional of record.

Core openings only in areas indicated on the documents and in additional areas only with the approval of the structural design professional.

Do not attach or suspend any MEP items from metal deck.

Survey location of concrete reinforcement before drilling anchors in reinforced concrete walls, beams, or slabs. Do not cut any reinforcing bars during drilling of anchors unless approved by the structural design professional.

Provide patching of fireproofing removed or accidentally damaged during the attachment of suspended items. Provide documentation that patch shall does not reduce performance of the fireproofing system.

For steel framing, maximum load from hangers attached to steel beams shall be 400 pounds. For the parts that will be fireproofed, if clamps or any other attachments are attached after the fireproofing is in place, enough fireproofing must be removed at the point of contact so that the attachment can be placed with the proper edge distance and develop the required "bite" on the steel. Patch fireproofing after attachment is in place.

## 2.3 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

- B. Manufacturers:

B-Line Systems, Inc.; a division of Cooper Industries,

Carpenter & Paterson, Inc.,  
Empire Industries, Inc.,  
ERICO/Michigan Hanger Co.,  
Globe Pipe Hanger Products, Inc.,  
Grinnell Corp.,  
National Pipe Hanger Corporation,  
PHD Manufacturing, Inc.,  
PHS Industries, Inc.,  
Piping Technology & Products, Inc.,  
Or approved equal

- C. Hanger Rods: For non-aquatic environments, continuous-thread rod, nuts, and washer made of carbon steel, stainless steel or copper-plated steel washers compatible with hangers and supports. For aquatic environments, continuous-thread rod, nuts, and washer made of carbon steel with non-corrosive coating or continuous-thread rod, nuts, and washer made of Fiberglass (FRP) or Aluminum.

- D. Carbon Steel (for non-aquatic environments only), Stainless Steel, and Copper Pipe or Tube Hangers and Supports:

Select material to match piping being supported.

For carbon steel piping hangers in non-aquatic spaces provide one of the following:

- a. Galvanized, Metallic Coatings: Pre-galvanized, hot dipped or electro-galvanized.
- b. Nonmetallic Coatings: Plastic coating or epoxy powder coated.

- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

## 2.4 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and hanger types specified.

## 2.5 METAL FRAMING SYSTEMS

- A. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes including cross bracing to support piping weight and resist wind loads. Provide G90 galvanized coated supports for outdoor locations.
- B. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
- C. Channels: For non-aquatic environments, continuous slotted carbon-steel, Type 304 stainless-steel or extruded-aluminum channel with in-turned lips. For aquatic environments, extruded aluminum channel with in-turned lips.
- D. Channel Width: Selected for applicable load criteria.



- E. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
- F. Hanger Rods: In non-aquatic environments, continuous-thread rod, nuts, and washer made of carbon steel or stainless-steel matching hanger material. In aquatic environments, continuous-thread rod, nuts, and washer made of Fiberglass (FRP) or aluminum.
- G. Manufacturers:
  - B-Line; an Eaton Business,
  - ERICO/Michigan Hanger Co.; ERISTRUT Div,
  - Flex-Strut, Inc.,
  - G-Strut,
  - GS Metals Corp.,
  - Haydon Corporation,
  - MIRO Industries,
  - Power-Strut Div.; Tyco International, Ltd.,
  - Thomas & Betts Corporation,
  - Unistrut Corp.; Tyco International, Ltd.,
  - Or approved equal
- H. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- I. Non-metallic Coatings: Plastic coating, jacket, or liner.

## 2.6 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield. Insert shall be capable of supporting weight of pipe, insulations and fluid without crushing.
- B. Manufacturers:
  - Carpenter & Paterson, Inc.,
  - ERICO/Michigan Hanger Co.,
  - PHS Industries, Inc.,
  - Pipe Shields, Inc.,
  - Rilco Manufacturing Company, Inc.,
  - Value Engineered Products, Inc.,
  - Or approved equal
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.7 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities meeting supported loads and suitable for use with building materials.

Manufacturers:

- a. B-Line Systems, Inc.; a division of Cooper Industries,
- b. Empire Industries, Inc.,
- c. Hilti, Inc.,
- d. ITW Ramset/Red Head,
- e. MKT Fastening, LLC,
- f. Powers Fasteners,
- g. Or approved equal

## 2.8 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

Available Manufacturers:

- a. ERICO/Michigan Hanger Co.,
- b. MIRO Industries,
- c. Or approved equal

Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.

Hardware: Galvanized steel or polycarbonate.

Accessories: Protection pads.

- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

Available Manufacturers:

- a. MIRO Industries,
- b. Or approved equal

Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.

Vertical Members: Two stainless-steel, continuous-thread 1/2-inch (12-mm) rods.

Horizontal Member: Adjustable horizontal, stainless-steel pipe support channels.

Pipe Supports: Galvanized-steel, Roller or Clevis hanger.

Hardware: Stainless steel.

Accessories: Protection pads.

Height: 12 inches (300 mm) above roof unless indicated otherwise.

- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

Available Manufacturers:

- a. ERICO/Michigan Hanger Co.,
- b. MIRO Industries,
- c. Portable Pipe Hangers,
- d. Or approved equal

Base: Stainless steel.

Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

Pipe Supports: Galvanized-steel, roller or clevis hanger.

Hardware: Stainless steel.

- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

Available Manufacturers:

- a. Portable Pipe Hangers,
- b. Or approved equal

Bases: One or more vulcanized rubber or molded polypropylene.

Vertical Members: Two or more protective-coated-steel channels.

Horizontal Member: Protective-coated-steel channel.

Pipe Supports: Galvanized-steel, roller or clevis hanger.

- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

## 2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## 2.10 MISCELLANEOUS MATERIALS

- A. Carbon Steel: ASTM A1011/A1011M.
- B. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- C. Stainless Steel: ASTM A240/A240M.
- D. Stainless Steel: ASTM A240/A240M.
- E. Threaded Rods: Continuously threaded. Zinc-plated or (hot-dipped for aquatic environments) galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.
- F. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.  
Properties: Non-staining, noncorrosive, and nongaseous.  
Design Mix: 5000-psi, 28-day compressive strength.

### **PART 3 - EXECUTION**

#### **3.1 APPLICATION**

- A. Comply with requirements in Division 07 for fire-stopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- C. Examine areas and equipment to receive wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- D. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 HANGER AND SUPPORT SCHEDULE**

- A. Specific hanger and support requirements are specified in other Division 23 Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications in non-aquatic environments.
- F. Use Type 316 stainless-steel pipe hangers and stainless-steel corrosion-resistant attachments for hostile environment applications, including aquatic environments.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.

- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, provide and space hangers in accordance with the following table:

Nom. Pipe Size (inches)	Max. Span (feet)	Min. Rod Size (inches)	Hanger Type
0.75 and Smaller	5	0.375	Clevis Hanger
1	6	0.375	Clevis Hanger
1.25	7	0.375	Clevis Hanger
1.5	8	0.375	Clevis Hanger
2	8	0.375	Clevis Hanger
2.5	11	0.5	Clevis Hanger
3	12	0.5	Clevis Hanger
4	12	0.625	1 Rod Roller Type Hangers
5	12	0.625	1 Rod Roller Type Hangers
6	12	0.75	1 Rod Roller Type Hangers
8 – 12	12	0.75 (two)	2 Rod Roller Type Hangers
14 – 18	12	0.875 (two)	2 Rod Roller Type Hangers
20	12	1.25 (two)	2 Rod Roller Type Hangers
24	12	1.25 (two)	2 Rod Roller Type Hangers
Vertical Piping	15		
Note: This Table is based on the 2018 IMC and 2018 MSS SP-58 Standards using acceptable spacing for copper tubing (up to 2 inch) and steel pipe (2.5 inch and larger IPS). For FRP fiberglass hangers, consult manufacturer for weight limitations.			

Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes.

Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.

Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.

Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

Top-Beam C-Clamps (MSS Type 19): For use under roof installations to attach to top flange of structural shape excluding bar-joist construction.

Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

C-Clamps (MSS Type 23): For structural shapes excluding bar-joist construction.

Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

- a. Light (MSS Type 31): 750 lb.
- b. Medium (MSS Type 32): 1500 lb.
- c. Heavy (MSS Type 33): 3000 lb.

- Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
- Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
- Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
- Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
- Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
- Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
- Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
- Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
- Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
- Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
- Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
- Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
- Horizontal (MSS Type 54): Mounted horizontally.
  - Vertical (MSS Type 55): Mounted vertically.
  - Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-58 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

### 3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with MSS SP-58. Install hangers, supports, clamps, and attachments to properly support piping from building structure.

- B. Pipe hangers:

Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

- a. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
- b. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

Metal Framing Pipe Hanger System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.

Comply with MSS SP-58 for pipe hanger selections and applications that are not specified in piping system Sections.

Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

- C. Insulated piping installation: Install shield in pipe hanger for insulated piping.

Attach clamps and spacers to piping.

- a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
- b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

- a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

- a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

Shield Dimensions for Pipe: Not less than the following:

- a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
- b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
- c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.



- d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
- e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

- D. Fastener System Installation: Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe Stand Installation:  

Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts. Where attachments to structure may eccentrically place weight on the bottom web of structural steel beams, alternate hangers to minimize bending moment (e.g. support supply pipe from one side of bottom flange and return pipe on other side) or provide alternate clamps that symmetrically load structural member.  

For bar joist construction, do not eccentrically load bar-joist members. Support piping from supplemental steel pipe or unistrut members spanning a minimum of two joists, attached at panel points only unless specifically approved otherwise by the joist manufacturer installation instructions. Connect supplemental supports to bar-joist in accordance with joist manufacturer installation instructions. All supports shall concentrically load bar-joist.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

### 3.4 EQUIPMENT SUPPORTS

- A. Equipment Support Installation: Fabricate from welded-structural-steel shapes to suspend equipment from structure overhead or to support equipment above floor.

- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.5 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

Obtain fusion without undercut or overlap.

Remove welding flux immediately.

Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.6 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

### 3.7 PAINTING

- A. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.  
Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

END OF SECTION

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## SECTION 230533 - HEAT TRACING FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes heat tracing for HVAC piping with the following electric heating cables:
  - 1. Self-regulating, parallel resistance.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
  - 2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- B. Shop Drawings: For electric heating cable.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include diagrams for power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

#### 1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Three years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - 1. BriskHeat,
  - 2. Chromalox,
  - 3. Delta-Therm Corporation,
  - 4. Easy Heat; a division of EGS Electrical Group LLC,
  - 5. Pyrotenax; a brand of Tyco Thermal Controls LLC,
  - 6. Raychem; a brand of Tyco Thermal Controls LLC,
  - 7. Thermon Americas Inc.,
  - 8. Trasor Corp.,
  - 9. Or approved equal.
- B. Comply with IEEE 515.1.
- C. Heating Element: Pair of parallel No. 16 AWG, tinned, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
- D. Electrical Insulating Jacket: Flame-retardant polyolefin.
- E. Cable Cover: Tinned-copper braid.
- F. Maximum Operating Temperature (Power On): 150 deg F.
- G. Maximum Exposure Temperature (Power Off): 185 deg F.
- H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- I. Capacities and Characteristics:
  - 1. Maximum Heat Output: 5 W/ft..
  - 2. Piping Diameter: 3 in.
  - 3. Electrical Characteristics for Single-Circuit Connection:
    - a. Volts: 120.
    - b. Phase: 1.
    - c. Hertz: 60.
    - d. Full-Load Amperes: 16.
    - e. Minimum Circuit Ampacity: 20.
    - f. Maximum Overcurrent Protection: 20.

## 2.2 CONTROLS

- A. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
- B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
- C. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
- D. Corrosion-resistant, waterproof control enclosure.

## 2.3 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Labels: Refer to Division 23 for identification of HVAC piping and equipment.
- C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
  - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
  - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
  - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install electric heating cable across expansion joints according to manufacturer's written instructions; use slack cable to allow movement without damage to cable.
- B. Install electric heating cables after piping has been tested and before insulation is installed.
- C. Install electric heating cables according to IEEE 515.1.
- D. Install insulation over piping with electric cables according to Division 23 for HVAC piping insulation.
- E. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- F. Set field-adjustable switches and circuit-breaker trip ranges.

### 3.3 CONNECTIONS

- A. Ground equipment according to Division 26 for grounding and bonding for electrical systems.
- B. Connect wiring according to Division 26 for low-voltage electrical power conductors and cables.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
  - 2. Test cables for electrical continuity and insulation integrity before energizing.
  - 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.5 PROTECTION

- A. Protect installed heating cables, including nonheating leads, from damage during construction.
- B. Remove and replace damaged heat-tracing cables.

END OF SECTION

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## SECTION 230548 - VIBRATION CONTROLS FOR HVAC

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

##### A. Section Includes

- 1. Vibration Isolation Devices:
  - a. Elastomeric isolation pads.
  - b. Elastomeric isolation mounts.
  - c. Restrained elastomeric isolation mounts.
  - d. Open-spring isolators.
  - e. Restrained-spring isolators.
  - f. Pipe-riser resilient supports.
  - g. Resilient pipe guides.
  - h. Elastomeric hangers.
  - i. Spring hangers.
  - j. Vibration isolation equipment bases.
  - k. Restrained isolation roof-curb rails.

##### B. Related Requirements:

- 1. Division 21 for vibration isolation for fire-suppression equipment and systems.
- 2. Division 22 for vibration isolation for plumbing equipment and systems.

#### 1.3 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

- 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
- 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
- 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

**B. Shop Drawings:**

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

**C. Delegated-Design Submittal:**

1. For each vibration isolation device.
  - a. Include design calculations and details for selecting vibration isolators and vibration isolation bases.
  - b. Design Calculations: Calculate static and dynamic loading due to equipment weight and required to select vibration isolators and for designing vibration isolation bases.
    - 1) Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
  - c. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.
2. Wind-Restraint Details:
  - a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
  - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during design wind speed. Indicate association with vibration isolation devices.
  - c. Comply with requirements in other Sections for equipment mounted outdoors.

**1.4 INFORMATIONAL SUBMITTALS**

**A. Coordination Drawings:**

1. Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

**B. Qualification Data: For professional engineer and testing agency.**

**C. Welding certificates.**

**D. Field quality-control reports.**



1.5      QUALITY ASSURANCE

- A.    Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B.    Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1      PERFORMANCE REQUIREMENTS

- A.    Wind-Restraint Loading:
  - 1.    Basic Wind Speed: 125 MPH.
  - 2.    Building Classification Category: III.
  - 3.    Minimum 10 lb/sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.

2.2      ELASTOMERIC ISOLATION PADS

- A.    Elastomeric Isolation Pads:
  - 1.    Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
    - a.    Ace Mountings Co., Inc.,
    - b.    California Dynamics Corporation,
    - c.    Isolation Technology, Inc.,
    - d.    Kinetics Noise Control, Inc.,
    - e.    Mason Industries, Inc.,
    - f.    Vibration Eliminator Co., Inc.,
    - g.    Vibration Isolation,
    - h.    Vibration Mountings & Controls, Inc.,
    - i.    Or approved equal.
  - 2.    Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
  - 3.    Size: Factory or field cut to match requirements of supported equipment.
  - 4.    Pad Material: Oil and water resistant with elastomeric properties.
  - 5.    Surface Pattern: Smooth, Ribbed or Waffle pattern.
  - 6.    Load-bearing metal plates adhered to pads.
  - 7.    Sandwich-Core Material: Resilient and elastomeric.
    - a.    Surface Pattern: Smooth, Ribbed or Waffle pattern.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

### A. Double-Deflection, Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
  - a. Ace Mountings Co., Inc.,
  - b. California Dynamics Corporation,
  - c. Isolation Technology, Inc.,
  - d. Kinetics Noise Control, Inc.,
  - e. Mason Industries, Inc.,
  - f. Vibration Eliminator Co., Inc.,
  - g. Vibration Isolation,
  - h. Vibration Mountings & Controls, Inc.,
  - i. Or approved equal.
2. Mounting Plates:
  - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
  - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

### A. Restrained Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
  - a. Ace Mountings Co., Inc.,
  - b. California Dynamics Corporation,
  - c. Isolation Technology, Inc.,
  - d. Kinetics Noise Control, Inc.,
  - e. Mason Industries, Inc.,
  - f. Vibration Eliminator Co., Inc.,
  - g. Vibration Isolation,
  - h. Vibration Mountings & Controls, Inc.,
  - i. Or approved equal.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

- a. Housing: Cast-ductile iron or welded steel.
- b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.5 OPEN-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
  - a. Ace Mountings Co., Inc.,
  - b. California Dynamics Corporation,
  - c. Isolation Technology, Inc.,
  - d. Kinetics Noise Control, Inc.,
  - e. Mason Industries, Inc.,
  - f. Vibration Eliminator Co., Inc.,
  - g. Vibration Isolation,
  - h. Vibration Mountings & Controls, Inc.,
  - i. Or approved equal.
- 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- 6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
- 7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

## 2.6 RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
  - a. Ace Mountings Co., Inc.,
  - b. California Dynamics Corporation,
  - c. Isolation Technology, Inc.,
  - d. Kinetics Noise Control, Inc.,
  - e. Mason Industries, Inc.,

- f. Vibration Eliminator Co., Inc.,
  - g. Vibration Isolation,
  - h. Vibration Mountings & Controls, Inc.,
  - i. Or approved equal.
- 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
  - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
  - b. Top plate with threaded mounting holes and elastomeric pad.
  - c. Internal leveling bolt that acts as blocking during installation.
- 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
- 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.7 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2 inch- thick neoprene.
  - 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
  - 2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

## 2.8 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2 inch- thick neoprene.
  - 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and re-insertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.9 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
    - a. Ace Mountings Co., Inc,
    - b. California Dynamics Corporation,

- c. Isolation Technology, Inc.,
  - d. Kinetics Noise Control, Inc.,
  - e. Mason Industries, Inc.,
  - f. Vibration Eliminator Co., Inc.,
  - g. Vibration Mountings & Controls, Inc.,
  - h. Or approved equal.
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
  3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

## 2.10 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
    - a. Ace Mountings Co., Inc.,
    - b. California Dynamics Corporation,
    - c. Kinetics Noise Control, Inc.,
    - d. Mason Industries, Inc.,
    - e. Vibration Eliminator Co., Inc.,
    - f. Vibration Isolation,
    - g. Vibration Mountings & Controls, Inc.,
    - h. Or approved equal.
  2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

## 2.11 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
  1. California Dynamics Corporation,
  2. Kinetics Noise Control,
  3. Mason Industries, Inc.,
  4. Vibration Eliminator Co., Inc.,
  5. Vibration Isolation,
  6. Vibration Mountings & Controls, Inc.,
  7. Or approved equal.
- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
  1. Design Requirements: Lowest possible mounting height with not less than 1 inch clearance above the floor or structural support. Include equipment anchor bolts and auxiliary motor slide rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
  4. For equipment mounted outdoor, structural steel rails and hardware shall be corrosion resistant hot dipped galvanized steel.
- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
  1. Design Requirements: Lowest possible mounting height with not less than 1 inch clearance above the floor or structural support. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
  4. For equipment mounted outdoor, structural steel rails and hardware shall be corrosion resistant hot dipped galvanized steel.
- D. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
  1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Provide base with height saving brackets for connection to isolators. Inertia base

weight (frame + concrete) shall be a minimum of 2 times the total installed equipment weight.

- a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

## 2.12 RESTRAINED ISOLATION ROOF-CURB RAILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
  1. Ace Mountings Co., Inc.,
  2. California Dynamics Corporation,
  3. Kinetics Noise Control,
  4. Mason Industries, Inc.,
  5. Thybar Corporation,
  6. Or approved equal.
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- C. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.
- D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counter-flashed over roof materials.

## 2.13 THRUST RESTRAINTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

1. Ace Mountings Co., Inc.,
  2. California Dynamics Corporation,
  3. Kinetics Noise Control,
  4. Mason Industries, Inc.,
  5. Thybar Corporation,
  6. Or approved equal.
- B. Description: Spring element combined with steel angles, backup plates, threaded rod, washers and nuts to produce a pair of devices capable of limiting movement of air handling equipment to 0.25 inch.
- C. Restraint shall be convertible in the field from compression type to tension type.
- D. Unit shall be pre-compressed.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas and equipment to receive vibration isolation- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 APPLICATIONS**

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

#### **3.3 VIBRATION CONTROL DEVICE INSTALLATION**

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Comply with requirements in Division 07 for installation of roof curbs, equipment supports, and roof penetrations.
- D. Piping Restraints:
  1. Comply with requirements in MSS SP-127.
  2. Space lateral supports a maximum of 40 feet on center, and longitudinal supports a maximum of 80 feet on center.
  3. Brace a change of direction longer than 12 feet.



- E. Install cables so they do not bend across edges of adjacent equipment or building structure.
- F. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- J. Drilled-in Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
  - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3.4 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

### 3.5 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03.

### 3.6 VIBRATION ISOLATION SCHEDULES

- A. Provide vibration isolators and equipment bases for all rotating, piston driven or vibrating equipment in accordance with the following schedules. Selection of equipment isolators shall be based on approved equipment shop drawings.

B.

Base & Isolator Types				
Base Types			Isolator Types	
A	No base, isolators attached directly to equipment.	1	Elastomeric pad.	
B	Structural steel rails or base.	2	Elastomeric floor mount or hanger. Use restrained elastomeric mount where seismic restraint is required.	
C	Concrete inertia base.	3	Spring floor isolator or hanger.	
D	Curb-mounted base.	4	Restrained spring isolator.	
		5	Thrust restraint.	

C.

Vibration Isolation - Pumps															
Pump Type	Horsepower and Other	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Large Inline	5 to 25	All	A	3	0.75	A	3	1.5	A	3	1.5	A	2	1.5	
	≥30	All	A	3	1.5	A	3	1.5	A	3	1.5	A	3	2.5	
End suction and split case	≤40	All	C	3	0.75	C	3	0.75	C	3	1.5	C	3	1.5	1
	50 to 125	All	C	3	0.75	C	3	0.75	C	3	1.5	C	3	2.5	1
	≥150	All	C	3	0.75	C	3	0.75	C	3	2.5	C	3	3.5	1
Notes:															
1. Pumps: Type C bases strength and shape shall accommodate base elbow supports. Concrete bases (type C) shall be designed for a thickness of one-tenth the longest dimension with minimum thickness as follows: (1) for up to 30 hp, 6 in.; (2) for 40 to 75 hp, 8 in.; and (3) for 100 hp and up, 12 in. Pumps over 75 hp and multistage pumps shall be provided with supplemental restraining devices.															

Vibration Isolation - Boilers															
Boiler Type	Horsepower and Other	RPM	Floor Span												Table Notes
			Slab on Grade		Up to 20 ft			20 to 30 ft			30 to 40 ft				
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Fire-tube	All	All	A	1	0.25	B	4	0.75	B	4	1.5	B	4	2.5	1
Notes:															
1. Where equipment manufacturer indicates component cannot be installed directly on individual isolators (type A) provide equipment manufacturer recommended supplemental support (base type).															

Vibration Isolation - Axial Fans, Fan Heads, Cabinet Fans, Fan Sections															
Fan Size	Fan Static Pressure	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Up to 22 in. diameter	All	All	A	2	0.25	A	3	0.75	A	3	0.75	C	3	0.75	1,2,3
24 in. diameter & up	≤2 in. SP	Up to 300	B	3	2.5	C	3	3.5	C	3	3.5	C	3	3.5	2,3
		300 to 500	B	3	0.75	B	3	1.5	C	3	2.5	C	3	2.5	2,3

		501 and up	B	3	0.75	B	3	1.5	B	3	1.5	B	3	1.5	2,3
	≥2.1 in. SP	Up to 300	C	3	2.5	C	3	3.5	C	3	3.5	C	3	3.5	2,3
		300 to 500	C	3	1.5	C	3	1.5	C	3	2.5	C	3	2.5	2,3
		501 and up	C	3	0.75	C	3	1.5	C	3	1.5	C	3	2.5	2,3
Notes: 1. Where equipment manufacturer indicates component cannot be installed directly on individual isolators (type A) provide equipment manufacturer recommended supplemental support (base type). 2. Select isolator deflection so that resonance frequency is 40 percent or less of the lowest normal operating speed of equipment. Add a 1 in. thick pad (type 1) to the base plate of spring isolators (type 3). 3. To limit undesirable movement, thrust restraints (type 5) are required for all ceiling-suspended and floor-mounted units operating at 2 in. of water or more total static pressure. 4. Concrete inertia bases (type C) shall be designed for a minimum thickness of one-tenth the longest dimension, minimum 6 inches.															

Vibration Isolation - Centrifugal Fans															
Fan Size	Fan Horse-power	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Up to 22 in. diameter	All	All	B	2	0.25	B	3	0.75	B	3	0.75	B	3	1.5	3,4
24 in. diameter & up	≤40	Up to 300	B	3	2.5	B	3	3.5	B	3	3.5	B	3	3.5	2,4
		300 to 500	B	3	1.5	B	3	1.5	B	3	2.5	B	3	2.5	2,4
		501 and up	B	3	0.75	B	3	0.75	B	3	0.75	B	3	1.5	2,4
	≥50	Up to 300	C	3	2.5	C	3	3.5	C	3	3.5	C	3	3.5	1,2,3,4
		300 to 500	C	3	1.5	C	3	1.5	C	3	2.5	C	3	2.5	1,2,3,4
		501 and up	C	3	1.0	C	3	1.5	C	3	1.5	C	3	2.5	1,2,3,4
	<b>Notes:</b> 1. Increase isolator deflection so isolator stiffness is less than one-tenth the stiffness of the supporting structure, as defined by the deflection due to load at the equipment support. 2. Select isolator deflection so that resonance frequency is 40 percent or less of the lowest normal operating speed of equipment. Add a 1 in. thick pad (type 1) to the base plate of spring isolators (type 3). 3. Provide thrust restraints (type 5) for all ceiling-suspended and floor-mounted units operating at 2 in. of water or more total static pressure. 4. Fans and Air-Handling Equipment: For fans operating under 300 rpm, select isolator deflection so the isolator natural frequency is 40 percent or less than the fan speed. Flexible duct connectors shall be installed at the intake and discharge of all fans and air-handling equipment to reduce vibration transmission to air duct structures. Provide inertia bases (type C) for all class 2 and 3 fans and air handling equipment. Concrete inertia bases (type C) shall be designed for a minimum thickness of one-tenth the longest dimension, minimum 6 inches. Provide thrust restraints (type 5) with same deflection as isolators for all fans and all base-mounted and suspended air-handling equipment operating at 2 in. or more total static pressure. Adjust restraint movement under normal operational static pressures.														

Vibration Isolation - Heat Pumps, Fan Coil Units and Computer Room Units							
Equipment Type	Horsepower and Other	RPM	Floor Span				Table Notes
			Slab on Grade	Up to 20 ft	20 to 30 ft	30 to 40 ft	

			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Heat Pumps, Fan Coil Units and Computer Room Units	All	All	A	3	0.75	A	3	0.75	A	3	0.75	A/D	3	1.5	

Vibration Isolation - Condensing Units															
Equipment Type	Horsepower and Other	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Condensing Units	All	All	A	1	0.25	A	4	0.75	A	4	1.5	A/D	4	1.5	

Vibration Isolation - Packaged Air Handling Unit, Air Conditioning Units, Heating & Ventilating Units															
Fan Size	Fan HP, Static Pressure	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
All	≤10	All	A	3	0.75	A	3	0.75	A	3	0.75	A	3	0.75	5,6
	≥15, ≤4 in. SP	Up to 300	A	3	0.75	A	3	3.5	A	3	3.5	C	3	3.5	1,3,4,5,6
		300 to 500	A	3	0.75	A	3	2.5	A	3	2.5	A	3	2.5	3,5,6
		501 and up	A	3	0.75	A	3	1.5	A	3	1.5	A	3	1.5	3,5,6
	≥15, ≥4 in. SP	Up to 300	B	3	0.75	C	3	3.5	C	3	3.5	C	3	3.5	1,2,3,4,5
		300 to 500	B	3	0.75	C	3	1.5	C	3	2.5	C	3	2.5	1,2,3,5
		501 and up	B	3	0.75	C	3	1.5	C	3	1.5	C	3	2.5	1,2,3,5

Vibration Isolation - Packaged Rooftop Air Conditioning Equipment															
Fan Size	Fan HP, Static Pressure	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
All	All	All	A/D	1	0.25	D	3	0.75	DO NOT ALLOW						1,2,3

Vibration Isolation - Ducted Rotating Equipment															
Equipment Type	Airflow (cfm)	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base	Isolator	Min	Base	Isolator	Min	Base	Isolator	Min	Base	Isolator	Min	

			Type	Type	Defl., (in.)	Type	Type	Defl., (in.)	Type	Type	Defl., (in.)	Type	Type	Defl., (in.)	
Small fans, fan-powered boxes, cabinet heaters, unit heaters	≤600	All	A	3	0.5	A	3	0.5	A	3	0.5	A	3	0.5	
	≥601	All	A	3	0.75	A	3	0.75	A	3	0.75	A	3	0.75	

Vibration Isolation - Engine-Driven Generators															
Generator Type	Horsepower and Other	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
All	All	All	A	3	0.75	C	3	1.5	C	3	2.5	C	3	3.5	1,2
Notes:															
1. Increase isolator deflection so isolator stiffness is less than one-tenth the stiffness of the supporting structure, as defined by the deflection due to load at the equipment support.															
2. Where equipment manufacturer indicates component cannot be installed directly on individual isolators (type A) provide equipment manufacturer recommended supplemental support (base type).															

### 3.7 PIPING SYSTEM VIBRATION ISOLATION

#### A. Vibration isolators for suspended piping:

1. Provide spring hangers for all piping in equipment rooms and up to 50 ft from vibration-isolated equipment and PRV stations. The first three hangers from the equipment shall be provided with the same deflection as the equipment isolators, with a maximum limitation of 2 in. deflection. Remaining hangers shall be spring or combination spring and elastomeric with 0.75 in. deflection. The first two hangers adjacent to the equipment shall be the positioning or pre-compressed type. Provide positioning hangers for all isolated piping 8 in. and larger. Piping over 2 inches in diameter suspended below or within 50 ft of conference rooms, classrooms and auditorium areas shall be hung with isolation hangers.

#### B. Vibration isolators for floor-supported piping:

1. Provide vibration isolators for floor supports for piping in equipment rooms to isolate equipment. Isolators shall be selected according to the guidelines for hangers. The first two adjacent floor supports shall be the restrained spring type, with a restraint/blocking feature to prevent load transfer to equipment flanges as the piping is filled or drained. Provide a slide plate where pipe is subjected to large thermal movement (PTFE, graphite, or steel) and shall be installed on top of the isolator. Provide a thermal barrier when rubber products are installed directly beneath steam or hot-water lines.

#### C. Vibration isolation for piping riser supports:

1. Provide resilient pipe riser support near to midpoint of riser and provide spring hangers at each floor or structural level to support riser and allow thermal expansion risers.
2. Provide spring hangers for first three hangers connected to branch piping at each level.

END OF SECTION

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## **SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Duct labels.
  - 5. Valve tags.
  - 6. Warning tags.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

#### **1.4 COORDINATION**

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

#### A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

#### B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

#### C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

### 2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black .
- C. Background Color: Yellow.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.



- I. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  2. Lettering Size: At least 1-1/2 inches high.

## 2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, polyester, vinyl or plastic labels, minimum 5 mil thick.
- B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 16 inches.
- D. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- E. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
  1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
  2. Lettering Size: At least 1-1/2 inches high.

## 2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  1. Tag Material: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or

space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

## 2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Reinforced grommet and wire or string.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 "Interior Painting"
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  1. Near each valve and control device.
  2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  4. At access doors, manholes, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label Color Schedule:
1. Chilled-Water Piping:
    - a. Background Color: Blue.
    - b. Letter Color: White.
  2. Condenser-Water Piping:
    - a. Background Color: Light Blue.
    - b. Letter Color: White.
  3. Heating Water Piping:
    - a. Background Color: Red.
    - b. Letter Color: White.
  4. Refrigerant Piping:
    - a. Background Color: White.
    - b. Letter Color: Black.

### 3.4 DUCT LABEL INSTALLATION

- A. Install **self-adhesive** duct labels with permanent adhesive on air ducts in the following color codes:
1. Background and Letter Color:
    - a. Supply Air: Green background, white letters.
    - b. General Exhaust Air: Yellow background, black letters
    - c. Outside Air, Relief, Return Ducts: Blue background, white letters.
    - d. Hazardous Exhaust Air: ASME A13.1 Colors and Designs.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

### 3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:
  - a. Chilled Water: 1-1/2 inches, round.
  - b. Condenser Water: 1-1/2 inches, round.
  - c. Refrigerant: 1-1/2 inches, round.
  - d. Hot Water: 1-1/2 inches, round.
  - e. Gas: 1-1/2 inches, round.
2. Valve-Tag Color:
  - a. Chilled Water: Natural.
  - b. Condenser Water: Natural.
  - c. Refrigerant: Natural.
  - d. Hot Water: Natural.
  - e. Gas: Natural.
3. Letter Color:
  - a. Chilled Water: White.
  - b. Condenser Water: White.
  - c. Refrigerant: White.
  - d. Hot Water: White.
  - e. Gas: White.

### 3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

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## SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- C. Refer to Division 01 and Division 23 for systems commissioning requirements applicable to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Testing, Adjusting, and Balancing of Air Systems:
    - a. Constant-volume air systems.
    - b. Variable-air-volume systems.
  - 2. Testing, Adjusting, and Balancing of Hydronic Piping Systems:
    - a. Variable-flow hydronic systems.
  - 3. Testing, adjusting, and balancing of steam and condensate piping systems.
  - 4. Testing, adjusting, and balancing of equipment.
  - 5. Testing, adjusting, and balancing of existing HVAC systems and equipment.
  - 6. Duct leakage test verification.
  - 7. Pipe leakage test verification.
  - 8. HVAC-control system verification.
  - 9. Smoke-control system tests.

#### 1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers
- C. NEBB: National Environmental Balancing Bureau.
- D. SMACNA: Sheetmetal and Air Conditioning National Association
- E. TAB: Testing, adjusting, and balancing.
- F. TABB: Testing, Adjusting, and Balancing Bureau.
- G. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

- H. TDH: Total dynamic head.
- I. UFAD: Underfloor air distribution.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 75 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

#### 1.5 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by AABC, NEBB or TABB:
  - 1. TAB Field Supervisor: Employee of the TAB firm certified as a TAB specialist.
  - 2. TAB Technician: Employee of the TAB firm certified as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111-2008 (RA 2017) "Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems," Section 4, "Instrumentation."
- C. ASHRAE 62.1-2019 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing and Verification of Outdoor Air Performance."
- D. ASHRAE/IES 90.1-2019 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.3.3 - "System Balancing."
- E. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.
- F. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this specification.
- G. TAB Report Forms: Use standard TAB contractor forms meeting requirements of this section approved by Design Professional and the Commissioning Authority.

#### 1.6 FIELD CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

#### 1.7 COORDINATION

- A. Notice: Provide seven-day advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

### PART 2 - PRODUCTS (NOT APPLICABLE)

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data, including fan and pump curves.
1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible, and their controls are connected and functioning.
- J. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.
- K. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
  - 1. Equipment and systems to be tested.
  - 2. Strategies and step-by-step procedures for balancing the systems.
  - 3. Instrumentation to be used.
  - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
  - 1. General:
    - a. Permanent electrical-power wiring is complete.
    - b. Automatic temperature-control systems are operational.
  - 2. Airside:
    - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
    - b. Duct systems are complete with terminals installed.
    - c. Volume, smoke, and fire dampers are open and functional.
    - d. Equipment and duct access doors are securely closed.



- e. Clean filters are installed.
  - f. Fans are operating, free of vibration, and rotating in correct direction.
  - g. Variable-frequency controllers' startup is complete, and safeties are verified.
  - h. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - i. Windows and doors are installed and closed so indicated conditions for system operation can be met.
  - j. Suitable access to balancing devices and equipment is provided.
3. Hydronics:
- a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
  - b. Piping is complete with terminals installed.
  - c. Water treatment is complete.
  - d. Systems are flushed, filled, and air purged.
  - e. Strainers are pulled and cleaned.
  - f. Control valves are functioning in accordance with the sequence of operation.
  - g. Shutoff and balance valves have been verified to be 100 percent open.
  - h. Pumps are started, and proper rotation is verified.
  - i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
  - j. Variable-frequency controllers' startup is complete, and safeties are verified.
  - k. Suitable access to balancing devices and equipment is provided.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in this Section and the applicable portions of one of the following standards and guidelines. Where the selected standard does not include all required procedures, select from alternate standard. Where conflicting procedures are found, comply with requirements of ASHRAE Standard 111 as required by ASHRAE 62.1-2019, Section 7.2.2, "Air Balancing and Verification of Outdoor Air Performance."
  - 1. AABC "National Standards for Total System Balance."
  - 2. ASHRAE 111 "Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems."
  - 3. NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
  - 4. SMACNA "HVAC Systems - Testing, Adjusting and Balancing."
- B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Division 23.
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in units indicated on the drawings (IP or Metric).

### 3.4 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

- A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
  1. HVAC Motors.
  2. Pumps.
  3. Fans and ventilators.
  4. Terminal heating and cooling equipment.
  5. Heating Equipment.
  6. DX units (rooftop, condensing units, condensers, evaporators).
  7. Cooling and heat rejection equipment.
  8. Air-handling, heating and ventilating and energy-recovery units.

### 3.5 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
  1. Air Systems:
    - a. Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
    - b. Air Outlets and Inlets:  
Plus or minus 10 percent
  2. Hydronic Systems - Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent

### 3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' Record drawings duct layouts.

- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Check that duct sealing is complete as specified in Division 23.

### 3.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
    - c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
  - 2. Measure fan static pressures as follows:
    - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    - c. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
    - d. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    - e. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
    - f. Report artificial loading of filters at the time static pressures are measured.
  - 3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

4. Obtain approval from Design Professional, Owner, Construction Manager and Commissioning Authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts. Where sufficient space in sub-main and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
  2. Adjust submain and branch duct volume dampers for specified airflow.
  3. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust sub-main and branch ducts to indicated airflows within specified tolerances.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
  2. Measure inlets and outlets airflow. Measure terminal outlets using a direct-reading hood or outlet manufacturer written instructions and calculating factors.
  3. Adjust each inlet and outlet for specified airflow within specified tolerances without generating noise levels above limitations prescribed in the contract documents.
  4. Adjust patterns of adjustable outlets for proper distribution without drafts.
  5. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
  2. Re-measure and confirm that total airflow is within design.
  3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
  4. Mark all final settings.
  5. Test system in economizer mode. Verify proper operation and adjust if necessary.
  6. Measure and record all operating data.
  7. Record final fan-performance data.

### 3.8 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal

units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts

B. Adjust pressure independent, variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located roughly two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses. Where static pressure exceeds design setpoint by more than 15 percent, provide a static pressure profile of the system between the system fan and the control static pressure sensor for review by the Design Professional. Also include profile of suction or discharge side of the system opposite of the controlling sensor. Record terminals determined to require critical pressure setpoint.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
  - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
  - b. Measure airflow and adjust calibration factor for design maximum airflow. Record calibration factor. When maximum airflow is correct, balance the air outlets downstream from terminal units.
  - c. Adjust controls so that terminal is calling for minimum airflow. Measure airflow and adjust calibration factor for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow
  - d. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
  - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
  - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
  - c. Where duct conditions allow, measure airflow by main Pitot-tube traverse including multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
  - d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

6. Measure fan static pressures as follows:
  - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
  - b. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
  - c. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  - d. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
  - e. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
  - f. Report artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
  - a. Balance the return-air ducts and inlets.
  - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to DDC system contractor.
9. Verify final system conditions as follows:
  - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
  - b. Re-measure and confirm that total airflow is within design.
  - c. Re-measure final fan operating data, speed, volts, amps, and static profile.
  - d. Mark final settings.
  - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
  - f. Verify tracking between supply and return fans.

### 3.9 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
  1. Check expansion tank for proper setting.
  2. Check highest vent for adequate pressure.
  3. Check makeup water-station pressure gauge for adequate pressure for highest vent.

4. Check flow-control valves for specified sequence of operation and set at indicated flow.
  5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
  6. Set system controls so automatic valves are wide open to heat exchangers.
  7. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
  8. Verify that motor controllers are equipped with properly sized thermal protection.
  9. Check that air has been purged from the system by verifying a forceful liquid flow exiting from vents when manually operated.
  10. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
- D. Measure and record upstream and downstream pressure of each piece of equipment.
- E. Measure and record upstream and downstream pressure of pressure-reducing valves.
- F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
1. Check settings and operation of each safety valve. Record settings.

### 3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Adjust the variable-flow hydronic system as follows:
1. Verify pressure-differential sensor(s) location at end of main bypass branches.
  2. Compensating for Diversity: When the total flow rate of all terminal units is more than the indicated flow of the pumps, place a selected number of terminal units at minimum set-point flow with the remainder at maximum-flow condition until the total flow of the terminal units equals the indicated flow of the pump. Select the reduced-flow terminal units so they are distributed evenly among the branch piping.
    - a. Determine diversity factor.
    - b. Simulate system diversity by closing required number of control valves, as approved by the Design Professional.
  3. Adjust pumps to deliver total design pump flow.
    - a. Measure pump TDH as follows:
      - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      - 3) Convert pressure to head and correct for differences in gauge heights.
      - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed and pump at full speed. Note the point on manufacturer pump curve at zero flow, and verify that the pump has the intended impeller size.

- a) If impeller size is not correct, and actual required flow and head cannot be achieved, manufacturer shall replace impeller with correct size.
  - 5) With valves open, start pump at slow speed and then ramp speed up until design water flow is achieved. Do not operate at full speed and use throttling to achieve desired flow. If pump is operating below 45 Hz at design flow, notify the design professional who will determine if pump impellers need to be trimmed due to field conditions and to allow full range of turn down.
  - 6) Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
  - 7) Report flow rates that are not within plus or minus 10 percent of design.
  - b. Measure total water flow.
    - 1) Position valves for full flow through coils.
    - 2) Measure flow by main flow meter, if installed.
    - 3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
  - c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
1. Measure flow in main and branch pipes.
  2. Adjust main and branch balance valves for design flow.
  3. Re-measure each main and branch after all have been adjusted.
- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
1. Measure flow at terminals.
  2. Adjust each terminal to design flow.
  3. Re-measure each terminal after it is adjusted.
  4. For three-way control valves, after verifying flow with valve open to the terminal, position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
  5. Perform temperature tests after flows have been balanced.
- D. For systems with pressure-independent valves at terminals:
1. Measure differential pressure, and verify that it is within manufacturer's specified range.
  2. Perform temperature tests after flows have been verified.
- E. For systems without pressure-independent valves or flow-measuring devices at terminals:
1. Measure and balance coils by either coil pressure drop or temperature method.



2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- F. Open control valves that were shut. Close enough control valves that were previously open to maintain diversity, and balance terminals that were just opened.
- G. Prior to verifying final system conditions, determine system pressure-differential set point(s).
- H. Mark final settings and verify that memory stops have been set.
- I. Verify final system conditions as follows:
  1. Re-measure and confirm that total water flow is within design.
  2. Re-measure final pump operating data, TDH, volts, amps, and system pressure drop profile.
  3. Measure the differential-pressure-control-valve settings at conclusion of balancing.
  4. Check settings and operation of each safety valve. Record settings.
  5. Mark final settings.
- J. Verify that memory stops have been set.

### 3.11 PROCEDURES FOR MOTORS

- A. Motors 0.5 HP and Larger: Test at final balanced conditions and record the following data:
  1. Manufacturer's name, model number, and serial number.
  2. Motor horsepower rating.
  3. Motor rpm.
  4. Phase and hertz.
  5. Nameplate and measured voltage, each phase.
  6. Nameplate and measured amperage, each phase.
  7. Starter size and thermal-protection-element rating.
  8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

### 3.12 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

- A. Verify proper rotation of fan(s).
- B. Measure and record entering- and leaving-air temperatures.
- C. Measure and record entering and leaving refrigerant pressures.
- D. Measure and record operating data of compressor(s), fan(s), and motors.

3.13 PROCEDURES FOR AIR-COOLED CONDENSERS

- A. Verify proper rotation of fan(s).
- B. Measure and record entering- and leaving-air temperatures.
- C. Measure and record entering and leaving refrigerant pressures.
- D. Measure and record operating data of fan(s) and motor(s).

3.14 PROCEDURES FOR BOILERS

- A. Hydronic Boilers:
  - 1. Measure and record entering- and leaving-water temperatures.
  - 2. Measure and record water flow.
  - 3. Measure and record pressure drop.
  - 4. Measure and record relief valve(s) pressure setting.
  - 5. Capacity: Calculate in Btu/h of heating output.
  - 6. Fuel Consumption: If boiler fuel supply is equipped with flow meter, measure and record consumption.
  - 7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
  - 8. Fan, motor, and motor controller operating data.

3.15 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each hydronic coil:
  - 1. Entering- and leaving-water temperature.
  - 2. Water flow rate.
  - 3. Water pressure drop.
  - 4. Dry-bulb temperature of entering and leaving air.
  - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
  - 6. Airflow.
  - 7. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
  - 1. Nameplate data.
  - 2. Airflow.
  - 3. Entering- and leaving-air temperature at full load.
  - 4. Air pressure drop.
  - 5. Voltage and amperage input of each phase at full load.
  - 6. Calculated kilowatt at full load.
  - 7. Fuse or circuit-breaker rating for overload protection.

- C. Measure, adjust, and record the following data for each steam coil:
  - 1. Dry-bulb temperature of entering and leaving air.
  - 2. Airflow.
  - 3. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:
  - 1. Dry-bulb temperature of entering and leaving air.
  - 2. Wet-bulb temperature of entering and leaving air.
  - 3. Airflow.
  - 4. Air pressure drop.
  - 5. Entering and leaving refrigerant pressure and temperatures.

### 3.16 DUCT LEAKAGE TESTS

- A. Witness the duct leakage testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

### 3.17 PIPE LEAKAGE TESTS

- A. Witness the pipe pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

### 3.18 HVAC CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
  - 1. Verify HVAC control system is operating within the design limitations.
  - 2. Confirm that the sequences of operation are operating in compliance with Contract Documents.
  - 3. Verify that controllers are calibrated and function as intended.
  - 4. Verify that controller set points are as indicated.
  - 5. Verify the operation of lockout or interlock systems.
  - 6. Verify the operation of valve and damper actuators.
  - 7. Verify that controlled devices are properly installed and connected to correct controller.
  - 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
  - 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.19 PROCEDURES FOR SMOKE-CONTROL SYSTEM TESTING

- A. Before testing smoke-control systems, review design documents to understand operating requirements and design intent:
  - 1. Review boundaries of each smoke zone.
  - 2. Review location, size, and operating characteristics of equipment, such as smoke and fire smoke dampers.
  - 3. Review sequence of operation, operating status of equipment, and position of smoke and fire dampers for each smoke zone alarm condition.
  - 4. Review location and type of alarm detection used to initiate smoke control for each smoke zone.
  - 5. Review other smoke-control system attributes not listed but required for code compliance and acceptance by authorities having jurisdiction.
- B. Before testing smoke-control systems, verify that construction is complete and verify the integrity of each smoke-control zone boundary.
  - 1. Verify that windows, doors, walls, ceilings, and floors (six-sided boundary) are closed and that applicable safing, gasket, and firestops and sealants are installed.
  - 2. Report deficiencies and postpone testing until after the reported deficiencies are corrected.
- C. Measure and record barometric pressure, wind speed and direction, outdoor-air temperature, and relative humidity on each test day.
- D. Measure, adjust, and record airflow of each smoke-control system, with all fans that are a part of system operating as intended by the design.
  - 1. Measure, adjust, and record the airflow of each fan. For ducted systems, measure fan airflow by duct Pitot-tube traverse.
  - 2. Measure, adjust, and record the airflow of each exhaust inlet and supply outlet.
  - 3. Measure, adjust, and record airflow in main and branch ducts.
- E. Operational Tests:
  - 1. Check the proper activation of each zone of each smoke-control system in response to all means of activation, both automatic and manual.
  - 2. Check automatic activation in response to fire alarm signals received from the building's fire alarm system. Initiate a separate alarm for each means of activation to ensure that the proper operation of the correct zone of each smoke-control system occurs.
  - 3. Check and record proper operation of fans, dampers, and related equipment for each separate zone of each smoke-control system:
    - a. Zone in which a smoke-control system automatically activates.
    - b. Type of signal that activates smoke-control system, such as sprinkler flow or smoke detector.
    - c. Smoke zone(s) where maximum mechanical exhaust to the outside is implemented and no supply air is provided.

- d. Positive-pressure smoke-control zone(s) where maximum air supply is implemented and no exhaust to the outside is provided.
  - e. Fan(s) "ON" to implement the smoke-control system. Multiple- or variable-speed fans should be further noted to verify that the intended control configuration is achieved.
  - f. Fan(s) "OFF" to implement the smoke-control system.
  - g. Damper(s) "OPEN" or at an adjustable position where maximum airflow must be achieved.
  - h. Damper(s) "CLOSED" where no airflow should take place.
  - i. Auxiliary functions to achieve the smoke-control system configuration, such as changes or override of normal operating pressure and temperature-control set points.
  - j. If standby power is provided for the smoke-control system, test to verify that the system functions while operating under both normal and standby power.
  - k. Check operation in accordance with design indicated.
- F. AHJ Tests: Conduct additional tests required by authorities having jurisdiction. Unless required by authorities having jurisdiction, perform testing without the use of smoke or products that simulate smoke.
- G. Report: Prepare and submit a complete report of observations, measurements, and deficiencies. Include names and contact information of individuals conducting tests and of individuals witnessing tests.
- 3.20 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS
- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
- 1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fan(s).
  - 2. Measure and record flows, temperatures, and pressures of each piece of equipment in each hydronic system. Compare the values to design or nameplate information, where information is available.
  - 3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
  - 4. Check the refrigerant charge.
  - 5. Check the condition of filters.
  - 6. Check the condition of coils.
  - 7. Check the operation of the drain pan and condensate-drain trap.
  - 8. Check bearings and other lubricated parts for proper lubrication.
  - 9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing

equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:

1. New filters are installed.
  2. Coils are clean and fins combed.
  3. Drain pans are clean.
  4. Fans are clean.
  5. Bearings and other parts are properly lubricated.
  6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan speed and the face velocity of filters and coils.
  2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
  3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
  4. Balance each air outlet.

### 3.21 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### 3.22 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  2. Include a list of instruments used for procedures, along with proof of calibration.
  3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.

2. Fan curves.
  3. Manufacturers' test data.
  4. Field test reports prepared by system and equipment installers.
  5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
  2. Name and address of the TAB specialist.
  3. Project name.
  4. Project location.
  5. Architect's name and address.
  6. Engineer's name and address.
  7. Contractor's name and address.
  8. Report date.
  9. Signature of TAB supervisor who certifies the report.
  10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  11. Summary of contents, including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  12. Nomenclature sheets for each item of equipment.
  13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  14. Notes to explain why certain final data in the body of reports vary from indicated values.
  15. Test conditions for fans performance forms, including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.
    - d. Heating coil, dry-bulb conditions.
    - e. Face and bypass damper settings at coils.
    - f. Fan drive settings, including settings and percentage of maximum pitch diameter.
    - g. Variable-frequency controller settings for variable-air-volume systems.
    - h. Settings for pressure controller(s).
    - i. Other system operating conditions that affect performance.

16. Test conditions for pump performance forms, including the following:
  - a. Variable-frequency controller settings for variable-flow hydronic systems.
  - b. Settings for pressure controller(s).
  - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
  1. Quantities of outdoor, supply, return, and exhaust airflows.
  2. Water and steam flow rates.
  3. Duct, outlet, and inlet sizes.
  4. Pipe and valve sizes and locations.
  5. Terminal units.
  6. Balancing stations.
  7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units, include the following:
  1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Unit arrangement and class.
    - g. Discharge arrangement.
    - h. Sheave make, size in inches, and bore.
    - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
    - j. Number, make, and size of belts.
    - k. Number, type, and size of filters.
  2. Motor Data:
    - a. Motor make, and frame type and size.
    - b. Horsepower and speed.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches, and bore.
    - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
  3. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm.



- b. Total system static pressure in inches wg.
  - c. Fan speed.
  - d. Inlet and discharge static pressure in inches wg.
  - e. For each filter bank, filter static-pressure differential in inches wg.
  - f. Preheat-coil static-pressure differential in inches wg.
  - g. Cooling-coil static-pressure differential in inches wg.
  - h. Heating-coil static-pressure differential in inches wg.
  - i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
  - j. Outdoor airflow in cfm.
  - k. Return airflow in cfm.
  - l. Outdoor-air damper position.
  - m. Return-air damper position.
  - n. Exhaust airflow to recovery coil in cfm (L/s).
- F. Apparatus-Coil Test Reports:
- 1. Coil Data:
    - a. System identification.
    - b. Location.
    - c. Coil type.
    - d. Number of rows.
    - e. Fin spacing in fins per inch o.c.
    - f. Make and model number.
    - g. Face area in sq. ft..
    - h. Tube size in NPS.
    - i. Tube and fin materials.
    - j. Circuiting arrangement.
  - 2. Test Data (Indicated and Actual Values):
    - a. Airflow rate in cfm.
    - b. Average face velocity in fpm.
    - c. Air pressure drop in inches wg.
    - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
    - e. Return-air, wet- and dry-bulb temperatures in deg F.
    - f. Entering-air, wet- and dry-bulb temperatures in deg F.
    - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
    - h. Refrigerant expansion valve and refrigerant types.

- i. Refrigerant suction pressure in psig.
  - j. Refrigerant suction temperature in deg F.
- G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
  - 1. Unit Data:
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Fuel type in input data.
    - g. Output capacity in Btu/h.
    - h. Ignition type.
    - i. Burner-control types.
    - j. Motor horsepower and speed.
    - k. Motor volts, phase, and hertz.
    - l. Motor full-load amperage and service factor.
    - m. Sheave make, size in inches, and bore.
    - n. Center-to-center dimensions of sheave and amount of adjustments in inches.
  - 2. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm.
    - b. Entering-air temperature in deg F.
    - c. Leaving-air temperature in deg F.
    - d. Air temperature differential in deg F.
    - e. Entering-air static pressure in inches wg.
    - f. Leaving-air static pressure in inches wg.
    - g. Air static-pressure differential in inches wg.
    - h. Low-fire fuel input in Btu/h.
    - i. High-fire fuel input in Btu/h.
    - j. Manifold pressure in psig.
    - k. High-temperature-limit setting in deg F.
    - l. Operating set point in Btu/h.
    - m. Motor voltage at each connection.
    - n. Motor amperage for each phase.
    - o. Heating value of fuel in Btu/h.

- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and size.
    - e. Manufacturer's serial number.
    - f. Arrangement and class.
    - g. Sheave make, size in inches, and bore.
    - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
  2. Motor Data:
    - a. Motor make, and frame type and size.
    - b. Horsepower and speed.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches, and bore.
    - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
    - g. Number, make, and size of belts.
    - h. Heater size.
  3. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm.
    - b. Total system static pressure in inches wg.
    - c. Fan speed.
    - d. Discharge static pressure in inches wg.
    - e. Suction static pressure in inches wg.
    - f. Direction of rotation and revolutions per minute.
    - g. Fan curves showing variation of air flow with static pressure at operating speed and motor loading.
    - h. Actual air flow percentage above or below design.
- I. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
    - a. System fan and air-handling-unit number.
    - b. Location and zone.
    - c. Traverse air temperature in deg F.

- d. Duct static pressure in inches wg.
  - e. Duct size in inches.
  - f. Duct area in sq. ft..
  - g. Indicated airflow rate in cfm.
  - h. Indicated velocity in fpm.
  - i. Actual airflow rate in cfm.
  - j. Actual average velocity in fpm.
  - k. Barometric pressure in psig.
- J. Air-Terminal-Device Reports:
- 1. Unit Data:
    - a. System and air-handling unit identification.
    - b. Location and zone.
    - c. Apparatus used for test.
    - d. Area served.
    - e. Make.
    - f. Number from system diagram.
    - g. Type and model number.
    - h. Size.
    - i. Effective area in sq. ft..
  - 2. Test Data (Indicated and Actual Values):
    - a. Airflow rate in cfm.
    - b. Air velocity in fpm.
    - c. Preliminary airflow rate in cfm.
    - d. Preliminary velocity in fpm.
    - e. Final airflow rate in cfm.
    - f. Final velocity in fpm.
    - g. Space temperature in deg F.
- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
- 1. Unit Data:
    - a. System and air-handling-unit identification.
    - b. Location and zone.
    - c. Room or riser served.
    - d. Coil make and size.
    - e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
  - a. Airflow rate in cfm.
  - b. Entering-water temperature in deg F.
  - c. Leaving-water temperature in deg F.
  - d. Water pressure drop in feet of head or psig.
  - e. Entering-air temperature in deg F.
  - f. Leaving-air temperature in deg F.
- L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:
  1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Service.
    - d. Make and size.
    - e. Model number and serial number.
    - f. Water flow rate in gpm.
    - g. Water pressure differential in feet of head or psig.
    - h. Required net positive suction head in feet of head or psig.
    - i. Pump speed.
    - j. Impeller diameter in inches.
    - k. Motor make and frame size.
    - l. Motor horsepower and rpm.
    - m. Voltage at each connection.
    - n. Amperage for each phase.
    - o. Full-load amperage and service factor.
    - p. Seal type.
  2. Test Data (Indicated and Actual Values):
    - a. Static head in feet of head or psig.
    - b. Pump shutoff pressure in feet of head or psig.
    - c. Actual impeller size in inches.
    - d. Full-open flow rate in gpm.
    - e. Full-open pressure in feet of head or psig.
    - f. Final discharge pressure in feet of head or psig.
    - g. Final suction pressure in feet of head or psig.
    - h. Final total pressure in feet of head or psig.

- i. Final water flow rate in gpm.
  - j. Voltage at each connection.
  - k. Amperage for each phase.
- M. Boiler Test Reports
  - 1. Unit Data:
    - a. System identification.
    - b. Location.
    - c. Boiler type.
    - d. Make and model number.
  - 2. Test Data:
    - a. Hot Water Boilers
      - 1) Entering water temperature.
      - 2) Leaving water temperature.
      - 3) Water flow
- N. VFD Report Data:
  - 1. Manufacturer and model number.
  - 2. Line voltage (input).
  - 3. VA rating.
  - 4. Input current.
  - 5. Output current.
  - 6. Output frequency.
  - 7. Output voltage.
  - 8. Acceleration time.
  - 9. Deceleration time.
- O. Outdoor Air Data Report:
  - 1. Size of inlet.
  - 2. Actual free area.
  - 3. Manufacturer's test factor.
  - 4. Measured velocity.
  - 5. Outdoor air temperature.
- P. Instrument Calibration Reports:
  - 1. Report Data:
    - a. Instrument type and make.
    - b. Serial number.

- c. Application.
- d. Dates of use.
- e. Dates of calibration.

### 3.23 VERIFICATION OF TAB REPORT

#### A. TAB Specialist Initial Verification:

1. After testing and balancing are complete, TAB Specialist shall operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
  - a. Measure airflow of at least 10 percent of air outlets.
  - b. Measure water flow of at least 5 percent of terminals.
  - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
  - d. Verify that balancing devices are marked with final balance position.
  - e. Note deviations from the Contract Documents in the final report.

#### B. Final Verification:

1. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Owner, Design Professional, Construction Manager and Commissioning Authority.
2. Commissioning Authority or Design Professional shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
3. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
4. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.
5. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
  - a. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
  - b. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

#### C. Prepare test and inspection reports.

3.24      ADDITIONAL TESTS

- A.      Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B.      Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

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## SECTION 230700 - HVAC INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes insulating the following duct services:
  - 1. Combined Heating and Cooling Ducts – Climate Zones 5, 6, 7 and 8
  - 2. Unconditioned Outside Air Intake Ducts/Plena and Exhaust Relief Duct and Plena Inside the Building Envelope – Climate Zones 2 through 8
  - 3. Unconditioned Outside Air Intake Ducts/Plena and Exhaust/Relief Duct and Plena Outside the Building Envelope – Climate Zones 2 through 8
  - 4. Shower Exhaust Ducts – Climate Zones 0 through 8
- B. Section includes insulation for breeching, flues and connectors not factory insulated.
- C. Section includes insulating the following HVAC equipment that is not factory insulated:
  - 1. Cooling Coil and Humidifier Drain Pans
  - 2. Cooling System Equipment
  - 3. Heating Hot Water Equipment
- D. Section includes insulating the following HVAC piping systems
  - 1. Heating Hot Water Systems: 141 deg F to 200 deg F
  - 2. Heating Hot Water Systems: 85 deg F to 140 deg F
  - 3. Cooling Coil Condensate Piping and Equipment Drain Piping
  - 4. Air Conditioning Refrigerant Suction, Hot Gas, Outdoor Liquid Line and Hot Gas Piping
- E. Section includes insulation for Outdoor, Underground Piping (excluding loose fill insulated piping).
- F. Referenced Standards:
  - 1. ASTM International (ASTM)
  - 2. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE).
  - 3. North American Insulation Manufacturers Association (NAIMA).

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance, thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of field-applied jackets.
  - 2. Detail application at linkages of control devices.
  - 3. Detail application of protective duct shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 4. Detail insulation application at duct elbows, fittings, dampers, specialties and flanges for each type of insulation.
  - 5. Detail attachment and covering of equipment heat tracing inside insulation.
  - 6. Detail removable insulation at equipment connections.
  - 7. Detail field application for each equipment type.
  - 8. Detail application of protective piping shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 9. Detail attachment and covering of piping heat tracing inside insulation.
  - 10. Detail insulation application at pipe expansion joints for each type of insulation.
  - 11. Detail insulation application at pipe elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 12. Detail removable insulation at valves and piping specialties.

### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

#### 1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23.
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate clearance requirements with equipment Installer for equipment insulation application. Coordinate installation and testing of equipment heat tracing.
- D. Coordinate clearance requirements with piping Installer for piping insulation application. Coordinate installation and testing of piping heat tracing.

#### 1.7 SCHEDULING

- A. Schedule insulation application after pressure and leak testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

### PART 2 - PRODUCTS

#### 2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation Non-Plenum Applications: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials and Type I for tubular materials. For indoor applications insulation meet ASTM E84 Flame Spread and Smoke Developed ratings of 25/50 for thickness required. For duct applications, color shall be selected by the architect from manufacturer standard color options.
  1. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Aeroflex USA, Inc.; Aerocel,

- b. Armacell LLC; AP Armaflex and Armaflex FS,
  - c. K-Flex USA; Insul-Sheet and Insul-Tube,
  - d. Or approved equal.
- G. Flexible Elastomeric Insulation in Supply, Return, Exhaust, Relief and Ventilation Air Plenums: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials and Type I for tubular materials. For indoor applications insulation shall be listed and labelled to UL 723 or ASTM E84 Flame Spread and Smoke Developed ratings of 25/50 for thickness required. For duct applications, color shall be selected by the architect from manufacturer standard color options.
  - 1. **Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Armacell LLC; Armaflex ULTRA,
    - b. Or approved equal.
- H. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. Pittsburgh Corning Corporation,
    - b. Or approved equal.
  - 2. Block Insulation: ASTM C 552, Type I.
  - 3. Special-Shaped Insulation: ASTM C 552, Type III.
  - 4. Board Insulation: ASTM C 552, Type IV.
  - 5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
  - 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- I. Mineral-Fiber (Fiberglass) Blanket Duct Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I for insulation without jackets, Type II with factory-applied vinyl jacket, Type III with factory-applied FSK jacket or Type III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. CertainTeed Corp.; SoftTouch Duct Wrap,
    - b. Johns Manville; Microlite,
    - c. Knauf Insulation; Atmosphere Duct Wrap with ECOSE Technology,
    - d. Manson Insulation Inc.; Alley Wrap,
    - e. Owens Corning; SOFTR All-Service Duct Wrap,
    - f. Or approved equal.

- J. Rigid Mineral-Fiber (Fiberglass) Board Duct Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB.
1. For duct and plenum applications in mechanical rooms and concealed locations, provide insulation with factory applied FSK jacket.
  2. For duct and plenum applications exposed in occupied spaces, provide insulation with paintable factory applied ASJ jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  3. Provide insulation with factory applied ASJ for equipment. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  4. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. CertainTeed Corp.; Commercial Board,
    - b. Fibrex Insulations Inc.; FBX,
    - c. Johns Manville; 800 Series Spin-Glas,
    - d. Knauf Insulation; Earthwool Insulation Board with ECOSE Technology,
    - e. Manson Insulation Inc.; AK Board,
    - f. Owens Corning; Fiberglas 700 Series,
    - g. Or approved equal.
- K. Mineral-Fiber (Fiberglass), Preformed Pipe Insulation
1. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory and field installed jackets identified in pipe insulation schedules.
  2. Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory and field installed jackets identified in pipe insulation schedules.
  3. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Johns Manville; a Berkshire Hathaway company,
    - b. Knauf Insulation,
    - c. Manson Insulation Inc.,
    - d. Owens Corning,
    - e. Or approved equal.
- L. Polyisocyanurate: Prefabricated, rigid cellular polyisocyanurate material intended for use as piping thermal insulation. Comply with ASTM C591.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. Johns Manville; a Berkshire Hathaway company,
    - b. Or approved equal.

2. Prefabricated insulation, with factory-applied ASJ or with factory-applied ASJ-SSL. Provide with specified field applied jacket.
3. Type IV, except thermal conductivity (k-value) do not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
4. Flame-spread index is 25 or less, and smoke-developed index is 50 or less for thicknesses of up to 1.5 inch as tested in accordance with ASTM E84.
5. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
6. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

M. Semi-Rigid Mineral-Fiber (Fiberglass) Insulation

1. Duct Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Minimum nominal density is 2.5 lb/cu. ft.. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
2. Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Minimum nominal density is 2.5 lb/cu. ft.. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
3. [Available Manufacturers](#): Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
  - a. CertainTeed Corp.; CrimpWrap,
  - b. Johns Manville; MicroFlex,
  - c. Knauf Insulation; Earthwool Pipe & Tank Insulation with ECOSE Technology,
  - d. Knauf Insulation: Kwik-Flex Pipe & Tank Insulation,
  - e. Manson Insulation Inc.; AK Flex,
  - f. Owens Corning; Fiberglas Pipe and Tank Insulation,
  - g. [Or approved equal.](#)

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. [Available Manufacturers](#): Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
  - a. Ramco Insulation, Inc.; Super-Stik,
  - b. [Or approved equal.](#)

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. [Available Manufacturers](#): Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:

- a. Ramco Insulation, Inc.; Thermokote V,
  - b. Or approved equal.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
  - 1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote,
    - b. Or approved equal.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
  - 1. Adhesives shall have a VOC content of 250 g/L or less or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, 9 mcg/cu. m or 7 ppb, whichever is less, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Aeroflex USA, Inc.; Aeroseal Low VOC,
    - b. Armacell LLC; Armaflex 520BLV Adhesive,
    - c. K-Flex USA; 720-LVOC Contact Adhesive,
    - d. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75,
    - e. Or approved equal.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127,
    - b. Eagle Bridges - Marathon Industries; 225,
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70,
    - d. Or approved equal.
- D. ASJ, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82,
  - b. Eagle Bridges - Marathon Industries; 225,
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50,
  - d. Mon-Eco Industries, Inc.; 22-25,
  - e. Or approved equal.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
  1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Dow Corning Corporation; 739, Dow Silicone,
    - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive,
    - c. P.I.C. Plastics, Inc.; Welding Adhesive,
    - d. Speedline Corporation; Polyco VP Adhesive,
    - e. Or approved equal.
- F. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-97,
  - b. Eagle Bridges - Marathon Industries; 290,
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27,
  - d. Mon-Eco Industries, Inc.; 22-30,
  - e. Vimasco Corporation; 760,
  - f. Or approved equal.
- G. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
  1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84,
    - b. Or approved equal.

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.



1. VOC Content: 300 g/L or less.
  2. Low-Emitting Materials: Mastic coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, 9 mcg/cu. m or 7 ppb, whichever is less, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
1. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90,
    - b. Vimasco Corporation; 749,
    - c. Or approved equal.
  2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F.
  4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel,
    - b. Eagle Bridges - Marathon Industries; 570,
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96,
    - d. Or approved equal.
  2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
  3. Service Temperature Range: Minus 50 to plus 220 deg F.
  4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
  5. Color: White.
- D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10,
    - b. Eagle Bridges - Marathon Industries; 550,

- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50,
  - d. Mon-Eco Industries, Inc.; 55-50,
  - e. Vimasco Corporation; WC-1/WC-5,
  - f. Or approved equal.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F.
  4. Solids Content: 60 percent by volume and 66 percent by weight.
  5. Color: White.

## 2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
  1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2,
    - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36,
    - c. Vimasco Corporation; 713 and 714,
    - d. Or approved equal.
  2. Adhesives shall have a VOC content of 250 g/L or less.
  3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, 9 mcg/cu. m or 7 ppb, whichever is less, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
  4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
  5. Service Temperature Range: 0 to plus 180 deg F.
  6. Color: White.

## 2.6 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
  1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76,

- b. Eagle Bridges - Marathon Industries; 405,
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44,
    - d. Mon-Eco Industries, Inc.; 44-05,
    - e. Or approved equal.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Fire- and water-resistant, flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 40 to plus 250 deg F.
  5. Color: Aluminum.
  6. Sealant shall have a VOC content of 420 g/L or less.
  7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, 9 mcg/cu. m or 7 ppb, whichever is less, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
- B. ASJ Flashing Sealants and PVC Flashing Sealants:
  1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76,
    - b. Or approved equal.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Fire- and water-resistant, flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 40 to plus 250 deg F.
  5. Color: White.
- C. Joint Sealants:
  1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76,
    - b. Marathon Industries; 405,
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45,
    - d. Mon-Eco Industries, Inc.; 44-05,
    - e. Pittsburgh Corning Corporation; Pittseal 444,
    - f. Or approved equal.

## 2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
  - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I. Permeance of jacket shall not exceed 0.02 perm.
  - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I. Permeance of jacket shall not exceed 0.02 perm.
  - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II. Permeance of jacket shall not exceed 0.02 perm.

## 2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.
  - 1. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5,
    - b. Or approved equal
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.
  - 1. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab,
    - b. Vimasco Corporation; Elastafab 894,
    - c. Or approved equal.

## 2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..
  - 1. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59,
    - b. Or approved equal.

## 2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- C. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- D. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- E. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches OC and at end joints.
- F. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- G. PVC Jacket: 30 Mil, High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. [Johns Manville](#); Zeston,
    - b. [P.I.C. Plastics, Inc.](#); FG Series,
    - c. [Proto Corporation](#); LoSmoke,
    - d. [Speedline Corporation](#); SmokeSafe,
    - e. Or approved equal.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: White.
  4. Factory-fabricated tank heads and tank side panels.
- H. Metal Jacket:
1. [Available Manufacturers](#): Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. [Childers Brand, Specialty Construction Brands, Inc.](#), a business of H. B. Fuller Company; Metal Jacketing Systems,

- b. [ITW Insulation Systems](#); Aluminum and Stainless Steel Jacketing,
  - c. [RPR Products, Inc.](#); Insul-Mate,
  - d. Or approved equal.
- 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - a. Factory cut and rolled to size.
  - b. Finish and thickness are indicated in field-applied jacket schedules.
  - c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
  - d. Factory-Fabricated Fitting Covers:
    - 1) Same material, finish, and thickness as jacket.
    - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - 3) Tee covers.
    - 4) Flange and union covers.
    - 5) End caps.
    - 6) Beveled collars.
    - 7) Valve covers.
    - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- I. Underground Direct-Buried Piping Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
  - 1. [Available Manufacturers](#): Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. [Pittsburgh Corning Corporation](#); Pittwrap,
    - b. [Polyguard Products, Inc.](#); Insulrap No Torch 125,
    - c. Or approved equal.
- J. Self-Adhesive Outdoor Jacket: Minimum 12 mil thick, vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; UV resistant, zero permeability with white aluminum-foil facing, impact and tear resistant.
  - 1. [Available Manufacturers](#): Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. [Polyguard Products, Inc.](#); Alumaguard CoolWrap,
    - b. Venture Tape Corporation; VentureClad (White Embossed),
    - c. Or approved equal.

2. Subject to compliance with requirements for thickness, UV resistance, tear resistance and permeability, flexible elastomeric insulation manufacturer cladding may be used for outdoor insulation in lieu of field installed jacketing.

## 2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  1. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. **ABI, Ideal Tape Division;** 428 AWF ASJ,
    - b. **Avery Dennison Corporation, Specialty Tapes Division;** Fasson 0836,
    - c. **Compac Corporation;** 104 and 105,
    - d. **Venture Tape;** 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ,
    - e. **Knauf Insulation; EXPERT Tapes:** ASJ+ Tape OR ASJ Tape,
    - f. Or approved equal.
  2. Width: minimum 3 inches.
  3. Thickness: minimum 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  1. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. **ABI, Ideal Tape Division;** 491 AWF FSK,
    - b. **Avery Dennison Corporation, Specialty Tapes Division;** Fasson 0827,
    - c. **Compac Corporation;** 110 and 111,
    - d. **Venture Tape;** 1525 CW NT, 1528 CW, and 1528 CW/SQ,
    - e. **Knauf Insulation; EXPERT Tapes:** FSK Tape,

- f. Or approved equal.
  2. Width: minimum 3 inches.
  3. Thickness: minimum 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. [ABI, Ideal Tape Division](#); 370 White PVC tape,
    - b. [Compac Corporation](#); 130,
    - c. [Venture Tape](#); 1506 CW NS,
    - d. Or approved equal.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - a. [ABI, Ideal Tape Division](#); 488 AWF,
    - b. [Avery Dennison Corporation](#), Specialty Tapes Division; Fasson 0800,
    - c. [Compac Corporation](#); 120,
    - d. [Venture Tape](#); 3520 CW,
    - e. Knauf Insulation; EXPERT Tapes: 2 MIL Foil Tape,
    - f. Or approved equal.
  2. Width: minimum 2 inches.
  3. Thickness: minimum 3.7 mils.
  4. Adhesion: 100 ounces force/inch in width.
  5. Elongation: 5 percent.
  6. Tensile Strength: 34 lbf/inch in width.



## 2.12 SECUREMENTS

### A. Bands:

1. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
  - a. **ITW Insulation Systems;** Gerrard Strapping and Seals.
  - b. **RPR Products, Inc.;** Insul-Mate Strapping, Seals, and Springs.
  - c. Or approved equal.
2. Wing seals are primarily used for fastening bands together. Closed seals are occasionally used for large, 84-inch- diameter applications and where fastening bands are used with springs. Wing seals are reusable; closed seals are not.
3. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 1/2 inch wide with wing seal.
4. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 1/2 inch wide with wing seal.
5. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

### B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- or 0.135-inch- diameter shank, length to suit depth of insulation indicated.
  - a. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - 1) **AGM Industries, Inc.;** CWP-1
    - 2) **GEMCO;** CD
    - 3) **Midwest Fasteners, Inc.;** CD
    - 4) **Nelson Stud Welding;** TPA, TPC, and TPS.
    - 5) Or approved equal.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- or 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  - a. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - 1) **AGM Industries, Inc.;** CHP-1.
    - 2) **GEMCO;** Cupped Head Weld Pin.
    - 3) **Midwest Fasteners, Inc.;** Cupped Head.

- 4) Nelson Stud Welding; CHP.
  - 5) Or approved equal.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - 1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
    - 2) GEMCO; Perforated Base.
    - 3) Midwest Fasteners, Inc.; Spindle.
    - 4) Or approved equal.
  - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Copper- or zinc-coated, low-carbon steel, or Aluminum, or Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - 1) GEMCO; Nylon Hangers.
    - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
    - 3) Or approved equal.
  - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
  - c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:

- a. **Available Manufacturers:** Subject to compliance with requirements, available products that may be incorporated into the Work include the following, or approved equal:
    - 1) AGM Industries, Inc; Tactoo Self-Adhering Insul-Hangers.
    - 2) GEMCO; Peel and Press.
    - 3) Midwest Fasteners, Inc.; Self Stick.
    - 4) Or approved equal.
  - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Copper- or zinc-coated, low-carbon steel, or Aluminum, or Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel, or aluminum, or stainless-steel sheet matching hanger materials, with beveled edge sized to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. **Available Manufacturers:** Subject to compliance with requirements:
    - 1) AGM Industries, Inc.; RC-150,
    - 2) GEMCO; R-150,
    - 3) Midwest Fasteners, Inc.; WA-150,
    - 4) Nelson Stud Welding; Speed Clips.
    - 5) Or approved equal.
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. **Available Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - 1) GEMCO,
    - 2) Midwest Fasteners, Inc.,
    - 3) Or approved equal.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.
- 1. **Available Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

- a. C and F Wire,
- b. Or approved equal.

## 2.13 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Duct Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application including dirt, scale, oil, rust and other foreign matter.
- B. Equipment Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- C. Piping Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- D. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- E. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Protect insulation from exposure to moisture prior to and after installation. All insulation other than flexible elastomeric that becomes wet shall be replaced at no cost to the project.
- B. Install insulation after systems have been tested, proved tight. Remove dirt, scale, oil, rust and other foreign matter prior to installation of insulation.

- C. Install insulation, mastics, adhesives, coatings, covers, weather-protection and other work in accordance with manufacturer's recommendations. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic. Leakage in vapor barrier or voids in insulation will not be accepted.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated and cannot be maintained at hanger penetrations, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Where blanket type duct insulation is used, provide a 6-inch long full perimeter section of rigid board insulation with vapor barrier at each unistrut and angle iron support. Seal joints between rigid board and blanket insulation vapor barriers with vapor-barrier mastic.
  - 4. Install insulated insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 5. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied non-self-sealing jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches OC
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at manufacturer recommended spacing but space no further than 4 inches OC
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
- L. Install insulation with self-sealing factory-applied jackets as follows:

1. Locate all longitudinal pipe insulation jacketing laps in least visible location.
  2. Draw jacket tight and smooth.
  3. For proper sealing, seal lap joints with reasonable pressure being applied with a plastic squeegee or sealing tool.
  4. Vapor seal all circumferential joints with factory furnished matching pressure sensitive butt strips installed with reasonable pressure being applied with a plastic squeegee or sealing tool.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. Insulate flex connections to same thickness as material as adjoining system
- Q. Duct Insulation Requirements:
1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
  2. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
  3. Insulate standing seams with same material and thickness as duct.
  4. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
  5. Insulate flex connections to same thickness as material as adjoining ductwork.
- R. Equipment Insulation Requirements:
1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
  2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
  3. For above ambient services, do not install insulation to the following:
    - a. Vibration-control devices.
    - b. Testing agency labels and stamps.
    - c. Nameplates and data plates.
    - d. Manholes.
    - e. Handholes.
    - f. Cleanouts.
- S. Piping Insulation Requirements:

1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
3. For piping systems operating below 60 deg F, seal ends of pipe insulation onto the jacket and seal insulation onto the pipe with approved fire-retardant vapor barrier mastic, at flanges, valves and fittings and at intervals of no more than every fourth section of pre-formed insulation or 20 feet on continuous runs of piping whichever is less.
4. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
5. Insulate flex connections to same thickness as material as adjoining piping.
6. For above ambient services, do not install insulation to the following:
  - a. Vibration-control devices.
  - b. Testing agency labels and stamps.
  - c. Nameplates and data plates.
  - d. Manholes.
  - e. Handholes.
  - f. Cleanouts.

### 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant.
  3. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
    - a. For insulated piping penetrating the building roof, insulate section of piping passing through from 6 inches inside the envelope to 6 inches above the end of the sleeve with a section of rigid polyisocyanurate pipe insulation with thickness to match outdoor insulation thickness. Provide section with field applied aluminum jacket with moisture barrier over entire section passing through the sleeve. Seal all insulation joints and section ends with vapor retarder mastic.
  4. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  5. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant.
  3. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
    - a. For insulated piping penetrating the building exterior walls, insulate section of piping passing through from 6 inches inside the envelope to 6 inches past the end of the sleeve with a section of rigid polyisocyanurate pipe insulation with thickness to match outdoor insulation thickness. Provide section with field applied aluminum jacket with moisture barrier over entire section passing through the sleeve. Seal all insulation joints and section ends with vapor retarder mastic.
  4. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  5. Seal jacket to wall flashing with flashing sealant.
  - D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire-Rated): Install insulation continuously through walls and partitions.
  - E. Ductwork Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
    1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.
  - F. Duct Insulation Installation at Floor Penetrations:
    1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
    2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.
  - G. Piping Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
    1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.
  - H. Piping Insulation Installation at Floor Penetrations:
    1. Pipe: Install insulation continuously through floor penetrations.
    2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.
- 3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION
- A. Seal longitudinal seams and end joints with manufacturer recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
  - B. Insulation Installation on Pipe Flanges:
    1. Install pipe insulation to outer diameter of pipe flange.



2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  4. Secure insulation to flanges and seal seams with manufacturer recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install removable preformed valve covers and covers for specialties manufactured of same material as pipe insulation when available.
  2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body or specialties. Arrange insulation to permit access to packing and to allow operation without disturbing insulation.
  3. Install insulation to flanges as specified for flange insulation application.
- E. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area recommended by the insulation manufacturer but no less than for 50 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches OC
    - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches OC each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not over compress insulation during installation. Maximum allowable compressions shall be as recommended by the insulation manufacturer.
    - e. Impale insulation over pins and attach speed washers.

- f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch OC. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 20-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
  - 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches OC.
  - 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  - 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches OC.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
  - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area recommended by the insulation manufacturer but no less than for 50 percent coverage of duct and plenum surfaces.
  - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches OC.
    - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches OC each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not over-compress insulation during installation.
    - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch OC. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
  5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches OC.
- C. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  3. For insulation with factory-applied jackets on above-ambient surfaces, secure using the self-seal system per manufacturer's recommendations or for non-self-seal systems, secure laps with outward-clinched staples at 6 inches OC.
  4. For insulation with factory-applied jackets on below-ambient surfaces, secure using the self-seal systems per manufacturer's recommendations, or for non-self-seal systems, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- D. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
  4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- E. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

**F. Insulation Installation on Valves and Pipe Specialties:**

1. Install removable preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body and specialties.
3. Arrange insulation to permit access to packing and to allow operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

**3.7 FIELD-APPLIED JACKET INSTALLATION**

- A.** Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B.** Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C.** Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D.** Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches OC and at end joints.

**3.8 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION**

- A.** Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area recommended by the insulation manufacturer but no less than for 50 percent coverage of tank and vessel surfaces.
  2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
  3. Protect exposed corners with secured corner angles.
  4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
    - a. Do not weld anchor pins to ASME-labeled pressure vessels.
    - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches OC in both directions.
    - d. Do not over-compress insulation during installation.
    - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    - f. Impale insulation over anchor pins and attach speed washers.
    - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
  6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches OC. Install a wire ring around each end and around outer periphery of center openings, and stretch pre-stressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches OC. Use this network for securing insulation with tie wire or bands.
  7. Stagger joints between insulation layers at least 3 inches.
  8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
  9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
  10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply manufacturer recommended coverage of adhesive but no less than 50% to surface with manufacturer's recommended adhesive.
  2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
  2. Fabricate boxes from galvanized steel for indoor pumps and aluminum or stainless steel, at least 0.050 inch thick.
  3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

### 3.9 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties (except steam traps)\_with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves and specialties using removable preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gauges, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.
- 3.10 INSTALLATION OF CALCIUM SILICATE INSULATION
- A. Insulation Installation on Boiler Breechings, Flues and Connectors:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
  2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

**B. Insulation Installation on Straight Pipes and Tubes:**

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

**C. Insulation Installation on Pipe Flanges:**

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

**D. Insulation Installation on Pipe Fittings and Elbows:**

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

**E. Insulation Installation on Valves and Pipe Specialties:**

1. Install removable mitered segments of calcium silicate insulation to valve body and specialties. Arrange insulation to permit access to packing and to allow operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

**3.11 INSTALLATION OF CELLULAR-GLASS INSULATION**

**A. Insulation Installation on Straight Pipes and Tubes:**

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.



2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches OC
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

**B. Insulation Installation on Pipe Flanges:**

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

**C. Insulation Installation on Pipe Fittings and Elbows:**

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

**D. Insulation Installation on Valves and Pipe Specialties:**

1. Install removable preformed sections of cellular-glass insulation to valve body and specialties.
2. Arrange insulation to permit access to packing and to allow operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

**3.12 FINISHES**

**A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 for exterior and interior painting.**

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
  - a. Finish Coat Material: Interior, flat, latex-emulsion size.

**B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating. Coating for outdoor insulation shall be UV resistant and waterproof.**

**C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.**

**D. Do not field paint aluminum or stainless-steel jackets.**

**3.13 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
  - 2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two location(s) for each type of equipment defined in the Part 3. For large equipment, remove only a portion adequate to determine compliance.
  - 3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

**3.14 DUCT INSULATION SCHEDULE GENERAL**

- A. Items Not Insulated:
  - 1. Fibrous-glass ducts.
  - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA scheduled values below.
  - 3. Factory-insulated flexible ducts.
  - 4. Factory-insulated plenums and casings.
  - 5. Vibration-control devices.
  - 6. Factory-insulated access panels and doors.

**3.15 DUCT AND PLENUM INSULATION SCHEDULE**

- A. Provide insulation materials and thicknesses identified below. If more than one material is listed for a duct location, selection from materials listed is Division 23 option.
- B. Duct Insulation Schedules:
  - 1. Where application of rigid versus blanket insulation on components such as coils and supply fans is to be based on the height of a component, height shall be determined based on the bottom of the component listed. Extend applicable insulation over the entire component before transitioning to alternate material. For ductwork, transition from blanket to rigid insulation shall occur no lower than height listed.

2. Exposed ductwork between air volume terminal or local heating or cooling unit mounted within the space served and associated diffusers or registers does not require external insulation. Where air volume terminal or local heating or cooling unit are mounted outside the space served, insulate ductwork between the air volume terminal or local heating or cooling unit and the wall of the space served.

Combined Heating and Cooling Supply, Return and Heat/Energy Recovery System Exhaust Ducts Climate Zone 5, 6, 7 and 8						
Duct Location	Minimum As-Installed R-Value	Insulation Type	Minimum Thickness (inches)	Minimum Density (lb/cu.ft)	Factory Applied Jacket	Field Applied Jacket
All ductwork, plena, duct mounted coils and supply fans exterior to building envelope. For rectangular and flat oval ductwork taper top insulation to prevent water accumulation by increasing thickness 1/8" per foot up from minimum listed to high point for drainage.	R-12.0	Rigid Mineral-Fiber Board	3.0	6.0	FSK	Self-Adhesive Outdoor Jacket
		Semi-Rigid Mineral-Fiber Board	3.0	1.5	FSK	
		Flexible Elastomeric	3.0	N/A	N/A	
All concealed ductwork, plena, duct mounted coils and supply fans in unconditioned spaces including shafts, non-plenum return ceiling cavities and crawlspaces (ventilated and non-ventilated) and all exposed ductwork, plena, duct mounted coils and supply fans in mechanical rooms located more than 10 feet above finished floor.	R-6.0	Mineral-Fiber Blanket	2.0	1.0	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	1.5	1.5	FSK	N/A
All exposed ductwork, plena, duct mounted coils and supply fans in mechanical rooms 10 feet or less above finished floor.	R-6.0	Rigid Mineral-Fiber Board	1.5	6.0	FSK	N/A
Concealed supply ductwork, plena, duct mounted coils and supply fans in indirectly conditioned spaces including return air plenums with or without exposed roofs above and exposed ductwork in spaces having operable envelope elements (windows and doors) including loading dock areas.	R-1.9	Mineral-Fiber Blanket	1.5	0.75	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	1.5	1.5	FSK	N/A
		Listed and Labelled Flexible Elastomeric	0.5	N/A	N/A	N/A
All round ductwork and supply fans in mechanical rooms and all round ductwork in exposed location below 10 feet above finished floor.	R-6.0	Semi-Rigid Mineral-Fiber Board	1.5	1.5	FSK	N/A
Backs of air outlets and outlet plenums with face area larger than 5 square feet that are exposed to unconditioned and indirectly conditioned spaces.	R-2.0	Mineral-Fiber Blanket	1.5	0.75	FSK	N/A
		Listed and Labelled Flexible Elastomeric	0.5	N/A	N/A	N/A
All exposed supply ductwork passing through occupied spaces from heating and cooling unit or shaft to the supply air terminal box inlet or wall of space served and ductwork between the	R-1.9	Rigid Mineral-Fiber Board	1.5	3.0	ASJ	N/A
		Semi-Rigid Mineral-Fiber Board	1.5	1.5	ASJ	N/A

Combined Heating and Cooling Supply, Return and Heat/Energy Recovery System Exhaust Ducts Climate Zone 5, 6, 7 and 8						
Duct Location	Minimum As-Installed R-Value	Insulation Type	Minimum Thickness (inches)	Minimum Density (lb/cu.ft)	Factory Applied Jacket	Field Applied Jacket
terminal box and the wall of space served.		Flexible Elastomeric	0.5	N/A	N/A	N/A

Unconditioned Outside Air Intake Ducts/Plena and Exhaust/Relief Duct/Plena Inside Building Envelope Climate Zones 2 Through 8						
Duct Location	Minimum As-Installed R-Value	Insulation Type	Minimum Thickness (inches)	Minimum Density (lb/cu.ft)	Factory Applied Jacket	Field Applied Jacket
For outside air intakes, all ductwork and plena between the building envelope and the first system heating coil, cooling coil or air handling unit connection.	R-12.0	Rigid Mineral-Fiber Board	3.0	6.0	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	3.0	1.5	FSK	
For exhaust/relief ducts and plena, all ductwork and plena between the building envelope and first system isolation damper.	R-12.0	Rigid Mineral-Fiber Board	3.0	6.0	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	3.0	1.5	FSK	

Unconditioned Outside Air Intake Ducts/Plena and Exhaust/Relief Duct/Plena Outside Building Envelope Climate Zones 2 Through 8						
Duct Location	Minimum As-Installed R-Value	Insulation Type	Minimum Thickness (inches)	Minimum Density (lb/cu.ft)	Factory Applied Jacket	Field Applied Jacket
For outside air intakes where isolation damper between indoors and outdoors is located outdoors, all rectangular ductwork and plena between the isolation damper and building envelope penetration.	R-12.0	Rigid Mineral-Fiber Board	3.0	6.0	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	3.0	1.5	FSK	
For exhaust/ relief ducts and plena where isolation damper between indoors and outdoors is located outdoors, all rectangular ductwork and plena between the isolation damper and the building envelope.	R-12.0	Rigid Mineral-Fiber Board	3.0	6.0	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	3.0	1.5	FSK	

Shower Exhaust Ducts Climate Zones 0 Through 8						
Duct Location	Minimum As-Installed R-Value	Insulation Type	Minimum Thickness (inches)	Minimum Density (lb/cu.ft)	Factory Applied Jacket	Field Applied Jacket
All ductwork and plena exterior to building envelope. For exterior ductwork taper insulation to prevent water accumulation by increasing thickness from minimum listed to high point for drainage.	R-3.5	Rigid Mineral-Fiber Board	1.0	6.0	FSK	Self-Adhesive Outdoor Jacket
		Semi-Rigid Mineral-Fiber Board	1.5	1.5	FSK	
All ductwork and plena in unconditioned shafts and in mechanical spaces (prior to recovery device or air handling unit return connection only).	R-3.5	Rigid Mineral-Fiber Board	1.0	6.0	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	1.5	1.5	FSK	

### 3.16 BREECHING, FLUES AND CONNECTORS INSULATION SCHEDULE

- A. Breeching, flues and connector insulation shall be one of the following:
1. Calcium Silicate: 4 inches thick.
  2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
  3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

### 3.17 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option. Refer to duct insulation tables for supply fan and duct mounted coils requirements.
- B. Insulate indoor and outdoor equipment that is not factory insulated.

Cooling Coil and Humidifier Drain Pans		
Insulation Type	Minimum Thickness (inch)	Factory Applied Jacket
Rigid Mineral-Fiber Board: Minimum Density = 6 lb/cu.ft	1	FSK
Semi-Rigid Mineral-Fiber Board: Minimum Density = 1.5 lb/cu.ft		
Flexible Elastomeric - Provide listed and labelled insulation in active plenums.		N/A

Heating Hot Water Equipment Insulation Schedule					
Equipment Type	Insulation Type	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket – Outdoor Only
Heating-hot-water pumps	Rigid Mineral-Fiber Board: Minimum Density = 6 lb/cu.ft	1	2	FSK	Self-Adhesive Outdoor Jacket
Heating-hot-water air-separator	Semi-Rigid Mineral-Fiber Board: Minimum Density = 1.5 lb/cu.ft				
Piping system filter-housing					
Heat-exchanger (water-to-water for heating service)	Rigid Mineral-Fiber Board: Minimum Density = 6 lb/cu.ft	2	4	FSK	Self-Adhesive Outdoor Jacket
Heating-hot-water system tanks, heat recovery tanks and thermal storage tanks	Semi-Rigid Mineral-Fiber Board: Minimum Density = 1.5 lb/cu.ft				
Radiant Heating Panel and Exposed Bottom Surface of Radiant Floor Heating. Adjacent building envelope insulation counts towards the specified minimum R-Value.	Mineral-Fiber Blanket: Minimum Density = 0.75 lb/cu.ft, Minimum R-Value = 3.5.	1.5	N/A	N/A	N/A

### 3.18 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.19 PIPING INSULATION SCHEDULE

- A. Provide insulation materials and thicknesses scheduled for each system type and pressure/temperature range. If more than one material is listed for a system, selection from materials listed is Division 23 option.
- B. For dual temperature systems (heating and cooling), provide thickness equal to greater of heating or cooling scheduled value. Dual temperature piping shall also meet all vapor barrier requirements for cooling insulation (perm rating).
- C. Insulation for pre-insulated piping shall meet all specified requirements.
- D. Insulate piping operating at temperatures below 40 deg F and systems operating between 40 deg F to 65 deg F in accordance with NAIMA Guide to Insulating Chilled Water Piping Systems with Mineral Fiber Pipe Insulation. Comply with all recommendations including but not limited to the requirement for vapor dams every fourth section of insulation.

- E. Outdoor piping insulation requirements apply to all piping outside the building envelope and including pipes in unconditioned piping vestibules connected to outdoor equipment.
- F. Pipe Insulation Schedules:

Heating Hot Water Systems: 85 deg F to 140 deg F						
Insulation Conductivity Btu-in/hr-deg F-SF at Mean Temp (deg F)	Insulation Type	Pipe Size (inch)	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket
0.22 to 0.28 at 100	Mineral Fiber (Fiberglass) Preformed Pipe, Type I or Pipe and Tank Insulation for 14" and Larger Pipe Size	Less than 1	1.0	2.0	ASJ or ASJ-SSL	Indoor: PVC for exposed piping in mechanical rooms when mounted 10 feet or lower above finished floor  Outdoor: Aluminum with Moisture Barrier
		1 to Less than 1.5	1.0	2.0		
		1.5" to Less than 4	1.5	3.0		
		4 to Less than 8	1.5	3.0		
		8 and Larger	1.5	3.0		



Cooling and Glycol Energy Recovery Systems: Below 40 deg F Applies to the Following Systems: Chilled Water, Refrigerant, Brine, Glycol Energy Recovery Systems (winter mode), Cooling Tower/Condenser Water Piping When Used for Winter Free Cooling and All Outdoor Heat Traced Piping						
Insulation Conductivity Btu-in/hr-deg F-SF at Mean Temp (deg F)	Insulation Type	Pipe Size (inch)	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket
0.20 to 0.26 at 50	Mineral Fiber (Fiberglass) Preformed Pipe, Type I or Pipe and Tank Insulation for 14" and Larger Pipe Size	Less than 1	1.5	3.0	ASJ or ASJ-SSL	Indoor: PVC for exposed piping in mechanical rooms when mounted 10 feet or lower above finished floor  Outdoor: Aluminum with Moisture Barrier
		1 to Less than 1.5	1.5	3.0		
		1.5 to Less than 4	1.5	3.0		
		4 to Less than 8	1.5	3.0		
		8 and Larger	1.5	3.0		

Cooling and Glycol Energy Recovery Systems: 40 deg F to 65 deg F Applies to the Following Systems: Chilled Water, Refrigerant, Brine, Glycol Energy Recovery Systems (winter mode), Cooling Tower/Condenser Water Piping When Used for Winter Free Cooling and All Outdoor Heat Traced Piping						
Insulation Conductivity Btu-in/hr-deg F-SF at Mean Temp (deg F)	Insulation Type	Pipe Size (inch)	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket
0.21 to 0.27 at 75	Mineral Fiber (Fiberglass) Preformed Pipe, Type I or Pipe and Tank Insulation for 14" and Larger Pipe Size	Less than 1	1.5	3.0	ASJ or ASJ-SSL	Indoor: PVC for exposed piping in mechanical rooms when mounted 10 feet or lower above finished floor  Outdoor: Aluminum with Moisture Barrier
		1 to Less than 1.5	1.5	3.0		
		1.5 to Less than 4	1.5	3.0		
		4 to Less than 8	1.5	3.0		
		8 and Larger	1.5	3.0		

Cooling Coil Condensate Piping and Equipment Drain Piping: All						
Insulation Conductivity Btu-in/hr-deg F-SF at Mean Temp (deg F)	Insulation Type	Pipe Size (inch)	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket
Mineral Fiber with Conductivity = 0.20 to 0.26 at 50  Flexible Elastomeric with Conductivity = 0.26 at 0 (2013 ASHRAE Fundamentals Handbook)	Mineral Fiber (Fiberglass) Preformed Pipe, Type I or Flexible Elastomeric - Provide listed and labelled insulation in active plenums.	Less than 1	0.75	2.0	ASJ or ASJ-SSL for Mineral Fiber  N/A for Flexible Elastomeric	Indoor Mineral Fiber: PVC for exposed piping in mechanical rooms when mounted 10 feet or lower above finished floor.  Indoor Flexible Elastomeric: N/A  Outdoor Mineral Fiber: Aluminum with Moisture Barrier  Outdoor Flexible Elastomeric: Glass-Fiber Cloth
		1 to Less than 1.5	0.75	2.0		
		1.5 to Less than 4	0.75	2.0		
		4 to Less than 8	0.75	2.0		
		8 and Larger	0.75	2.0		

Air Conditioning System Refrigerant Suction, Outdoor Liquid Line and Hot Gas Piping: All Minimum Pipe Operating Temperature 40 deg F						
Insulation Conductivity Btu-in/hr-deg F-SF at Mean Temp (deg F)	Insulation Type	Pipe Size (inch)	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket
0.26 at 0 (2013 ASHRAE Fundamentals Handbook)	Flexible Elastomeric - Provide listed and labelled insulation in active plenums.	Less than 3	1.5	1.5	N/A	Indoor: N/A  Outdoor: Glass-Fiber Cloth
		3 to 4	1.5	2.0		
		6 to 8	1.5	2.5		
		10 to 14	1.5	3.0		
		16 to 24	1.5	3.5		

3.20 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Refer to Duct, Plenum, Equipment and Pipe insulation schedules for outdoor field applied jacketing requirements. If more than one material is listed, selection from materials listed is Contractor's option.
- C. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

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## SECTION 230800 - COMMISSIONING OF HVAC

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
  - 1. Division 01 "General Commissioning Requirements" for general commissioning process requirements.

#### 1.3 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

#### 1.5 ALLOWANCES

- A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 "Allowances."

#### 1.6 UNIT PRICES

- A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

**1.7 CONTRACTOR'S RESPONSIBILITIES**

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meeting.
- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

**1.8 CXA'S RESPONSIBILITIES**

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

**1.9 COMMISSIONING DOCUMENTATION**

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
  - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
  - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
  - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
  - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
  - 5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
  - 6. Test and inspection reports and certificates.
  - 7. Corrective action documents.
  - 8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
  - 1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
  - 2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
  - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
  - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

### 3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R Contractor, testing and balancing Contractor, and HVAC&R Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

### 3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in HVAC boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.
- B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 for instrumentation and control for HVAC and sequence and operations for HVAC controls. Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
  - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of

piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.

2. Description of equipment for flushing operations.
  3. Minimum flushing water velocity.
  4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of gas and hot water systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION

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## SECTION 230900 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. DDC system for monitoring and controlling of HVAC systems including control components for terminal heating and cooling units not supplied with factory-wired control components.
  - 2. This Section shall provide electric circuit breakers and all power wiring from normal and standby power panels to each DDC system component.
  - 3. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation;
    - a. Ductwork automatic control dampers, airflow stations and terminal unit controllers.
    - b. Hydronic piping control valves, flow switches, flow meters, temperature sensor wells and sockets.
    - c. Refrigerant piping pressure and temperature sensor wells and sockets.
  - 4. Installation of products furnished under other sections;
    - a. Refrigerant leak detection system.
    - b. Packaged equipment thermostats and duct static pressure sensors.
  - 5. Integration with equipment furnished by other sections with packaged controls;
    - a. Boiler and boiler plant controls.
    - b. Packaged rooftop unit controls including discharge air temperature, economizer and air volume controls.
    - c. Crossflow sensors provided on VAV terminal units.
    - d. Variable frequency drives.
    - e. Duct mounted smoke detectors.
    - f. Duct fire-smoke dampers.
    - g. Lighting controls.
  - 6. Control valves and actuators for DDC systems.

7. Control dampers and actuators for DDC systems.
8. Sequence of operations outlined on the drawings.

B. Related Sections:

1. Division 26 and Division 27 for power and communications cabling, raceways, pathways, power and communication component identification requirements.

1.3 DEFINITIONS

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. BACnet Specific Definitions:
1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
  2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
  3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
  4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
  5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.
- D. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are included: Network Controller, Programmable Application Controller, and Application-Specific Controller.
- E. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
- F. COV: Change of value.
- G. Cv: Design valve coefficient.
- H. DDC: Direct-digital control.
- I. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work.
- J. Digital: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Binary" is sometimes used interchangeably with "Digital" to indicate a two-state signal.
- K. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.

- L. E/P: Voltage to pneumatic.
- M. Ethernet: Local area network based on IEEE 802.3 collection of standards. Trademark for a system of exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables. Ethernet is a registered trademark of Digital Equipment Corporation, Intel, and Xerox and is the basis for IEEE 8802-3
- N. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- O. HLC: Heavy load conditions.
- P. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), digital input (DI), analog output (AO) and digital output (DO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Binary," (BI) and (BO) is sometimes used interchangeably with "Digital," (DI) and (DO) respectively.
- Q. I/P: Current to pneumatic.
- R. Internet Protocol (IP): Global network that connects operator workstations and other host computers, servers and other devices to share information.
- S. LAN: Local area network.
- T. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- U. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.
- V. Modbus TCP/IP: An open protocol for exchange of process data.
- W. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- X. MTBF: Mean time between failures.
- Y. NBR: Nitrile butadiene rubber.
- Z. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers that communicates on peer-to-peer network for transmission of global data.
- AA. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- BB. PC: Personal computer
- CC. Peer to Peer: Networking architecture that treats all network stations as equal partners.
- DD. PID: Proportional plus integral plus derivative
- EE. POT: Portable operator terminal.
- FF. PTFE: Polytetrafluoroethylene
- GG. PUE: Performance usage effectiveness.
- HH. RAM: Random access memory.
- II. RF: Radio frequency.

- JJ. Router: Device connecting two or more networks at network layer.
- KK. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- LL. RTD: Resistance temperature detector
- MM. TCP/IP: Transport control protocol/Internet protocol.
- NN. UPS: Uninterruptible power supply.
- OO. USB: Universal Serial Bus.
- PP. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
- QQ. VAV: Variable air volume.
- RR. WLED: White light emitting diode.

#### 1.4 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

#### 1.5 ACTION SUBMITTALS

- A. General
  - 1. Provide shop drawings and other submittals on all hardware, software and installation to be provided. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent.
- B. Multiple Submissions:
  - 1. If multiple submissions are required to execute work within schedule, submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
  - 2. Clearly identify each submittal requirement and in which submission the information will be provided.
  - 3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.
- C. Product Data: For each type of product include the following:
  - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
  - 3. Product description with complete technical data, performance curves, and product specification sheets.
  - 4. Installation, operation and maintenance instructions including factors affecting performance.

5. Bill of materials, technical data and installation and maintenance instructions indicating manufacturer and extended model number for each unique product including but not limited to the following:
  - a. Workstations.
  - b. Printers.
  - c. Monitors
  - d. Keyboard
  - e. Gateways.
  - f. Routers.
  - g. Protocol analyzers.
  - h. DDC controllers and control panels.
  - i. Enclosures.
  - j. Electrical power devices.
  - k. UPS units.
  - l. Accessories.
  - m. Instruments.
  - n. Control dampers and actuators.
  - o. Control valves and actuators.
  - p. Interface equipment.
  - q. Transducers/transmitters
  - r. Sensors (including accuracy data)
  - s. Actuators
  - t. Valves
  - u. Relays/switches
  - v. Control panels
  - w. Power supply
  - x. Battery Backup
  - y. Operator interface equipment
  - z. Wiring
6. When manufacturer product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information. General catalogs shall not be accepted as datasheets to fulfill submittal requirements.
7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

**D. Software Submittal:**

1. Cross-referenced listing of software to be loaded on each operator workstation, gateway and DDC controller.
  2. Description and technical data of all software provided and cross-referenced to products in which software will be installed.
  3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
  4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
  5. Listing and description of each engineering equation used with reference source.
  6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
  7. Description of operator interface to alphanumeric and graphic programming.
  8. Description of each network communication protocol.
  9. Description of system database, including all data included in database, database capacity and limitations to expand database.
  10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.
  11. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
  12. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system
- E. Shop Drawings:
1. General Requirements:
    - a. Include cover drawing with Project name, location, Owner, Architect, Contractor and issue date with each Shop Drawings submission.
    - b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
    - c. Drawings Size: 11 inch x 17 inch minimum, 48 inch x 36 inch maximum.
  2. Include plans, elevations and mounting details.
  3. Include details of product assemblies. Indicate dimensions, weights, loads, clearance required, recommended method of field assembly, components, and location and size of each field connection.
  4. Detail means of vibration isolation and show attachments to rotating equipment.
  5. Plan Drawings indicating the following:
    - a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.

- b. Room names and numbers with coordinated placement to avoid interference with control products.
  - c. Each desktop workstation, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller.
  - d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
  - e. Network communication cable and raceway routing.
  - f. Information, drawn to scale, minimum 0.25 inch = 1 foot - 0 inches.
  - g. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services before installation.
6. Schematic drawings for each controlled HVAC system indicating the following:
- a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve.
  - b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number. Include:
    - 1) Point description: Provide building designation, system type, equipment type, engineering units, and functionality; include a description of its physical location.
    - 2) Expected range (upper and lower limit).
    - 3) Type of point (e.g. AI, AO, DI, DO, Network, Virtual, Calculated).
  - c. A graphic showing location of control I/O in proper relationship to HVAC system.
  - d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
  - e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
  - f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
  - g. Descriptive narrative of programs to perform sequences of operation. Narrative shall not merely duplicate design sequence of operation.
  - h. Graphic sequence of operation, showing all inputs and output logical blocks.
7. Control panel drawings indicating the following:
- a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
  - b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
  - c. Front, rear, and side elevations and nameplate legend.
  - d. Unique drawing for each panel.

- e. Wiring diagrams.
- 8. DDC system network riser diagram indicating the following:
  - a. Each device connected to network with unique identification for each.
  - b. Interconnection of each different network in DDC system.
  - c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
  - d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
- 9. DDC system electrical power riser diagram indicating the following:
  - a. Each point of connection to field power with requirements (volts, phase, hertz, amperes, connection type) listed for each.
  - b. Each control power supply including associated transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
  - c. Each product requiring power with requirements (volts, phase, hertz, amperes, connection type) listed for each.
  - d. Power wiring type and size, race type, and size for each.
- 10. Monitoring and control signal diagrams indicating the following:
  - a. Control signal cable and wiring between controllers and I/O.
  - b. Point-to-point schematic wiring diagrams for each product.
  - c. Control signal tubing to sensors, switches and transmitters.
  - d. Process signal tubing to sensors, switches and transmitters.
- 11. Color graphics indicating the following:
  - a. Itemized list of color graphic displays to be provided.
  - b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
  - c. Intended operator access between related hierarchical display screens.
  - d. Provide description of procedures to access each graphics screen.
- F. System Description:
  - 1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, controller types and applications, gateways, routers and other network devices, and power supplies.
  - 2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
  - 3. System and product operation under each potential failure condition including, but not limited to, the following:
    - a. Loss of power.



- b. Loss of network communication signal.
  - c. Loss of controller signals to inputs and outpoints.
  - d. Operator workstation failure.
  - e. Gateway failure.
  - f. Network failure
  - g. Controller failure.
  - h. Instrument failure.
  - i. Control damper and valve actuator failure.
- 4. Complete bibliography of documentation and media to be delivered to Owner.
- 5. Description of testing plans and procedures.
- 6. Description of Owner training.
- G. Delegated-Design Submittal: For DDC system products and installation below.
  - 1. Provide the following documentation showing DDC system complies with performance requirements indicated, including calculations and other documentation confirming compliance:
    - a. Schedule and design calculations for control dampers and actuators.
      - 1) Flow at project design and minimum flow conditions.
      - 2) Face velocity at project design and minimum airflow conditions.
      - 3) Pressure drop across damper at project design and minimum airflow conditions.
      - 4) AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop.
      - 5) Maximum close-off pressure.
      - 6) Leakage airflow at maximum system pressure differential (fan close-off pressure).
      - 7) Torque required at worst case condition for sizing actuator.
      - 8) Actuator selection indicating torque provided.
      - 9) Actuator signal to control damper (open, close or modulate).
      - 10) Actuator position on loss of power.
      - 11) Actuator position on loss of control signal.
    - b. Schedule and design calculations for control valves and actuators.
      - 1) Flow at project design and minimum flow conditions.

- 2) Pressure-differential drop across valve at project design flow condition.
- 3) Maximum system pressure-differential drop (pump close-off pressure) across valve at project minimum flow condition.
- 4) Design and minimum control valve coefficient with corresponding valve position.
- 5) Maximum close-off pressure.
- 6) Leakage flow at maximum system pressure differential.
- 7) Torque required at worst case condition for sizing actuator.
- 8) Actuator selection indicating torque provided.
- 9) Actuator signal to control damper (open, close or modulate).
- 10) Actuator position on loss of power.
- 11) Actuator position on loss of control signal.
- c. Schedule and design calculations for selecting flow instruments.
  - 1) Instrument flow range.
  - 2) Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter and output signal for remote control.
  - 3) Extreme points of extended flow range with corresponding accuracy, control signal to transmitter and output signal for remote control.
  - 4) Pressure-differential loss across instrument at Project design flow conditions.
  - 5) Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

## 1.6 INFORMATIONAL SUBMITTALS

### A. Qualification Data:

1. Systems Provider Qualification Data:
  - a. Resume of project manager assigned to Project.
  - b. Resumes of application engineering staff assigned to Project.
  - c. Resumes of installation and programming technicians assigned to Project.
  - d. Resumes of service technicians assigned to Project.
  - e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building primary function.

- f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
  - g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
  - h. Owner contact information for past project including name, phone number, and e-mail address.
  - i. Contractor contact information for past project including name, phone number, and e-mail address.
  - j. Architect and Engineer contact information for past project including name, phone number, and e-mail address.
- 2. Manufacturer qualification data.
- 3. Testing agency qualifications data.
- B. Product Certificates:
  - 1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.
- C. Product Test Reports: For each product that requires testing to be performed by manufacturer and witnessed by a qualified testing agency or performed by a qualified testing agency.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Sample Warranty: For manufacturer warranty.
- G. Schedules - Within one month of contract award, provide a schedule of the work indicating the following:
  - 1. Intended sequence of work items
    - a. Start dates of individual work items
    - b. Duration of individual work items
    - c. Planned delivery dates for major material and equipment and expected lead times.
    - d. Milestones indicating possible restraints on work by other trades or situations.
  - 2. Provide monthly written status reports indicating work completed and revisions to delivery dates including software development. An updated project schedule shall be included.

## 1.7 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Upon completion of installation and prior to final acceptance submit three copies of record (as-built) documents in accordance with Division 01. In addition to items specified in Division 01 include the following:
  - 1. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format and as ANSI B (11 inch x 17 inch) prints.
  - 2. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
  - 3. As-built versions of submittal Product Data.

4. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
5. Operator manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
6. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
7. Engineering, installation, and maintenance manuals that explain how to:
  - a. Design and install new points, panels, and other hardware.
  - b. Perform preventive maintenance and calibration.
  - c. Debug hardware problems.
  - d. Repair or replace hardware.
8. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
9. Backup copy of graphic files, programs, and database on electronic media such as DVDs or on an external hard drive.
10. List of recommended spare parts with part numbers and suppliers.
11. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
12. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
13. Licenses, guarantees, and warranty documents.
14. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
15. Owner training materials.
16. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Include product manufacturer recommended parts lists for proper product operation over four-year period following warranty period. Parts list shall be indicated for each year.
- C. Furnish parts, as indicated by manufacturer recommended parts list, for product operation during two-year period following warranty period.
- D. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:
  1. Network Controller: One.

2. Programmable Application Controller: One.
3. Application-Specific Controller: One.
4. Room Carbon Dioxide Sensor and Transmitter: One.
5. Room Moisture Sensor and Transmitter: One.
6. Room Pressure Sensor and Transmitter: One.
7. Room Temperature Sensor and Transmitter: One.
8. General-Purpose Relay: One.
9. Multifunction Time-Delay Relay: One.
10. Latching Relay: One.
11. Current-Sensing Relay: One.
12. Combination On-Off Status Sensor and On-Off Relay: One.
13. Transformer: One.
14. DC Power Supply: One.
15. Supply of 20 percent spare optical fiber cable splice organizer cabinets for 20 re-terminations.

#### 1.9 CODES AND STANDARDS

- A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:
1. National Electric Code (NEC)
  2. International Building Code (IBC)
  3. International Mechanical Code (IMC)
  4. Local codes

#### 1.10 QUALITY ASSURANCE

- A. DDC System Manufacturer Qualifications:
1. Nationally recognized manufacturer of DDC systems and products.
  2. DDC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
  3. DDC systems and products that have been successfully tested and in use on at least five past projects.
  4. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
  5. Having full-time in-house employees for the following:
    - a. Product research and development.
    - b. Product and application engineering.

- c. Product manufacturing, testing and quality control.
- d. Technical support for DDC system installation training, commissioning and troubleshooting of installations.
- e. Owner operator training.

**B. DDC System Provider Qualifications:**

- 1. Installer shall have an established working relationship with BAS manufacturer of not less than three years and shall be an authorized representative of, and trained by, DDC system manufacturer.
- 2. In-place facility located within 50 miles of Project.
- 3. Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
- 4. Demonstrated past experience on five projects of similar complexity, scope and value.
- 5. Each person assigned to Project shall have demonstrated past experience.
- 6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
- 7. Installer shall have successfully completed BAS manufacturer control system training. Upon request, Installer shall present certification of completed training including hours of instruction and course outlines.
- 8. Service and maintenance staff assigned to support Project during warranty period.
- 9. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.
- 10. DDC system manufacturer backing to take over execution of Work to comply with requirements. Include Project-specific written letter, signed by manufacturer corporate officer.

**C. Testing Agency Qualifications: Company Member of International Electrical Testing Association (NETA).**

- 1. Testing Agency Field Supervisor: Certified by NETA to supervise on-site testing.

**1.11 WARRANTY**

**A. Manufacturer Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.**

- 1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
- 2. Include updates or upgrades to software and firmware to resolve deficiencies. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve the contractor identified software deficiencies at no charge during warranty period. Notify owner of upgrades for functional enhancements available for purchase as part of in-warranty service agreements.
  - a. Install updates only after receiving Owner written authorization.
- 3. Warranty service shall occur during normal business hours and commence within 16 hours of Owner warranty service request.

4. Warranty Period: Two year(s) from final acceptance or date of Substantial Completion whichever is later.
  - a. For Gateway: Three-year parts and labor warranty for each.
5. Work shall have a single warranty date, even if the owner receives beneficial use due to early system start-up. Where specified work is split into multiple contracts or a multiphase contract, each contractor phase shall have a separate warranty start date and period.
6. Instrumentation shall be covered by manufacturer transferable "No Fault" warranty. If manufacturer warranty is not available, the BAS installer shall provide the same.

## **PART 2 - PRODUCTS**

### **2.1 DDC SYSTEM MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by the basis-of-design manufacturer by one of the following, or approved equal:
  1. Automated Logic Corporation (basis of design),
  2. Alerton Inc.,
  3. American Auto-Matrix,
  4. Delta Controls Inc.,
  5. Distech Controls,
  6. Honeywell International Inc.,
  7. Johnson Controls, Inc.,
  8. Schneider Electric USA, Inc.,
  9. Siemens Industry, Inc., Building Technologies Division,
  10. Trane,
  11. Or approved equal.
- B. The order of the above list of manufacturers does not indicate preference. Inclusion on this list does not guarantee acceptance of products or installation. DDC system shall comply with the terms of this specification and the project drawings.
- C. Provide operator workstation software, controller software, and custom application programming language, building controllers, programmable application controllers and application specific controllers from only one of the listed manufacturers.
- D. Other products specified herein (such as sensors, valves, dampers and actuators) need not be manufactured by the above manufacturers.

### **2.2 DDC SYSTEM DESCRIPTION**

- A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.

1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.
  2. The operator workstation shall provide for overall system supervision and configuration, graphical user interface, management report generation and alarm annunciation.
  3. Performance Monitoring: The BAS will provide the specified performance monitoring functionality, including required monitoring points and performance metrics, improved through system accuracy, data acquisition and data management capabilities, and required graphical and data displays.
  4. Event Response: The BAS will provide operational changes based on event response.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Ownership of Proprietary Material - Project-specific software and documentation shall become owner property. This includes but is not limited to the following:
1. Graphics
  2. Record drawings
  3. Database
  4. Application programming code
  5. Documentation
- D. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Do not use this installation as a product test site. Spare parts shall be available for at least five years after completion of this contract.

### 2.3 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall compose an open protocol BAS. Controller and operator interface communication shall conform to open-protocol body conformance and/or certification requirements.
- B. Each controller shall have a communication port.
- C. Where indicated on the project drawings, remote buildings or sites shall be connected to the enterprise network to allow for communication with each controller on the network.
- D. Network operator interface and value passing shall be transparent to internetwork architecture.
1. An operator interface connected to the BAS shall allow the operator to interface with each networked controller as if directly connected. BAS information such as data, status, reports, system software, and custom programs shall be viewable and editable.
  2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be available on the network. Program and test all cross-controller links required to execute specified BAS operation. An authorized operator shall be able to manage, maintain, and access the BAS network of controllers.
- E. Workstations, building control panels and controllers with real-time clocks shall use the open-protocol time synchronization service. The system shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight savings and standard time.



## 2.4 WEB ACCESS

- A. DDC system shall be Web compatible.
  - 1. Web-Compatible Access to DDC System:
    - a. Workstation shall perform overall system supervision and configuration, graphic user interface, management report generation, and alarm annunciation.
    - b. DDC system shall support Web browser access to building data. Operator using a standard Web browser shall be able to access control graphics and change adjustable set points.
    - c. Web access shall be password protected.

## 2.5 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional to select components and design DDC system to satisfy system performance objectives:
  - 1. DDC system shall manage HVAC systems.
  - 2. DDC system control shall operate HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
  - 3. DDC system shall respond to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
  - 4. DDC system shall operate while unattended by an operator and through operator interaction.
  - 5. DDC system shall record trends and transaction of events and produce report information such as performance, energy, occupancies, and equipment operation.
- B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
- C. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: 25 or less.
  - 2. Smoke-Developed Index: 50 or less.
- D. DDC System Speed:
  - 1. Response Time of Connected Input/Output:
    - a. AI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
    - b. DI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
    - c. AO points connected to DDC system shall begin to respond to controller output commands within two second(s). Global commands shall also comply with this requirement.

- d. DO point values connected to DDC system shall respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
  - 2. Display of Connected I/O:
    - a. Analog point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
    - b. Binary point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
    - c. Alarms of analog and digital points connected to DDC system shall be displayed within 15 seconds of activation or change of state.
    - d. Graphic display shall indicate current data within 10 seconds and shall refresh within eight seconds.
    - e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.
  - 3. Device Reaction Performance:
    - a. Devices shall react to a digital command within two seconds.
    - b. Devices shall begin to react to an analog command within two seconds.
  - 4. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. Select execution times consistent with the mechanical process under control.
  - 5. Performance: Programmable controllers shall be able to completely execute DDC control system PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.
  - 6. Multiple Alarm Annunciation: Each work station on the network shall receive alarms within 5 seconds of other workstations.
- E. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions. Calculate bandwidth usage and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.
- F. DDC System Data Storage:
  - 1. Include capability to store and archive:
    - a. Not less than 36 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.
    - b. Not less than 36 months of data from all energy meters. DDC system shall be capable of recording energy meter data on an hourly, daily, weekly, monthly and annual basis.
  - 2. Local Storage:
    - a. Provide external drive with data storage indicated using IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.

**G. DDC Data Access:**

1. When logged into the system, operator shall be able to also interact with any DDC controller connected to DDC system for functional operation of DDC system.
2. System(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.

**H. Future Expandability:**

1. DDC system size shall be expandable to an ultimate capacity of at least two times total I/O points indicated.
2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.

**I. Input Point Displayed Accuracy and Control Accuracy:**

1. Input point displayed values shall meet following end-to-end overall system accuracy and control accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion. Where multiple accuracies are listed, values labeled STD are for standard building controls and values labeled MV are for sensors used for measurement and verification.

TEMPERATURE AND HUMIDITY SENSORS							
Variable	Sensor Value Type	Sensor Type or Calculation Method	Range	End to End Accuracy – Plus or Minus	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control - Plus or Minus
Ambient dry-bulb temperature	AI	Locate in weather station or ventilated enclosure in fully shaded location away from thermal mass bodies.	–20 deg F to 120 deg F	1.0 deg F (STD) 0.35 deg F (MV)	1	10	2 deg F
Ambient average daily outdoor temperature	Calculated	Average of instantaneous measured values	—	0.35 deg F (MV)	1	10	0.35 deg F
Ambient wet-bulb temperature	AI	Locate in weather station or ventilated enclosure in fully shaded location away from thermal mass bodies	–20 deg F to 120 deg F	3.0 deg F (STD) 0.5 deg F (MV)	1	10	3 deg F
Ambient dewpoint temperature	AI	Chilled mirror, infrared, Capacitive Locate in weather station or ventilated enclosure in fully shaded location away from thermal mass bodies	10 deg F to 100 deg F	3 deg F	1	10	3 deg F
Zone (space) air Temperature	AI	10000 ohm thermistor or 1000 ohm RTD	30 deg F to 100 deg F	1.0 deg F (STD) 0.5 deg F (MV)	1	1	1 deg F
Zone (space) wet-bulb temperature	Calculated	Calculated from temperature and relative humidity	—	2 deg F	1	1	2 deg F
Zone (space) and duct relative humidity (RH)	AI	—	20 percent to 80 percent	5 percent RH	1	1	5 percent RH
Zone (space) and duct dewpoint temperature	Calculated	Chilled mirror, infrared, Capacitive	10 deg F to 100 deg F	1.8 deg F	1	1	1.8 deg F
Ducted air temperature	AI	10000 ohm thermistor or 1000 ohm RTD	45 deg F to 140 deg F	1.0 deg F	1	1	1 deg F
Ducted air wet-bulb temperature	Calculated	Calculated from temperature and relative humidity	—	2 deg F	1	1	2 deg F
Air-handling unit supply air temperature	AI	10000 ohm thermistor or 1000 ohm RTD	45 deg F to 120 deg F	0.35 deg F	1	10	1 deg F
Air-handling unit mixed air temperature	AI	Locate in air handler mixed air section; to minimize effects of stratification use averaging sensor	40 deg F to 100 deg F	0.35 deg F	1	10	1 deg F
Air-handling unit return air temperature	AI	Locate upstream of air handler return air damper	60 deg F to 90 deg F	0.35 deg F	1	10	1 deg F
Water or glycol temperature	AI	—	32 deg F to 225 deg F	1 deg F	1	1	1 deg F
Water or glycol system delta-T	AI	10000 ohm thermistor or 1000 ohm RTD matched pair	—	0.25 deg F	1	1	0.25 deg F
Plant chilled-water temperature (supply and return)	AI	10000 ohm thermistor or 1000 ohm RTD	—	0.1 deg F (MV)	1	1	1 deg F
Plant chilled-water supply to return temperature difference	Calculated	Calculated difference of two measured values; sensors should be a matched pair	—	2 percent of reading or 0.15 deg F	1	1	0.15 deg F
Steam temperature	AI	1000 ohm RTD	0 deg F to 400 deg F	2 deg F	1	1	1 deg F

PRESSURE SENSORS							
Variable	Sensor Value Type	Sensor Type or Calculation Method	Range	End-to End Accuracy - Plus or Minus	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control - Plus or Minus
Air Pressure (ducts)	AI	Variable capacitance	0 to 8 in. wg	0.1 in. wg	1	1	0.1 in. wg
Air Pressure (space)	AI	Variable capacitance	-0.35 to 0.35 in. wg	0.01 in. wg	1	1	0.005 in. wg
Water Pressure	AI	—	0 to 150 psi	2 percent of full scale	1	1	0.5 psi
Steam Pressure	AI	—	0 to 150 psi	2 percent of reading	1	1	0.5 psi

FLOW SENSORS						
Variable	Sensor Value Type	Sensor Type or Calculation Method	End-to End Accuracy - Plus or Minus	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control - Plus or Minus
Fan airflow rate	AI	Duct Mounted Vortex Shedding Sensor or Piezometer Ring on Fan Inlet	5 percent of reading down to 150 ft/min	1	1	5 percent of reading down to 150 ft/min
Total air-handling unit supply airflow	Calculated	Sum of measured values	5 percent	1	10	5 percent
Airflow rate (duct and equipment except terminal units measuring stations)	AI	Electronic or differential pressure	5 percent of reading down to 150 ft/min	1	1	5 percent of reading down to 150 ft/min
Airflow (terminal units)	AI	Electronic or differential pressure	10 percent of reading	1	1	10 percent of reading
Airflow (pressurized spaces)	AI	Electronic or differential pressure	3 percent of reading	1	1	3 percent of reading
Whole-building total water flow rate	AI	Hot tapped insertion flowmeter	2 percent of reading >20:1 turndown	1	1	0.005 L/s (0.1 gpm)
Water flow	AI	—	2 percent of reading	1	1	0.1 gpm
Chilled-water plant chilled-water flowrate	AI	Full-bore magnetic flowmeter (preferred)	0.75 percent of reading	1	1	0.75 percent of reading
Steam flow rate	AI	Vortex	1.5 percent of reading >25:1 turndown	1	1	1.5 percent of reading

AIR HANDLING UNIT DAMPER POSITION AND OUTDOOR AIR FLOW CALCULATION							
Variable	Sensor Value Type	Sensor Type or Calculation Method	Range	End-to End Accuracy	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control
Air-handling unit outdoor air and return air demanded damper position	AI	Virtual point that commands the damper position	0 percent to 100 percent	N/A	1	10	0.1 percent
Air-handling unit percentage outdoor air	Calculated	See Note 1	0 percent to 100 percent	N/A	1	1	0.1 percent
<p>Note 1: When temperature difference between OAT and AHU RAT is greater than 5 deg F, calculate percent OA as follows:  percent OA = (AHU MAT – AHU RAT)/(OAT – AHU RAT)  Where: MAT = Mixed air Temperature, RAT = Return Air Temperature, OAT = Outdoor Ambient Air Temperature</p>							

HVAC ENERGY USE SENSORS						
Variable	Sensor Value Type	Sensor Type or Calculation Method	End-to End Accuracy	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control
Whole-building area-normalized gas energy-use intensity	Calculated	Calculated value integrated over a given interval divided by building area, ft <sup>2</sup>	±1.5 percent	1	10	±1.5 percent
Chiller Power	AI	True RMS, three-phase, integrated equipment, stand-alone analog or pulse output or networked power meter; use maximum resolution if pulse output	±1.5 percent of reading	1	1	0.001 kW
Pump power	AI/BI (pulse)	True RMS, three-phase, integrated equipment, stand-alone analog or pulse output or networked power meter; use maximum resolution if pulse output	±1.5 percent of reading; ±3.0 percent of reading if from VFD	1	1	0.001 kW
Chilled-water plant power	Calculated	Sum of measured chiller plant equipment power values	±1.5 percent	1	10	±1 kW
Fan power	AI/BI (pulse)	True RMS, three-phase, integrated equipment, stand-alone analog or pulse output or networked power meter; use maximum resolution if pulse output	±1.5 percent of reading; ±3.0 percent of reading if from VFD	1	1	0.001 kW
Total fan power	Calculated	Sum of calculated values	±1.5 percent	1	10	±1.5 percent
Chilled-water loop thermal cooling output	Calculated	Calculated value of temperature difference multiplied by measured flow rate value multiplied by 500 min-tons/deg F-gal	±3 percent	1	10	±3 percent
Chilled-water plant efficiency	Calculated	Calculated value of plant power divided by calculated value plant thermal output	±4 percent	1	10	±4 percent
Total Fan Specific power	Calculated	Calculated value of total fan power divided by calculated value of air handling unit supply airflow	±6 percent	1	10	±6 percent

GAS SENSORS							
Variable	Sensor Value Type	Sensor Type or Calculation Method	Range	End-to End Accuracy – Plus or Minus	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control – Plus or Minus
Carbon dioxide	AI	Non-dispersive infrared sensor technology	0 to 2000 ppm	Greater of 5 percent of reading or 50 ppm (STD) Greater of 3 percent of reading or 40 ppm (MV)	1	1	5 percent of reading
Carbon monoxide	AI	Electrochemical sensor	0 to 100 ppm	5 ppm	1	1	5 percent of reading
Oxygen	AI	Electrochemical sensor	0 to 25 percent	0.75 percent of full scale	1	1	5 percent of full scale
Refrigerant	AI	Semiconductor cell diffusion barrier or photo-acoustic infrared	15 to 500 ppm	10 ppm of reading	1	1	10 ppm of reading

LEVEL SENSORS/SWITCHES				
Variable	Sensor Value Type	Sensor Type or Calculation Method	Refresh Interval (min)	Trend Interval (min)
Fluid Level - Tanks, Basins	DI	Single Level Float Type or Multi-Level Electronic Type	10	COV
Fluid Level - Drain Pans	DI	UL 508 Electronic Type	1	COV

ELECTRICAL METERING						
Variable	Sensor Value Type	Sensor Type or Calculation Method	End-to End Accuracy	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control
Building main meter power	AI/BI (pulse)	True RMS (STD) True RMS to 50th harmonic (MV)	±1.0 percent of reading	1	1	1.0 kW (STD) 0.1 kW (MV)
Whole-building peak power	AI/BI (pulse)	Maximum of measured value over a given time interval	±1 percent	1	10	1 kW
Whole-building area-normalized electric energy-use intensity	Calculated	Measured value integrated over a given interval divided by a constant #C1 = building area, m <sup>2</sup> (ft <sup>2</sup> )	±1 percent	1	10	±1 percent
Electric power sub-meter (e.g., lighting circuits)	AI/BI (pulse)	True RMS to 50th harmonic	±1.0 percent of reading	1	1	0.001 kW
Electrical (A,V,W power factor not specified elsewhere)	AI/BI (pulse)	True RMS, three-phase, stand-alone analog or pulse output or networked meter; use maximum resolution if pulse output	±1 percent of full scale	1	1	1/100 s or less
Electrical (A,V,W power factor not specified elsewhere)	AI/BI (pulse)	True RMS, three-phase, stand-alone analog or pulse output or networked meter; use maximum resolution if pulse output	±1 percent of full scale	1	1	0.001 kW

NATURAL GAS METERS						
Variable	Sensor Value Type	Sensor Type or Calculation Method	End-to End Accuracy	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control
Building main natural gas meter	BI	Positive displacement pressure compensated; continuous output	±1 percent of reading, >10:1 turndown	1	1	0.1 scfm
Whole- building natural gas heat rate (Level 3)	Calculated	Measured value divided by 0.01 therm/standard cubic feet	±1.5 percent	1	10	±1.5 percent

J. Precision of I/O Reported Values: Values reported in database and displayed shall have following precision:

1. Current:
  - a. Milliamperes: Nearest 1/10th of a milliampere.
  - b. Amperes: Nearest 1/10th of an ampere up to 100 Amp; nearest ampere for 100 Amp and more.
2. Energy:
  - a. Electric Power:
    - 1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
    - 2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.

- 3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.
  - b. Thermal, Rate:
    - 1) Heating: For Btu/h, nearest Btu/h up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For Mbh, round to nearest Mbh up to 1000 Mbh; nearest 10 Mbh between 1000 and 10,000 Mbh; nearest 100 Mbh above 10,000 Mbh.
    - 2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons.
  - c. Thermal, Usage:
    - 1) Heating: For Btu, nearest 10 Btu up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For Mbtu, round to nearest Mbtu up to 1000 Mbtu; nearest 10 Mbtu between 1000 and 10,000 Mbtu; nearest 100 Mbtu above 10,000 Mbtu.
    - 2) Cooling: For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons.
3. Flow:
  - a. Air: Nearest cfm through 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.
  - b. Water: Nearest gpm through 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm.
4. Gas:
  - a. Carbon Dioxide (ppm): Nearest ppm.
  - b. Carbon Monoxide (ppm): Nearest ppm.
  - c. Oxygen (Percentage): Nearest 1/10th of 1 percent.
  - d. Refrigerant (ppm): Nearest ppm.
5. Moisture (Relative Humidity):
  - a. Relative Humidity (Percentage): Nearest 1 percent.
6. Level: Nearest 1/100th of an inch through 10 inches; nearest 1/10 of an inch between 10 and 100 inches; nearest inch above 100 inches.
7. Speed:
  - a. Rotation (rpm): Nearest 1 rpm.
  - b. Velocity: Nearest 1/10th fpm through 100 fpm; nearest fpm between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm.
8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.
9. Pressure:



- a. Air, Ducts and Equipment: Nearest 1/10th in. w.c.
  - b. Space: Nearest 1/100th in. w.c.
  - c. Water: Nearest 1/10 psig through 100 psig; nearest psig above 100 psig.
- 10. Temperature:
  - a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
  - b. Outdoor: Nearest degree.
  - c. Space: Nearest 1/10th of a degree.
  - d. Heating Hot Water: Nearest degree.
  - e. Heat Recovery Runaround: Nearest 1/10th of a degree.
- 11. Vibration: Nearest 1/10th in/s.
- 12. Voltage: Nearest 1/10 volt up to 100 V; nearest volt above 100 V.
- K. Environmental Conditions for Controllers, Gateways, and Routers:
  - 1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
    - a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated by product and application.
  - 2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
    - a. Outdoors: Type 4X.
    - b. Indoors: Type 2.
    - c. Mechanical Equipment Rooms: Type 12.
    - d. Localized Areas Exposed to Wash Down: Type 4X.
    - e. Within Duct Systems and Air-Moving Equipment: Type 4.
    - f. Hazardous Locations: Explosion-proof rating for condition.
- L. Environmental Conditions for Instruments and Actuators:
  - 1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
    - a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated to meet specific requirements of the instrument and application.

2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
  - a. Outdoors: Type 4X.
  - b. Indoors: Type 2.
  - c. Mechanical Equipment Rooms: Type 12.
  - d. Localized Areas Exposed to Washdown: Type 4X.
  - e. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
  - f. Hazardous Locations: Explosion-proof rating for condition.
- M. DDC System Reliability:
  1. Design, install and configure DDC system including controllers, gateways and routers to yield a MTBF of at least 40,000 hours, based on a confidence level of at least 90 percent. MTBF value shall include any failure for any reason to any part of products indicated.
  2. Include DDC system and product redundancy to maintain DCC system, and associated systems and equipment that are being controlled, operational and under automatic control.
  3. Critical systems and equipment that require a higher degree of DDC system redundancy than MTBF listed shall be indicated on Drawings.
- N. Electric Power Quality:
  1. Power-Line Surges:
    - a. Protect DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
    - b. Do not use fuses for surge protection.
    - c. Test protection in the normal mode and in the common mode, using the following two waveforms:
      - 1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
      - 2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.
  2. Power Conditioning:
    - a. Protect DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:
      - 1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.

- 2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
    - 3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
    - 4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.
  3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.
- O. Backup Power Source:
  1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.
- P. UPS:
  1. DDC system products powered by UPS units shall include the following:
    - a. DDC controllers.
  2. DDC system instruments and actuators powered by UPS units shall include the following:
    - a. Instruments, dampers, valves and associated actuators associated with the following systems controlled by DDC system:
      - 1) Heating plant equipment including ventilation systems.
- Q. Continuity of Operation after Electric Power Interruption:
  1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

## 2.6 SYSTEM ARCHITECTURE

- A. System architecture shall consist of no more than three levels of LANs.
  1. Level one LAN shall connect network controllers and operator workstations.
  2. Level one or Level two LAN shall connect programmable application controllers to other programmable application controllers and to network controllers.
  3. Level two or Level three LAN shall connect application-specific controllers to other application-specific controllers, to programmable application controllers and to network controllers.
- B. Provide data transfer and communication speed recommended by the BAS manufacturer subject to the following minimum requirements:
  1. LAN Connecting Programmable Application Controllers: 1000 kbps.
  2. LAN Connecting Application-Specific Controllers: 115,000 bps.

- C. DDC system shall consist of dedicated and separated LANs that are not shared with other building systems and not shared with tenant data and communication networks.
- D. System architecture shall be modular and have inherent ability to expand with no impact to performance indicated.
- E. System architecture shall perform modifications without having to remove and replace existing network equipment.
- F. Number of LANs and associated communication shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all DDC system LANs.
- G. System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.
- H. Upon loss of communication from a controller to the network or between paired controllers, an alarm shall be initiated at the DDC system head end computer.
- I. Special Network Architecture Requirements:
  - 1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling system air-handling unit(s) creating a DDC system LAN that aligns with air-handling system being controlled.

## **2.7 DDC SYSTEM OPERATOR INTERFACES**

- A. Operator Interface. PC-based workstations shall reside on a high-speed network with building controllers. Each workstation shall be able to access all BAS information. Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:
  - 1. Portable operator terminal with hard wired connection through LAN port.
  - 2. Portable operator workstation with wireless connection through LAN router.
  - 3. Mobile device and application with secured wireless connection through LAN router or cellular data service.
  - 4. Remote secure connection through web access.
- B. Access to system regardless of operator means used shall be transparent to operator.
- C. Workstation and controllers shall communicate using open protocol. Workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) data link/physical layer protocol and open protocol addressing as specified in open-protocol body guidelines and requirements.
- D. DDC Network Ports: For hard wired connection of desktop or portable workstation. DDC network port shall be easily accessible, properly protected, clearly labeled, and installed at the following locations:
  - 1. Each mechanical equipment room.
  - 2. Each boiler room.
  - 3. Each different roof level with roof-mounted air-handling units or rooftop units.
  - 4. Security system command center.

5. Fire-alarm system command center.
- E. Portable Workstations:
1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
  2. Able to communicate with any device located on any DDC system LAN.
  3. Connect to DDC system Level two and Level three LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
  4. Connect to system through a wireless router connected to Level one LAN.
  5. Connect to system through a cellular data service.
  6. Portable workstation shall be able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
  7. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
  8. Have dynamic graphic displays that are identical to desktop workstations.
- F. Portable Operators Terminal (POT):
1. Connect DDC controller through a communications port local to controller.
  2. Able to communicate with any DDC system controller that is directly connected or with LAN.
- G. Mobile Device:
1. Connect to system through a wireless router connected to LAN and cellular data service.
  2. Able to communicate with any DDC controller connected to DDC system using a dedicated application and secure web access.
- H. Telephone Communications:
1. Through use of a standard modem, operator shall be able to communicate with any device connected to any system LAN.
  2. Have auto-dial and auto-answer communications to allow desktop and portable workstations and DDC controllers to communicate with remote workstations and remote DDC controllers via telephone lines.
    - a. DDC Controllers:
      - 1) Shall not have modems unless specifically indicated for a unique controller.
      - 2) Controllers with modems shall automatically place calls to report critical alarms, or to upload trend and historical information for archiving.
      - 3) Analyze and prioritize alarms to minimize initiation of calls.
      - 4) Buffer noncritical alarms in memory and report them as a group of alarms, or until an operator manually requests an upload.

- 5) Make provisions for handling busy signals, no-answers, and incomplete data transfers.
  - 6) Call default devices when communications cannot be established with primary devices.
- I. Critical Alarm Reporting:
1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
  2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
  3. DDC system shall notify recipients by any or all means, including e-mail, text message and prerecorded phone message to mobile and landline phone numbers.
- J. Simultaneous Operator Use: Capable of accommodating up to 10 simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

## 2.8 PORTABLE OPERATOR TERMINAL

- A. Portable Operator Terminal. Furnish a portable operator terminal capable of accessing all BAS data. This device may be connected to any point on the system network or may be connected directly to any controller for programming, setup, and troubleshooting. This device may be connected to any point on the system network or it may be connected directly to controllers using open protocol. The portable operator terminal shall be a notebook-style PC including all software and hardware required.
- B. Description: Handheld device with integral keypad or touch screen operator interface.
- C. Display: Multiple lines of text display for use in operator interaction with DDC system.
- D. Cable: Flexible cable, at least 36 inches long, with a plug-in jack for connection to DDC controllers, network ports or instruments with an integral LAN port. As an alternative to hard wired connection, POT shall be accessible to DDC controllers through a wireless network connection.
- E. POT shall be powered through network connection.
- F. Connection of POT to DDC system shall not interrupt or interfere with normal network operation in any way, prevent alarms from being transmitted, or preclude central initiated commands and system modification.
- G. POT shall give operator the ability to do the following:
1. Display and monitor BI point status.
  2. Change BO point set point (on or off, open or closed).
  3. Display and monitor analog point values.
  4. Change analog control set points.
  5. Command a setting of AO point.
  6. Display and monitor I/O point in alarm.
  7. Add a new or delete an existing I/O point.
  8. Enable and disable I/O points, initiators, and programs.

9. Display and change time and date.
10. Display and change time schedules.
11. Display and change run-time counters and run-time limits.
12. Display and change time and event initiation.
13. Display and change control application and DDC parameters.
14. Display and change programmable offset values.
15. Access DDC controller initialization routines and diagnostics.

## 2.9 NETWORKS

- A. Acceptable networks for connecting workstations, mobile devices, and network controllers include the following subject to meeting performance specified:
  1. ATA 878.1, ARCNET.
  2. CEA-709.1-C.
  3. IP.
  4. IEEE 8802-3, Ethernet.
- B. Acceptable networks for connecting programmable application controllers include the following subject to meeting performance specified:
  1. ATA 878.1, ARCNET.
  2. CEA-709.1-C.
  3. IP.
  4. IEEE 8802-3, Ethernet.
- C. Acceptable networks for connecting application-specific controllers include the following subject to meeting performance specified:
  1. ATA 878.1, ARCNET.
  2. CEA-709.1-C.
  3. EIA-485A.
  4. IP.
  5. IEEE 8802-3, Ethernet.

## 2.10 NETWORK COMMUNICATION PROTOCOL

- A. Network communication protocol(s) used throughout entire DDC system shall be open to Owner and available to other companies for use in making future modifications to DDC system.
- B. Industry Standard Protocols:
  1. DDC system shall use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:
    - a. ASHRAE 135.
    - b. CEA-709.1-C.

- c. Modbus Application Protocol Specification V1.1b.
2. Operator workstations and network controllers shall communicate through ASHRAE 135 or CEA-709.1-C protocol.
3. Portions of DDC system networks using ASHRAE 135 communication protocol shall be an open implementation of network devices complying with ASHRAE 135. Network devices shall be tested and listed by BACnet Testing Laboratories.
4. Portions of DDC system networks using CEA-709.1-C communication protocol shall be an open implementation of LonWorks technology using CEA-709.1-C communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for DDC system.
5. Portions of DDC system networks using Modbus Application Protocol Specification V1.1b communication protocol shall be an open implementation of network devices and technology complying with Modbus Application Protocol Specification V1.1b.
6. Gateways shall be provided to connect networks and network devices using different protocols.

C. ASHRAE 135 Protocol:

1. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
2. Gateways required for integration shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
3. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

2.11 SYSTEM SOFTWARE

A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser 32- or 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Acceptable operating systems are Windows, the latest Windows Server release, Linux, and UNIX. Operating system shall be capable of operating DOS and Microsoft Windows applications. The operating system also shall support the use of other common software applications. Examples include Microsoft Excel, Microsoft Access, or other SQL database software.
3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software shall manage and control multiple network communications to provide exchange of global information and execution of global programs.



5. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

**B. Operator Interface Software:**

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Security Access:
  - a. All system security data shall be stored in an encrypted format.
  - b. Operator access to DDC system shall be under password control.
  - c. Each operator shall be required to log on to the system with a username and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. An alphanumeric password shall be field assignable to each operator. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application, editor, and object.
    - 1) Operator log-off shall be a manual operation or automatic if no keyboard or mouse activity is detected. Automatic sign-off period shall be programmable from one to 60 minutes in one-minute increments on a per operator basis.
    - 2) Operator sign-on and sign-off activity shall be recorded and sent to printer.
  - d. Operator password shall be same regardless of which computer or other interface means is used.
  - e. Additions or changes made to passwords shall be updated automatically.
  - f. Software shall have at least five access levels.
  - g. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
  - h. Display menu items to operator with those capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.
4. Data Segregation:
  - a. Include data segregation for control of specific data routed to a workstation, to an operator or to a specific output device, such as a printer.
  - b. Include at least 32 segregation groups.
  - c. Segregation groups shall be selectable such as "fire points," "fire points on second floor," "space temperature points," "HVAC points," and so on.

- d. Points shall be assignable to multiple segregation groups. Display and output of data to printer or monitor shall occur where there is a match of operator or peripheral segregation group assignment and point segregations.
  - e. Alarms shall be displayed and printed at each peripheral to which segregation allows, but only those operators assigned to peripheral and having proper authorization level will be allowed to acknowledge alarms.
  - f. Operators and peripherals shall be assignable to multiple segregation groups and all assignments are to be online programmable and under password control.
5. Operators shall be able to perform commands including, but not limited to, the following:
- a. Start or stop selected equipment.
  - b. Adjust set points.
  - c. Add, modify, and delete time programming.
  - d. Enable and disable process execution.
  - e. Lock and unlock alarm reporting for each point.
  - f. Enable and disable totalization for each point.
  - g. Enable and disable trending for each point.
  - h. Override control loop set points.
  - i. Enter temporary override schedules.
  - j. Define holiday schedules.
  - k. Change time and date.
  - l. Enter and modify analog alarm limits.
  - m. Enter and modify analog warning limits.
  - n. View limits.
  - o. Enable and disable demand limiting.
  - p. Enable and disable duty cycle.
  - q. Display logic programming for each control sequence.
6. Reporting:
- a. Generated automatically and manually.
  - b. Sent to displays, printers and disk files.
  - c. Types of Reporting:
    - 1) General listing of points.
    - 2) List points currently in alarm.
    - 3) List of off-line points.
    - 4) List points currently in override status.
    - 5) List of disabled points.

- 6) List points currently locked out.
  - 7) List of items defined in a "Follow-Up" file.
  - 8) List weekly schedules.
  - 9) List holiday programming.
  - 10) List of limits and deadbands.
7. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

1. The operator workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while online. An operator with the proper password level shall be able to add, delete, or change dynamic objects on a graphic. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.
2. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least ten levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
3. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface shall use a pointing device with pull-down or penetrating menus, color and animation to facilitate operator understanding of system.
4. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
5. Descriptors for graphics, points, alarms and such shall be modified through operator's workstation under password control.
6. Graphic displays shall be online user definable and modifiable using the hardware and software provided.
7. Data to be displayed within a graphic shall be assignable regardless of physical hardware address, communication or point type.
8. Graphics are to be online programmable and under password control.
9. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
10. Graphics shall also contain software points.
11. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding.

12. Back-trace feature shall permit operator to move upward in the hierarchy using a pointing device. Back trace shall show all previous penetration levels. Include operator with option of showing each graphic full screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
13. Display operator accessed data on the monitor.
14. Operator shall select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Defined and linked graphic below that selection shall then be displayed.
15. Include operator with means to directly access graphics without going through penetration path.
16. Dynamic data shall be assignable to graphics.
17. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
18. Use color, rotation, or other highly visible means, to denote status and alarm states. Color shall be variable for each class of points, as chosen by operator.
19. Points shall be dynamic with operator adjustable update rates on a per point basis from one second to over a minute.
20. For operators with appropriate privilege, points shall be commanded directly from display using pointing device.
  - a. For an analog command point such as set point, current conditions and limits shall be displayed and operator can position new set point using pointing device.
  - b. For a digital command point such as valve position, valve shall show its current state such as open or closed and operator could select alternative position using pointing device.
  - c. Keyboard equivalent shall be available for those operators with that preference.
21. Operator shall be able to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot and other information on other quadrants on screen. This feature shall allow real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
22. Help Features:
  - a. On-line context-sensitive help utility to facilitate operator training and understanding. Provide a context sensitive, online help system to assist the operator in operating and editing the system. Online help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
  - b. Bridge to further explanation of selected keywords. Document shall contain text and graphics to clarify system operation. If help feature does not have ability to bridge on keywords for more information, a complete set of user manuals shall be provided in an indexed word-processing program, which shall run concurrently with operating system software.
  - c. Available for Every Menu Item: Index items for each system menu item.
23. Graphic generation software:

- a. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Designer or AutoCAD.
- b. Furnish a complete library of standard HVAC equipment graphics including but not limited to chillers, boilers, air handlers, terminal units, chilled beams, fan-coils, unit ventilators, fans, coils, filters, dampers, valves, piping, pumps, ductwork and electrical symbols similar to those indicated on the design drawings. The library shall be furnished in a file format compatible with the graphics generation package program.
- c. Graphic development package shall use a pointing device in conjunction with a drawing program to allow operator to perform the following:
  - 1) Define background screens.
  - 2) Define connecting lines and curves.
  - 3) Locate, orient and size descriptive text.
  - 4) Define and display colors for all elements.
  - 5) Establish correlation between symbols or text and associated system points or other displays.
- D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:
  - 1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
  - 2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:
    - a. Room layouts with room identification and name.
    - b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
    - c. Location and identification of each hardware point being controlled or monitored by DDC system.
  - 3. Control schematic for each of following, including a graphic system schematic representation, similar to that indicated on Drawings, with point identification, set point and dynamic value indication, sequence of operation and control logic diagram.
  - 4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
  - 5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, gateways, operator workstations and other network devices.
- E. Customizing Software:

1. Provide software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The BAS shall be fully operable while custom routines are edited, compiled, and downloaded.
2. Software shall allow online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. As a minimum, include the following modification capability software:
  - a. Operator assignment shall include designation of operator passwords, access levels, point segregation and auto sign-off.
  - b. Peripheral assignment capability shall include assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points and enabling and disabling of print-out of operator changes.
  - c. System configuration and diagnostic capability shall include communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points and application programs and initiation of diagnostics. The system shall automatically monitor the operation of all work-stations, printers, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
  - d. System text addition and change capability shall include English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time and trouble condition.
  - e. Time and schedule change capability shall include time and date set, time and occupancy schedules, exception and holiday schedules and daylight savings time schedules.
  - f. Point related change capability shall include the following:
    - 1) System and point enable and disable.
    - 2) Run-time enable and disable.
    - 3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
    - 4) Assignment of alarm and warning limits.
  - g. Application program change capability shall include the following:
    - 1) Enable and disable of software programs.
    - 2) Programming changes.
    - 3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.

4. Software shall allow operator to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Additions and modifications shall be online programmable using operator workstation, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, database shall be uploaded and recorded on hard drive and disk for archived record.
  5. Include high-level language programming software capability for implementation of custom DDC programs. Software shall include a compiler, linker, and up- and down-load capability.
  6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:
    - a. Proportional control (P).
    - b. Proportional plus integral (PI).
    - c. Proportional plus integral plus derivative (PID).
    - d. Adaptive and intelligent self-learning control.
      - 1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
      - 2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.
  7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
  8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.
  9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
  10. Relational operators such as "Equal To," "Not Equal To," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.
- F. Alarm Handling Software:
1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways and other network devices.
  2. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system.
  3. Include first in, first out handling of alarms according to alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
  4. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.

5. Alarms display shall include the following:
  - a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
  - b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
  - c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-XXXX."
  - d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.
6. Alarms shall be directed to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
7. Send e-mail alarm messages to designated operators.
8. Send e-mail, page, text and voice messages to designated operators for critical alarms.
9. Alarms shall be categorized and processed by class.
  - a. Class 1:
    - 1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
    - 2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
    - 3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.
  - b. Class 2:
    - 1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
    - 2) Acknowledgement may be through a multiple alarm acknowledgment.
  - c. Class 3:
    - 1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.
    - 2) Each new alarm received shall cause an audible sound. Audible sound shall be silenced by "acknowledging" alarm or by pressing a "silence" key.
    - 3) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgement.
    - 4) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.



- d. Class 4:
  - 1) Routine maintenance or other types of warning alarms.
  - 2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.
- 10. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
- 11. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.
- G. Reports and Logs:
  - 1. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real-time logs of all objects by type or status (e.g., alarm, lockout, normal). Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications, including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer and shall be set to be printed either on operator command or at a specific time each day.
  - 2. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
  - 3. Each report shall be definable as to data content, format, interval and date.
  - 4. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation for historical reporting.
  - 5. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
- H. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.
  - 1. All I/O: With current status and values.
  - 2. Alarm: All current alarms, except those in alarm lockout.
  - 3. Disabled I/O: All I/O points that are disabled.
  - 4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
  - 5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
  - 6. Logs:
    - a. Alarm history.
    - b. System messages.
    - c. System events.
    - d. Trends.

- I. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.
- J. HVAC Equipment Reports: Prepare Project-specific reports.
- K. Utility Reports: Prepare Project-specific reports.
  - 1. Electric Report:
    - a. Include weekly report showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
    - b. Include monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each meter.
    - c. Include annual report showing the monthly electrical consumption and peak electrical demand with time and date stamp for each meter.
    - d. For each weekly, monthly and annual report, include sum total of submeters combined by load type, such as lighting, receptacles and HVAC equipment showing daily electrical consumption and peak electrical demand.
    - e. For each weekly, monthly and annual report, include sum total of all submeters in building showing electrical consumption and peak electrical demand.
  - 2. Natural Gas Report:
    - a. Include weekly report showing daily natural gas consumption and peak natural gas demand with time and date stamp for each meter.
    - b. Include monthly report showing the daily natural gas consumption and peak natural gas demand with time and date stamp for each meter.
    - c. Include annual report showing the monthly natural gas consumption and peak natural gas demand with time and date stamp for each meter.
    - d. For each weekly, monthly and annual report, include sum total of submeters combined by load type, such as boilers and service water heaters showing daily natural gas consumption and peak natural gas demand.
    - e. For each weekly, monthly and annual report, include sum total of all submeters in building showing natural gas consumption and peak natural gas demand.
  - 3. Service Water Report:
    - a. Include weekly report showing daily service water consumption and peak service water demand with time and date stamp for each meter.
    - b. Include monthly report showing the daily service water consumption and peak service water demand with time and date stamp for each meter.
    - c. Include annual report showing the monthly service water consumption and peak service water demand with time and date stamp for each meter.
    - d. For each weekly, monthly and annual report, include sum total of submeters combined by load type, such as cooling tower makeup and irrigation showing daily service water consumption and peak service water demand.
    - e. For each weekly, monthly and annual report, include sum total of all submeters in building showing service water consumption and peak service water demand.

- L. Energy Reports: Prepare Project-specific daily, weekly, monthly, annual and since-installed energy reports.
1. Prepare report for each purchased energy utility, indicating the following:
    - a. Time period being reported with beginning and end date, and time indicated.
    - b. Consumption in units of measure commonly used to report specific utility consumption over time.
    - c. Gross area served by utility.
    - d. Consumption per unit area served using utility-specific unit of measure.
    - e. Cost per utility unit.
    - f. Utility cost per unit area.
    - g. Convert all utilities to a common energy consumption unit of measure and report for each utility.
    - h. Consumption per unit area using common unit of measure.
  2. Prepare report for each renewable energy source, indicating the following:
    - a. Time period being reported with beginning and end date, and time indicated.
    - b. Harvested energy in units of measure commonly used to report specific harvested energy consumption over time.
    - c. Gross area served by renewable energy source.
    - d. Harvested energy per unit area served using specific unit of measure.
    - e. Cost per purchased utility unit displaced by renewable energy.
    - f. Cost savings attributed to harvested energy source.
    - g. Cost savings per unit area attributed to harvested energy.
    - h. Convert all renewable energy sources to a common energy consumption unit of measure and report for each.
    - i. Harvested energy per unit area using common unit of measure.
  3. Prepare purchased energy utility report for each sub-metered area that indicates the following:
    - a. Time period being reported with beginning and end date, and time indicated.
    - b. Gross area served.
    - c. Energy consumption by energy utility type.
    - d. Energy consumption per unit area by energy utility type.
    - e. Total energy consumption of all utilities in common units of measure.
    - f. Total energy consumption of all utilities in common units of measure per unit area.
    - g. Unit energy cost by energy utility type.
    - h. Energy cost by energy utility type.
    - i. Energy cost per unit area by energy utility type.

- j. Total cost of all energy utilities.
- k. Total cost of all energy utilities per unit area.
- 4. Prepare Project total purchased energy utility report that combines all purchased energy utilities and all areas served. Project total energy report shall indicate the following:
  - a. Time period being reported with beginning and end date, and time indicated.
  - b. Gross area served.
  - c. Energy consumption by energy utility type.
  - d. Energy consumption per unit area by energy utility type.
  - e. Total energy consumption of all utilities in common units of measure.
  - f. Total energy consumption of all utilities in common units of measure per unit area.
  - g. Unit energy cost by energy utility type.
  - h. Energy cost by energy utility type.
  - i. Energy cost per unit area by energy utility type.
  - j. Total cost of all energy utilities.
  - k. Total cost of all energy utilities per unit area.
- M. HVAC System Efficiency Reports: Prepare Project-specific daily weekly monthly, annual and since-installed HVAC system efficiency reports.
  - 1. Prepare report for each chilled-water system, indicating the following:
    - a. Time period being reported with beginning and end date, and time indicated.
    - b. Cooling energy supplied during time period.
    - c. Power energy consumed during time period by cooling equipment used to produce cooling energy supplied. List power consumed for each individual piece of equipment in system and summed total of all equipment in system.
    - d. Energy efficiency coefficient of performance determined by dividing power energy consumed into cooling energy supplied.
    - e. Energy efficiency determined by dividing cooling energy supplied into power energy consumed.
    - f. Units of measure used in report shall be consistent with units indicated for system.
  - 2. Prepare report for each hot-water system, indicating the following:
    - a. Time period being reported with beginning and end date, and time indicated.
    - b. Cooling energy supplied during time period.
    - c. Fuel consumed during time period by boilers used to produce heating energy supplied. List fuel consumed for each individual piece of equipment in system and summed total of all equipment in system.
    - d. Energy efficiency determined by dividing heating energy supplied into fuel energy consumed.
    - e. Units of measure used in report shall be consistent with units indicated for system.

3. Prepare report for each steam system, indicating the following:
  - a. Time period being reported with beginning and end date, and time indicated.
  - b. Cooling energy supplied during time period.
  - c. Fuel consumed during time period by boilers used to produce heating energy supplied. List fuel consumed for each individual piece of equipment in system and summed total of all equipment in system.
  - d. Energy efficiency determined by dividing heating energy supplied into fuel energy consumed.
  - e. Units of measure used in report shall be consistent with units indicated for system.
- N. PUE Reports: Prepare Project-specific daily, weekly, monthly, annual and since-installed PUE reports.
  1. Prepare separate report for each tenant.
  2. Prepare Project PUE report that combines PUE and all tenants served.
  3. Calculate PUE following guidelines in The Green Grid, White Paper No. 22.
- O. Weather Reports:
  1. Include daily report showing the following:
    - a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
    - b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
    - c. Daily minimum, maximum, and average outdoor dew point temperature.
    - d. Number of heating degree-days for each day calculated from a base temperature of **55 deg F**.
    - e. Number of cooling degree-days for each day calculated from a base temperature of **65 deg F**.
    - f. Daily minimum, maximum, and average outdoor carbon dioxide level.
    - g. Daily minimum, maximum, and average relative humidity.
    - h. Daily minimum, maximum, and average barometric pressure.
    - i. Daily minimum, maximum, and average wind speed and direction.
  2. Include weekly report showing the following:
    - a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
    - b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
    - c. Daily minimum, maximum, and average outdoor dew point temperature.
    - d. Number of heating degree-days for each day calculated from a base temperature of **55 deg F**.
    - e. Number of cooling degree-days for each day calculated from a base temperature of **65 deg F**.
    - f. Weekly minimum, maximum, and average outdoor carbon dioxide level.
    - g. Daily minimum, maximum, and average relative humidity.

- h. Daily minimum, maximum, and average barometric pressure.
    - i. Daily minimum, maximum, and average wind speed and direction.
  - 3. Include monthly report showing the following:
    - a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
    - b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
    - c. Daily minimum, maximum, and average outdoor dew point temperature.
    - d. Number of heating degree-days for each day calculated from a base temperature of **55 deg F**.
    - e. Number of cooling degree-days for each day calculated from a base temperature of **65 deg F**.
    - f. Monthly minimum, maximum, and average outdoor carbon dioxide level.
    - g. Daily minimum, maximum, and average relative humidity.
    - h. Daily minimum, maximum, and average barometric pressure.
    - i. Daily minimum, maximum, and average wind speed and direction.
  - 4. Include annual (12-month) report showing the following:
    - a. Monthly minimum, maximum, and average outdoor dry-bulb temperature.
    - b. Monthly minimum, maximum, and average outdoor wet-bulb temperature.
    - c. Monthly minimum, maximum, and average outdoor dew point temperature.
    - d. Number of heating degree-days for each month calculated from a base temperature of **55 deg F**.
    - e. Number of cooling degree-days for each month calculated from a base temperature of **65 deg F**.
    - f. Annual minimum, maximum, and average outdoor carbon dioxide level.
    - g. Monthly minimum, maximum, and average relative humidity.
    - h. Daily minimum, maximum, and average barometric pressure.
    - i. Daily minimum, maximum, and average wind speed and direction.
- P. Standard Trends:
  - 1. Trend all I/O point present values, set points, and other parameters indicated for trending.
  - 2. Trends shall be associated into groups, and a trend report shall be set up for each group.
  - 3. Trends shall be stored within DDC controller and uploaded to hard drives automatically on reaching 75 percent of DDC controller buffer limit, or by operator request, or by archiving time schedule.
  - 4. Preset trend intervals for each I/O point after review with Owner.
  - 5. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Minimum number of consecutive trend values stored at one time shall be 100 per variable.
  - 6. When drive storage memory is full, most recent data shall overwrite oldest data.

7. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.
- Q. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.
1. The operator shall be able to define a custom trend log for any data object in the system. Trend data shall be sampled and stored on the building controller panel, be archived on the hard disk, and be retrievable for use in spreadsheets and standard database programs. Trend data shall be exportable in a standard electronic format (.xls, .csv, .xml) for analysis external to the BAS.
  2. Each trend shall include interval, start time, and stop time.
  3. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation hard drives.
  4. Data shall be retrievable for use in spreadsheets and standard database programs.]
- R. Alarm Event Log:
1. The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.
- S. Group Trend Time Series Plots:
1. Provide user-selectable Y points.
  2. Provide user-editable titles, point names, and Y axis titles.
  3. Individual trended points shall be able to be grouped in groups of up to four points per plot with up to four plots per page.
- T. X-Y Trend Plots: The user shall be able to select the beginning and ending period for each X-Y chart, within the time domain of the database being used.
1. User-selectable X and Y trend inputs.
  2. User editable titles, point names and X and Y axis titles.
  3. User-selectable time period options:
    - a. 1-day 24-hour period.
    - b. 1-week 7-day period.
    - c. 1-month period, with appropriate days for the month selected; or
    - d. 1-year period.
  4. User-selectable display of up to 6 plots per screen in 2 columns.
- U. Programming Software:
1. Include programming software to execute sequences of operation indicated.
  2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
  3. Programming software shall be any of the following:

- a. Graphic Based: Programming using a library of function blocks made from preprogrammed code designed for DDC control systems.
    - 1) Function blocks shall be assembled with interconnection lines that represent to control sequence in a flowchart.
    - 2) Programming tools shall be viewable in real time to show present values and logical results of each function block.
  - b. Menu Based: Programming done by entering parameters, definitions, conditions, requirements and constraints.
  - c. Line by Line and Text Based: Programming shall declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.
4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

V. System Applications

1. Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation:
  - a. Automatic System Database Save and Restore. Each workstation shall store on the hard disk a copy of the current database of each building controller. This database shall be updated whenever a change is made in any system panel. The storage of these data shall be automatic and not require operator intervention. In the event of a database loss in a building management panel, the first work station to detect the loss shall automatically restore the database for that panel. This capability may be disabled by the operator.
  - b. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to save the database from any system panel. The operator also shall be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.

W. Database Management Software:

1. Where a separate SQL database is used for information storage, DDC system shall include database management software that separates database monitoring and managing functions by supporting multiple separate windows.
2. Database secure access shall be accomplished using standard SQL authentication including ability to access data for use outside of DDC system applications.
3. Database management function shall include summarized information on trend, alarm, event, and audit for the following database management actions:
  - a. Backup.
  - b. Purge.
  - c. Restore.
4. Database management software shall support the following:



- a. Statistics: Display database server information and trend, alarm, event, and audit information on database.
  - b. Maintenance: Include method of purging records from trend, alarm, event and audit databases by supporting separate screens for creating a backup before purging, selecting database, and allowing for retention of a selected number of day's data.
  - c. Backup: Include means to create a database backup file and select a storage location.
  - d. Restore: Include a restricted means of restoring a database by requiring operator to have proper security level.
5. Database management software shall include information of current database activity, including the following:
  - a. Ready.
  - b. Purging record from a database.
  - c. Action failed.
  - d. Refreshing statistics.
  - e. Restoring database.
  - f. Shrinking a database.
  - g. Backing up a database.
  - h. Resetting Internet information services.
  - i. Starting network device manager.
  - j. Shutting down the network device manager.
  - k. Action successful.
6. Database management software monitoring functions shall continuously read database information once operator has logged on.
7. Include operator notification through on-screen pop-up display and e-mail message when database value has exceeded a warning or alarm limit.
8. Monitoring settings window shall have the following sections:
  - a. Allow operator to set and review scan intervals and start times.
  - b. E-mail: Allow operator to create and review e-mail and phone text messages to be delivered when a warning or an alarm is generated.
  - c. Warning: Allow operator to define warning limit parameters, set reminder frequency and link e-mail message.
  - d. Alarm: Allow operator to define alarm limit parameters, set reminder frequency and link e-mail message.
  - e. Database Login: Protect system from unauthorized database manipulation by creating a read access and a write access for each of trend, alarm, event and audit databases as well as operator proper security access to restore a database.
9. Monitoring settings taskbar shall include the following informational icons:

- a. Normal: Indicates by color and size, or other easily identifiable means that all databases are within their limits.
- b. Warning: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their warning limit.
- c. Alarm: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their alarm limit.

## 2.12 OFFICE APPLICATION SOFTWARE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - 1. Microsoft,
  - 2. Or approved equal.
- B. Include current version of office application software at time of Substantial Completion.
- C. Office application software package shall include multiple separate applications and use a common platform for all applications, similar to Microsoft "Office Professional."
  - 1. Database.
  - 2. E-mail.
  - 3. Presentation.
  - 4. Publisher.
  - 5. Spreadsheet.
  - 6. Word processing.

## 2.13 MAINTENANCE MANAGEMENT SOFTWARE

- A. Scope:
  - 1. Include complete and functional software-driven maintenance management system. Software shall perform scheduling of preventive maintenance and generation of work orders, for mechanical and electrical equipment and systems.
  - 2. Work orders shall be automatically generated from alarm conditions, run time, and calendar time. Each work order generated shall list parts, tools, craftspeople, and define task to be performed.
  - 3. Work order generated shall be used to schedule a repair or preventive maintenance routine.
  - 4. Work order shall be used to track completion of work, parts used and total cost of repair.
  - 5. A database shall include an inventory tracking system. Work orders generated shall automatically update inventory database to show quantity of tools, repair parts and expendables used for a work order.
  - 6. Work orders and preventive maintenance schedules shall be printed on a dedicated printer assigned solely to maintenance management function.
- B. Additional Hardware Requirements:

1. Maintenance management software shall not require additional hardware, except for an additional printer that is dedicated to maintenance management.
  2. Maintenance management software shall be integrated into DDC system.
- C. Software Requirements:
1. From main menu of maintenance management system, it shall be possible through selection of icons to penetrate to individual functions described below.
  2. Work Orders:
    - a. Automatically generate work orders initiated from alarm conditions, accumulated run time or calendar time. Work orders generated shall specify a particular task to be accomplished including the labor, material and tools needed to accomplish work.
    - b. Include at least two of the following types of work orders:
      - 1) Corrective and emergency maintenance work orders shall be generated for a specific job or repair for emergency, breakdown, or scheduled work.
      - 2) Preventive maintenance that are used on a periodic basis to generate preventive maintenance work orders.
    - c. Include the following functions:
      - 1) Work Order Tracking: Perform every function related to processing work orders including creating, approving and initiating work orders, checking their status history and closing or reworking them when appropriate.
      - 2) Work Requests: Report any problems that require corrective maintenance activity generated by dispatchers and those people designated to request work orders.
      - 3) Quick Reporting: Report work done on an open work order or a small job.
      - 4) Work Manager: Specify the type of labor to be applied to a specific work order at specific times. It shall include the capability to dispatch one or more laborers to top-priority jobs on as-needed basis and to interrupt work in progress to reassign labor to higher priority tasks.
    - d. Reports:
      - 1) Daily Maintenance Schedule by Supervisor: List a schedule of open work orders for a specified date by supervisor.
      - 2) Equipment Cost Roll-up Report: Include a roll-up of equipment costs incurred since the date the report was last run.
      - 3) Delinquent Work Order Report: List open work orders whose target completion date is earlier than the date the report is run.
      - 4) Employee Job Assignments: List labor codes that have job assignments for the specified date.

- 5) Daily Work Order Assignment: List work orders that have labor assignments for the specified date.
  - 6) Estimated versus Actual Work Order Costs: List a cost summary of outstanding work orders.
  - 7) Open Work Orders Report: List open work orders for locations and equipment.
3. Custom Applications:
  - a. Include creation of customized database tables and application screens that supplement functions specified.
4. Setup:
  - a. Include configuration of database, security and setup applications.
  - b. Perform the following functions:
    - 1) Reports and Other Applications: Register reports and other applications for use within system.
    - 2) Documents: Enter, track and link information from Drawings to equipment and inventory items.
    - 3) Chart of Accounts: Add or modify accounts; set up financial periods; enter inventory accounts, company accounts, and resource recovery accounts; and define tax codes and rates.
    - 4) Signature Security: Establish each user access rights to modules, applications, screens and options.
    - 5) Database Configuration: Customize database, including adjusting field lengths and modifying data types.
    - 6) Application Setup: Change position of icons and menu items on the main menu screen.
    - 7) Application Launching: Allow for connecting of third-party applications to data fields and push buttons.
5. Utilities:
  - a. Include utilities module that allows system administrator to customize system and to maintain database.
  - b. Include the following functions:
    - 1) Interactive SQL: Include access to database for database management functions of import/export and backup.
    - 2) Edit Windows: Display a dialog box to customize an application.

- 3) Archive Data: Remove records from database and store them for future reference.

D. Documentation:

1. Include complete documentation for the system consisting of a User Manual and Systems Administrator Guide.
2. User Manual shall describe how to use each application module and screen with step-by-step instructions detailing entry and retrieval of data for functions specified.
3. Include a step-by-step description of how each report is defined and retrieved.
4. Bind documentation and clearly title it indicating volume number and use.]

2.14 ASHRAE 135 GATEWAYS

- A. Include gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment, only when specifically requested and approved by Owner.
- B. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.
- C. Gateway Minimum Requirements:
  1. Read and view all readable object properties on non-BACnet network to BACnet network and vice versa where applicable.
  2. Write to all writeable object properties on non-BACnet network from BACnet network and vice versa where applicable.
  3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet and vice versa.
  4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs according to ASHRAE 135.
  5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
  6. Backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

2.15 ASHRAE 135 PROTOCOL ANALYZER

- A. Analyzer and required cables and fittings for connection to ASHRAE 135 network.
- B. Analyzer shall include the following minimum capabilities:
  1. Capture and store to a file data traffic on all network levels.
  2. Measure bandwidth usage.
  3. Filtering options with ability to ignore select traffic.

**2.16 WIRELESS ROUTERS FOR OPERATOR INTERFACE**

**A. Single-Band Wireless Routers:**

1. Description: High-speed router with integral Ethernet ports.
2. Technology: IEEE 802.11n; 2.4-GHz minimum speed band.
3. Speed: Up to 300 Mbps.
4. Compatibility: IEEE 802.11n/g/b/a wireless devices.
5. Ethernet Ports: Four, gigabit (1000 Mbps).
6. Wireless Security: Wi-Fi Protected Access (WPA) and WPA2 according to IEEE 802.11i.

**B. Dual-Band Wireless Routers:**

1. Description: High-speed, dual-band router with integral Ethernet ports and USB port.
2. Technology: IEEE 802.11n; 2.4- and 5-GHz speed minimum bands.
3. Speed: Up to 300 Mbps on 2.4-GHz band and up to 450 Mbps on 5-GHz band.
4. Compatibility: IEEE 802.11n/g/b/a wireless devices.
5. Ethernet Ports: Four, gigabit (1000 Mbps).
6. USB Port: One, USB 2.0 or 3.0.
7. Wireless Security: Wi-Fi Protected Access (WPA) and WPA2 according to IEEE 802.11i.

**2.17 DDC CONTROLLERS GENERAL**

- A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
- C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
- D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.
- E. Communication. The controller shall reside on a BAS open protocol network using the device-level protocol. Each network of controllers shall be connected to one building controller.
- F. The Controller shall have a network connection for a laptop computer or a portable operator tool.
- G. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
- H. Environment Requirements:
  1. All controller hardware shall be suitable for the anticipated ambient conditions.
  2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F mounted in dust proof enclosures.

3. Controllers located outdoors shall be rated for operation at 40 to 150 deg F mounted in waterproof enclosures.
- I. Power and Noise Immunity for All Controllers:
  1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
  2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.
- J. Transformer. Power supply for the all controllers must be rated at minimum of 125 percent power consumption and shall be fused or current limiting type.
- K. DDC Controller Spare Processing Capacity:
  1. I/O Capacity. The controller shall contain I/O capacity to control the target system.
  2. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
    - a. Network Controllers: 50 percent.
    - b. Programmable Application Controllers: Not less than 60 percent.
    - c. Application-Specific Controllers: Not less than 70 percent.
  3. Memory shall support DDC controller operating system and database and shall include the following:
    - a. Monitoring and control.
    - b. Energy management, operation and optimization applications.
    - c. Alarm management.
    - d. Historical trend data of all connected I/O points.
    - e. Maintenance applications.
    - f. Operator interfaces.
    - g. Monitoring of manual overrides.
- L. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller. Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional controller boards or point modules shall be required to implement use of these spare points. Provide quantities as follows:
  1. Network Controllers:
    - a. 10 percent of each AI, AO, BI, and BO point connected to controller. Universal points may be used to meet this requirement.
    - b. Minimum Spare I/O Points per Controller: (3) AI; (3) AO; (3) DI; (3) DO. (12) Universal points may be used to meet this requirement.
  2. Programmable Application Controllers:
    - a. 10 percent of each AI, AO, BI, and BO point connected to controller. Universal points may be used to meet this requirement.
    - b. Minimum Spare I/O Points per Controller: (3) AI; (3) AO; (3) DI; (3) DO. (12) Universal points may be used to meet this requirement.

3. Application-Specific Controllers:
  - a. 10 percent of each AI, AO, BI, and BO point connected to controller. Universal points may be used to meet this requirement.
  - b. Minimum Spare I/O Points per Controller: (2) AI; (2) AO; (2) DI; (2) DO. (12) Universal points may be used to meet this requirement.
- M. Maintenance and Support: Include the following features to facilitate maintenance and support:
  1. Mount microprocessor components on circuit cards for ease of removal and replacement.
  2. Means to quickly and easily disconnect controller from network.
  3. Means to quickly and easily access connect to field test equipment.
  4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.
- N. Input and Output Point Interface:
  1. Controlling and master sensor inputs and controlled device output points shall be hard wired to the associated controller for system and zone level controls. Communication over the network is not acceptable. Sub-master sensors used to reset master sensor setpoints and monitor only input points may connect to network, programmable application and application-specific controllers and communicated to the BAS via the network.
  2. Input/Output System Capacity. The system size shall be expandable to at least twice the number of input/output objects/points required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.
  3. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
  4. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
  5. AIs:
    - a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
    - b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.
    - c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
    - d. Signal conditioning including transient rejection shall be provided for each AI.
    - e. Capable of being individually calibrated for zero and span.
    - f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.
  6. AOs:



- a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
  - b. Output signals shall have a range of 4 to 20 mA dc or zero- to 10-V dc to include proper control of output device.
  - c. Capable of being individually calibrated for zero and span.
  - d. Analog outputs on building or programmable application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override.
  - e. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.
7. DIs:
- a. Controller DIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
  - b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
  - c. DIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
  - d. DIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
8. Pulse accumulation input points shall comply with all requirements of DIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator command.
9. DOs:
- a. Controller DOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.
    - 1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.
    - 2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.
  - b. DOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
  - c. DOs shall be selectable for either normally open or normally closed operation.
  - d. Include tristate outputs (two coordinated DOs) for control of three-point floating-type electronic actuators without feedback.
10. Tri-State Outputs (Floating Point Control)
- a. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Control algorithms shall run

the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

- b. Use of floating type devices shall be limited to office, conference and corridor VAV terminal units and associated duct-mounted heating coils, zone dampers, radiation control valves and terminal unit control applications only. Use of floating type devices is not acceptable in laboratory, health care, data center and similar critical zone and system applications.

11. Universal Input/Output:

- a. I/O points shall be the universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point with appropriate properties. Application-specific controllers are exempted from this requirement.

2.18 NETWORK CONTROLLERS

A. Provide quantity of network controllers to achieve performance specified. Each of these controllers shall meet the following requirements.

- 1. The DDC system shall be composed of one or more independent, standalone, microprocessor-based network controllers to manage the global strategies described in the software paragraphs.
- 2. The network controller shall have memory capacity to support its operating system, database, and programming requirements.
- 3. Data shall be shared between network controllers.
- 4. The operating system of the network controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object/variable information and allow for central monitoring and alarms.
- 5. Controllers that perform scheduling shall have a real-time clock.
- 6. The network controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall
  - a. Assume a pre-determined failure mode, and
  - b. Generate an alarm notification.
- 7. Controllers shall be full programmable.

B. Communication:

- 1. The network controller shall communicate with networked BAS devices on the network using the protocol-specific communication requirements. Controller-to-controller communication shall be peer-to-peer and not require a master or host server for communication.
- 2. The network controller shall be certified, listed by or submitted for testing to a testing laboratory approved by open-protocol body.
- 3. Communication.
  - a. Each building controller shall reside on the open-protocol network.
  - b. The controller shall provide a communication port connection or network interface for a portable operator terminal.

- c. Network routers/repeaters/bridges shall be used to extend communications, change media type, or extend the network in order to ensure proper communication for the entire BAS.
  - 4. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers.
- C. Operator Interface:
  - 1. Controller shall be equipped with a service communications port for connection to a portable operator workstation or mobile device.
  - 2. Local Keypad and Display:
    - a. Equip controller with local keypad and digital display for interrogating and editing data.
    - b. The keypad shall allow for interrogating and editing data. A system security password shall be required to prevent unauthorized use of the keypad and display. If the manufacturer does not provide this keypad and display, provide a portable operator terminal.
- D. Network controller shall maintain BIOS and programming information in event of a power loss for at least 96 hours.

## 2.19 PROGRAMMABLE APPLICATION CONTROLLERS

- A. General Programmable Application Controller Requirements:
  - 1. Include quantity of controllers required to achieve performance specified.
  - 2. Controller shall have enough memory to support its operating system, database, and programming requirements.
  - 3. Data shall be shared between networked controllers and other network devices.
  - 4. Capable of standalone operation and shall continue to include control functions without being connected to the network.
  - 5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
  - 6. Controllers that perform scheduling shall have a real-time clock.
  - 7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
  - 8. Controllers shall be fully programmable.
  - 9. All controllers shall be tested and certified or listed by an official open-protocol testing laboratory as being compliant with the standardized open-protocol device capabilities.
- B. Communication:
  - 1. Programmable application controllers shall communicate with other devices on network.
  - 2. Each programmable application controller shall reside on a control network using the device-level protocol.

3. The controller shall provide a service communication port or network interface using an open-protocol for connection to a portable operator's terminal.
- C. Operator Interface:
  1. Controller shall be equipped with a service communications port for connection to a portable operator workstation or mobile device.
  2. Local Keypad and Display:
    - a. Equip controller with local keypad and digital display for interrogating and editing data.
    - b. Use of keypad and display shall require security password.
- D. Serviceability:
  1. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
  2. Programmable application controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

## 2.20 APPLICATION-SPECIFIC CONTROLLERS

- A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.
  1. Capable of standalone operation and shall continue to include control functions without being connected to the network.
  2. Data shall be shared between networked controllers and other network devices.
- B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.
- C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator workstation. Connection shall extend to port on space temperature sensor that is connected to controller.
- D. Each application specific controller shall be provided with sufficient I/O capacity to control the target system.
- E. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss for at least 90 days.
- F. Include BACnet communication ports as an equipment OEM standard option, for integration via a single communication cable. BACnet compliant application controllers required for, but not limited to, boilers, boiler plant, chillers, chiller plant and variable-speed drive controllers.
- G. Serviceability:
  1. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
  2. Application specific controller shall maintain BIOS and programming information in event of a power loss.

## 2.21 CONTROLLER SOFTWARE

### A. General Controller Software Requirements:

1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
2. I/O points shall be identified by up to 30-character point name and up to 16-character point descriptor. Same names shall be used at operator workstations.
3. Control functions shall be executed within controllers using DDC algorithms.
4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.

### B. Security:

1. Operator access shall be secured using individual security passwords and user names.
2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
3. Operator log-on and log-off attempts shall be recorded.
4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.

### C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:

#### 1. Weekly Schedule:

- a. Include separate schedules for each day of week.
- b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
- c. Each schedule may consist of up to 10 events.
- d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.

#### 2. Exception Schedules:

- a. Include ability for operator to designate any day of the year as an exception schedule.
- b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.

#### 3. Holiday Schedules:

- a. Include capability for operator to define up to 99 special or holiday schedules.
- b. Schedules may be placed on scheduling calendar and will be repeated each year.
- c. Operator shall be able to define length of each holiday period.

### D. System Coordination:

1. Include standard application for proper coordination of equipment.

2. Application shall include operator with a method of grouping together equipment based on function and location.
  3. Group may then be used for scheduling and other applications.
- E. Digital Alarms:
1. Each binary point shall be set to alarm based on operator-specified state.
  2. Include capability to automatically and manually disable alarming.
- F. Analog Alarms:
1. Each analog object shall have both high and low alarm limits.
  2. Alarming shall be able to be automatically and manually disabled.
- G. Alarm Reporting:
1. The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.
  2. Operator shall be able to determine action to be taken in event of an alarm.
  3. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
  4. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.
- H. Remote Communication:
1. System shall have ability to dial out in the event of an alarm.
- I. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.
- J. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.
- K. Control Loops:
1. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:
    - a. Two-position (on/off, open/close, slow/fast) control.
    - b. Proportional control.
    - c. Proportional plus integral (PI) control.
    - d. Proportional plus integral plus derivative (PID) control.
      - 1) Include PID algorithms with direct or reverse action and anti-windup.
      - 2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
      - 3) Controlled variable, set point, and PID gains shall be operator-selectable.

- e. Adaptive and intelligent self-learning control.
    - 1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
    - 2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.
  - L. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.
  - M. Anti-Short Cycling:
    - 1. DO points shall be protected from short-cycling.
    - 2. Feature shall allow minimum on-time and off-time to be selected.
  - N. On and Off Control with Differential:
    - 1. Include an algorithm that allows a DO to be cycled based on a controlled variable and set point.
    - 2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.
  - O. Run-Time Totalization:
    - 1. Include software to totalize run-times for all DI and DO points.
    - 2. A high run-time alarm shall be assigned, if required, by operator.
- 2.22 RELAYS
- A. General-Purpose Relays:
    - 1. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
    - 2. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
    - 3. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.
    - 4. Construct the contacts of either silver cadmium oxide or gold.
    - 5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
    - 6. Relays shall have LED indication and a manual reset and push-to-test button.
    - 7. Performance:
      - a. Mechanical Life: At least 10 million cycles.
      - b. Electrical Life: At least 100,000 cycles at rated load.
      - c. Pickup Time: 15 ms or less.
      - d. Dropout Time: 10 ms or less.
      - e. Pull-in Voltage: 85 percent of rated voltage.
      - f. Dropout Voltage: 50 percent of nominal rated voltage.

- g. Power Consumption: 2 VA.
  - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
- 8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
- 9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
- 10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.
- B. Multifunction Time-Delay Relays:
  - 1. Relays shall be continuous duty and rated for at least 10 A at 240-V ac and 60 Hz.
  - 2. Relays shall be DPDT relay with up to eight programmable functions to provide on/off delay, interval and recycle timing functions.
  - 3. Use a plug-in-style relay with either an 8- or 11-pin octal plug.
  - 4. Construct the contacts of either silver cadmium oxide or gold.
  - 5. Enclose the relay in a dust-tight cover.
  - 6. Include knob and dial scale for setting delay time.
  - 7. Performance:
    - a. Mechanical Life: At least 10 million cycles.
    - b. Electrical Life: At least 100,000 cycles at rated load.
    - c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
    - d. Repeatability: Within 2 percent.
    - e. Recycle Time: 45 ms.
    - f. Minimum Pulse Width Control: 50 ms.
    - g. Power Consumption: 5 VA or less at 120-V ac.
    - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
  - 8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
  - 9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
  - 10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.
- C. Latching Relays:
  - 1. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
  - 2. Relays shall be continuous duty and rated for at least 10 A at 250-V ac and 60 Hz.
  - 3. Relays shall be either DPDT or three-pole double throw, depending on the control application.
  - 4. Use a plug-in-style relay with a multi-bladed plug.
  - 5. Construct the contacts of either silver cadmium oxide or gold.



6. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
  7. Performance:
    - a. Mechanical Life: At least 10 million cycles.
    - b. Electrical Life: At least 100,000 cycles at rated load.
    - c. Pickup Time: 15 ms or less.
    - d. Dropout Time: 10 ms or less.
    - e. Pull-in Voltage: 85 percent of rated voltage.
    - f. Dropout Voltage: 50 percent of nominal rated voltage.
    - g. Power Consumption: 2 VA.
    - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
  8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
  9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
  10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.
- D. Current Sensing Relay:
1. Monitors ac current.
  2. Independent adjustable controls for pickup and dropout current.
  3. Energized when supply voltage is present and current is above pickup setting.
  4. De-energizes when monitored current is below dropout current.
  5. Dropout current is adjustable from 50 to 95 percent of pickup current.
  6. Include a current transformer, if required for application.
  7. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.
- E. Combination On-Off Status Sensor and On-Off Relay:
1. Description:
    - a. On-off control and status indication in a single device.
    - b. LED status indication of activated relay and current trigger.
    - c. Closed-Open-Auto override switch located on the load side of the relay.
  2. Performance:
    - a. Ambient Temperature: Minus 30 to 140 deg F.
    - b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.
  3. Status Indication:
    - a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.

- b. Current Sensor Range: Selected by application.
- c. Current Set Point: Fixed or adjustable by application.
- d. Current Sensor Output: Provide one of the following:
  - 1) Solid-state, single-pole double-throw contact rated for 30-V ac and dc and for 0.4 A.
  - 2) Solid-state, single-pole double-throw contact rated for 120-V ac and 1.0 A.
  - 3) Analog, zero- to 5- or 10-V dc.
  - 4) Analog, 4 to 20 mA, loop powered.
- 4. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.
- 5. Enclosure: NEMA 250, Type 2 enclosure.
- F. Time Delay Relays
  - 1. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable  $\pm 200$  percent (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 2 enclosure when not installed in local control panel.

## 2.23 ELECTRICAL POWER DEVICES

- A. Transformers:
  - 1. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80 percent of rated capacity.
    - a. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0 percent line and load combined, with 100-microsecond response time for 50 percent load changes. Unit shall have built-in overvoltage and overcurrent protection and shall be able to withstand a 150 percent current overload for at least three seconds without trip-out or failure.
      - 1) Unit shall operate between 0 deg C and 50 deg C (32 deg F and 120 deg F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MIL-STD 810C for shock and vibration.
      - 2) Line voltage units shall be UL recognized and CSA approved.
  - 2. Transformer shall be at least 40 VA.
- B. Power-Line Conditioner:
  - 1. General Power-Line Conditioner Requirements:
    - a. Design to ensure maximum reliability, serviceability and performance.

- b. Overall function of the power-line conditioner is to receive raw, polluted electrical power and purify it for use by electronic equipment. The power-line conditioner shall provide isolated, regulated, transient and noise-free sinusoidal power to loads served.
- 2. Standards: NRTL listed per UL 1012.
- 3. Performance:
  - a. Single phase, continuous, 100 percent duty rated KVA/KW capacity. Design to supply power for linear or nonlinear, high crest factor, resistive and reactive loads.
  - b. Automatically regulate output voltage to within 2 percent or better with input voltage fluctuations of plus 10 to minus 20 percent of nominal when system is loaded 100 percent. Use Variable Range Regulation to obtain improved line voltage regulation when operating under less than full load conditions.
    - 1) At 75 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 35 percent of nominal.
    - 2) At 50 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 40 percent of nominal.
    - 3) At 25 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 45 percent of nominal.
  - c. With input voltage distortion of up to 40 percent, limit the output voltage sine wave to a maximum harmonic content of 5 percent.
  - d. Automatically regulate output voltage to within 2.5 percent when load (resistive) changes from zero percent to 100 percent to zero percent.
  - e. Output voltage returns to 95 percent of nominal level within two cycles and to 100 percent within three cycles when the output is taken from no load to full resistive load or vice-versa. Recovery from partial resistive load changes is corrected in a shorter period of time.
  - f. K Factor: 30, designed to operate with nonlinear, non-sinusoidal, high crest factor loads without overheating.
  - g. Input power factor within 0.95 approaching unity with load power factor as poor as 0.6.
  - h. Attenuate load-generated odd current harmonics 23 dB at the input.
  - i. Electrically isolate the primary from the secondary. Meet isolation criteria as defined in NFPA 70, Article 250-5D.
  - j. Lighting and Surge Protection: Compares to UL 1449 rating of 330 V when subjected to Category B3 (6000 V/3000 A) combination waveform as established by IEEE C62.41.
  - k. Common-mode noise attenuation of 140 dB.
  - l. Transverse-mode noise attenuation of 120 dB.

- m. With loss of input power for up to 16.6 ms, the output sine wave remains at usable ac voltage levels.
  - n. Reliability of 200,000 hours' MTBF.
  - o. At full load, when measured at 1-m distance, audible noise is not to exceed 54 dB.
  - p. Approximately 92 percent efficient at full load.
4. Transformer Construction:
- a. Ferroresonant, dry type, convection cooled, 600V class. Transformer windings of Class H (220 deg C) insulated copper.
  - b. Use a Class H installation system throughout with operating temperatures not to exceed 150 deg C over a 40-deg C ambient temperature.
  - c. Configure transformer primary for multi-input voltage. Include input terminals for source conductors and ground.
  - d. Manufacture transformer core using M-6 grade, grain-oriented, stress-relieved transformer steel.
  - e. Configure transformer secondary in a 240/120-V split with a 208-V tap or straight 120 V, depending on power output size.
  - f. Electrically isolate the transformer secondary windings from the primary windings. Bond neutral conductor to cabinet enclosure and output neutral terminal.
  - g. Include interface terminals for output power hot, neutral and ground conductors.
  - h. Label leads, wires and terminals to correspond with circuit wiring diagram.
  - i. Vacuum impregnate transformer with epoxy resin.
5. Cabinet Construction:
- a. Design for panel or floor mounting.
  - b. NEMA 250, Type 2, indoor enclosure.
  - c. Manufacture the cabinet from heavy gauge steel complying with UL 50.
  - d. Include a textured baked-on paint finish.
- C. Transient Voltage Suppression and High-Frequency Noise Filter Unit:
- 1. Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:
    - a. Dielectric strength of 1000 V minimum
    - b. Response time of 10 nanoseconds or less
    - c. Transverse mode noise attenuation of 65 dB or greater
    - d. Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz
  - 2. The maximum continuous operating voltage shall be at least 125 percent.
  - 3. The operating frequency range shall be 47 to 63 Hz.
  - 4. Protection modes according to NEMA LS-1.

5. The rated single-pulse surge current capacity, for each mode of protection, shall be no less than the following:
    - a. Line to Neutral: 45,000 A.
    - b. Neutral to Ground: 45,000 A.
    - c. Line to Ground: 45,000 A.
    - d. Per Phase: 90,000 A.
  6. Clamping voltages shall be in compliance with test and evaluation procedures defined in NEMA LS-1. Maximum clamping voltage shall be as follows:
    - a. Line to Neutral: 360 V.
    - b. Line to Ground: 360 V.
    - c. Neutral to Ground: 360 V.
  7. Electromagnetic interference and RF interference noise rejection or attenuation values shall comply with test and evaluation procedures defined in NEMA LS-1.
    - a. Line to Neutral:
      - 1) 100 kHz: 42 dB.
      - 2) 1 MHz: 25 dB.
      - 3) 10 MHz: 21 dB.
      - 4) 100 MHz: 36 dB.
    - b. Line to Ground:
      - 1) 100 kHz: 16 dB.
      - 2) 1 MHz: 55 dB.
      - 3) 10 MHz: 81 dB.
      - 4) 100 MHz: 80 dB.
  8. Unit shall have LED status indicator that extinguishes to indicate a failure.
  9. Unit shall be listed by an NRTL as a transient voltage surge suppressor per UL 1449, and as an electromagnetic interference filter per UL 1283.
  10. Unit shall not generate any appreciable magnetic field.
  11. Unit shall not generate an audible noise.
- D. DC Power Supply:
1. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
  2. Enclose circuitry in a housing.
  3. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.

4. Performance:
  - a. Output voltage nominally 25-V dc within 5 percent.
  - b. Output current up to 100 mA.
  - c. Input voltage nominally 120-V ac, 60 Hz.
  - d. Load regulation within 0.5 percent from zero- to 100-mA load.
  - e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
  - f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

## 2.24 PIPING AND TUBING

### A. Tubing and Piping:

1. Products in this paragraph are intended for use with the following:
  - a.
2. Copper Tubing:
  - a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered, with chemical and physical properties according to ASTM B 75.
  - b. Performance, dimensions, weight and tolerance according to ASTM B 280.
  - c. Diameter, by application, not less than nominal 0.25 inch.
  - d. Wall thickness, by the application, but not less than 0.030 inch.
3. Copper Tubing Connectors and Fittings:
  - a. Brass, compression type.
  - b. Brass, solder-joint type.
4. Polyethylene Tubing:
  - a. Fire-resistant black virgin polyethylene according to ASTM D 1248, Type 1, Class C and Grade 5.
  - b. Tubing shall comply with stress crack test according to ASTM D 1693.
  - c. Diameter, by application, of not less than nominal 0.25 inch.
5. Polyethylene Tubing Connectors and Fittings:
  - a. Brass, barbed fittings.
  - b. Brass, compression type.

### B. Process Tubing:

1. Products in this paragraph are intended for signals to instruments connected to liquid and steam systems.
2. Copper Tubing:
  - a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered with chemical and physical properties according to ASTM B 75.
  - b. Performance, dimensions, weight and tolerance according to ASTM B 280.

- c. Diameter, by application, of not less than nominal 0.25 inch.
  - d. Wall thickness, by application, but not less than 0.030 inch.
- 3. Copper Tubing Connectors and Fittings:
  - a. Brass, compression type.
  - b. Brass, solder-joint type.

## 2.25 CONTROL WIRE AND CABLE

- A. Wire: Single conductor control wiring above 24 V.
  - 1. Wire size shall be selected to meet manufacturer recommended voltage drop based on length of run and shall be at least No. 18 AWG.
  - 2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
  - 3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
  - 4. Conductor colors shall be black (hot), white (neutral), and green (ground).
  - 5. Furnish wire on spools.
- B. Single Twisted Shielded Instrumentation Cable above 24 V:
  - 1. Wire size shall be selected to meet manufacturer recommended voltage drop based on length of run and shall be at least No. 18 AWG.
  - 2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
  - 3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
  - 4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
  - 5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
  - 6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
  - 7. Furnish wire on spools.
- C. Single Twisted Shielded Instrumentation Cable 24 V and Less:
  - 1. Wire size shall be selected to meet manufacturer recommended voltage drop based on length of run and shall be at least No. 18 AWG.
  - 2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
  - 3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
  - 4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
  - 5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
  - 6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.

7. Furnish wire on spools.
- D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
  1. Cable shall be balanced twisted pair.
  2. Comply with the following requirements and for balanced twisted pair cable described in Division 26 and 27.
    - a. Cable shall be plenum rated.
    - b. Cable shall have a unique color that is different from other cables used on Project.
- 2.26 RACEWAYS
  - A. Comply with requirements in Division 26 and Division 27.
- 2.27 OPTICAL FIBER CABLE AND CONNECTORS
  - A. Comply with requirements in Division 27.
- 2.28 PANEL-MOUNTED, MANUAL OVERRIDE SWITCHES
  - A. Manual Override of Control Dampers:
    1. Include panel-mounted, two-position, selector switch for each automatic control damper being controlled by DDC controller.
    2. Label each switch with damper designation served by switch.
    3. Label switch positions to indicate either "Manual" or "Auto" control signal to damper.
    4. With switch in "Auto" position signal to control damper actuator shall be control loop output signal from DDC controller.
    5. With switch in "Manual" position, signal to damper actuator shall be controlled at panel with either an integral or separate switch to include local control.
      - a. For Binary Control Dampers: Manual two-position switch shall have "Close" and "Open" switch positions indicated. With switch in "Close" position, damper shall close. With switch in "Open" position, damper shall open.
      - b. For Analog Control Dampers: A gradual switch shall have "Close" and "Open" switch limits indicated. Operator shall be able to rotate switch knob to adjust damper to any position from closed to open.
    6. DDC controller shall monitor and report position of each manual override selector switch. With switch placed in "manual" position, DDC controller shall signal an override condition to alert operator that damper is under manual, not automatic, control.
    7. Configure manual override switches to allow operator to manually operate damper while at panel without DDC controller installed and operational.
    8. Dampers associated with VAV terminal units, fan-coil units, and unit heaters do not require manual override unless otherwise indicated by sequence of operation.
  - B. Manual Override of Control Valves:
    1. Include panel-mounted, two-position, selector switch for each automatic control valve being controlled by a DDC controller.



2. Label each switch with valve designation served by switch.
3. Label switch positions to indicate either "Manual" or "Auto" control signal to valve.
4. With switch in "Auto" position, signal to control-valve actuator shall be a control loop output signal from DDC controller.
5. With switch in "Manual" position, signal to valve actuator shall be controlled at panel with either an integral or a separate switch to include local control.
  - a. For Two-Position Digital Control Valves: Manual two-position switch shall have "Close" and "Open" switch positions indicated. With switch in "Close" position, valve shall close. With switch in "Open" position, valve shall open.
  - b. For Modulating Analog Control Valves: A gradual switch shall have "Open" and "Close" switch limits indicated. Operator shall be able to rotate switch knob to adjust valve to any position from closed to open.
6. DDC controller shall monitor and report position of each manual override selector switch. With switch placed in "manual" position, DDC controller shall signal an override condition to alert operator that valve is under manual, not automatic, control.
7. Configure manual override switches to allow operator to manually operate valve while at panel without DDC controller installed and operational.
8. Valves associated with VAV terminal units, fan-coil units, and unit heaters do not require manual override unless otherwise indicated by sequence of operation.

## 2.29 ACCESSORIES

### A. Pneumatic Pressure gauges:

1. Pressure gauges shall a 1.5-inch- diameter face for pressures up through 30 psig and 2.5-inch- diameter face for greater pressures.
2. Include separate gauges for branch pressure and main pressure lines.
3. White dial face with black printing.
4. Include 1-psig increment for scale ranges through 30 psig and 2-psig increment for larger ranges.
5. Accuracy: Within 1 percent of full-scale range.

### B. Pressure Electric Switches:

1. Diaphragm-operated snap acting switch.
2. Set point adjustable from 3 to 20 psig.
3. Differential adjustable from 2 to 6 psig.
4. Rated for resistance loads at 120-V ac.
5. Body and switch housing shall be metal.

### C. Damper Blade Limit Switches:

1. Sense positive open and/or closed position of the damper blades.
2. NEMA 250, Type 13, oil-tight construction.
3. Arrange for the mounting application.

4. Additional waterproof enclosure when required by its environment.
  5. Arrange to prevent "over-center" operation.
- D. I/P and E/P Transducers:
1. Commercial Grade:
    - a. The transducer shall convert an AO signal to a stepped pneumatic signal. Unless otherwise required by the operating sequence, use a 3- to 15-psig pneumatic signal for pneumatic actuation.
    - b. Construct the entire assembly so that shock and vibration will neither harm the transducer nor affect its accuracy.
    - c. Transducer shall have auto/manual output switch, manual output control and an output pressure gauge.
    - d. Accuracy: Within 1.0 percent of the output span.
    - e. Linearity: Within 0.5 percent of the output span.
    - f. Output Capacity: Not less than 550 scim at 15 psig.
    - g. Transducer shall have separate zero and span calibration adjustments.
    - h. The transducer shall withstand up to 40 psig of supply pressure without damage.
    - i. For use on only modulating pneumatic outputs that are associated with terminal units, including fan-coil units, VAV units and unit heaters.
  2. Industrial Grade:
    - a. The transducer shall convert an AO signal to a proportional pneumatic signal. Unless otherwise required by the operating sequence, use a 3- to 15-psig pneumatic signal for pneumatic actuation. A stepped pneumatic signal is unacceptable.
    - b. Construct the entire assembly so that shock and vibration will neither harm the transducer nor affect its accuracy.
    - c. Suitable for operation in an ambient temperature range of minus 40 to 150 deg F.
    - d. Accuracy: Within 0.5 percent of the output span.
    - e. Linearity: Within 0.5 percent of the output span.
    - f. Output Capacity: Not less than 5 scfm.
    - g. Transducer shall have zero and span calibration adjustments.
    - h. The transducer shall withstand up to 50 psig of supply pressure without damage.
    - i. For use on all modulating pneumatic outputs, not requiring a commercial-grade transducer.
- E. E/P Switch:
1. Construct the body of cast aluminum or brass; three pipe body (common, normally open, and normally closed).
  2. Internal construction of steel, copper or brass.
  3. Air Connections: Barb.

4. Rating of 30 psig when installed in systems below 25 psig and of 150 psig when installed in systems above 25 psig.
  5. Include coil transient suppression.
- F. Instrument Enclosures:
1. Include instrument enclosure for secondary protection to comply with requirements indicated in "Performance Requirements" Article.
  2. NRTL listed and labeled to UL 50.
  3. Sized to include at least 25 percent spare area on subpanel.
  4. Instrument(s) mounted within enclosure on internal subpanel(s).
  5. Enclosure face with engraved, laminated phenolic nameplate for each instrument within enclosure.
  6. Enclosures housing pneumatic instruments shall include main pressure gauge and a branch pressure gauge for each pneumatic device, installed inside.
  7. Enclosures housing multiple instruments shall route tubing and wiring within enclosure in a raceway having a continuous removable cover.
  8. Enclosures larger than 12 inches shall have a hinged full-size face cover.
  9. Equip enclosure with lock and common key.
- G. Manual Valves:
1. Needle Type:
    - a. PTFE packing.
    - b. Construct of brass for use with copper and polyethylene tubing and of stainless steel for use with stainless-steel tubing.
    - c. Aluminum T-bar handle.
    - d. Include tubing connections.
  2. Ball Type:
    - a. Body: Bronze ASTM B 62 or ASTM B 61.
    - b. Ball: Type 316 stainless steel.
    - c. Stem: Type 316 stainless steel.
    - d. Seats: Reinforced PTFE.
    - e. Packing Ring: Reinforced PTFE.
    - f. Lever: Stainless steel with a vinyl grip.
    - g. 600 WOG.
    - h. Threaded end connections.
- H. Wall-Mounted Portable Workstation Cabinet:
1. Surface-mounted wall cabinet for tilt-out operation of laptop computers and large-format mobile devices.
  2. Cabinet shall have a load limit of 50 lb.

3. Cabinet shall include the following:
  - a. Oil-filled dampers for controlled lowering of equipment to operational position.
  - b. 3RU EIA mounting rails.
  - c. Removable laptop shelf.
  - d. Separate top compartment with mounting area, hinged rail and security lock.
  - e. Front ventilation slots.
  - f. Knockouts for conduit connections on top and bottom of cabinet.
4. Cabinet shall be constructed of steel and painted with a powder-coat epoxy.
5. Inside center of back-box shall have provision to mount a field-furnished and -installed, single gang electrical outlet box.

## 2.30 AUXILIARY CONTROL DEVICES AND SENSORS

- A. Motorized control dampers, unless otherwise specified elsewhere, shall be as follows:
  1. Dampers shall have stable operation throughout full range of operation, from design to minimum airflow over varying pressures and temperatures encountered.
  2. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
  3. Rectangular control dampers shall be the parallel or opposed blade type as follows unless otherwise scheduled or shown on drawings.
    - a. Outdoor and/or return air mixing dampers and face and bypass (F&BP) dampers shall be parallel blade, arranged to direct airstreams toward each other.
    - b. Other modulating dampers shall be the opposed blade type.
    - c. Two-position shutoff dampers may be parallel or opposed blade type with blade and side seals. Two-position dampers shall be full size of duct or equipment connection unless otherwise indicated.
  4. Modulating dampers shall provide a linear flow characteristic.
  5. Performance:
    - a. Leakage:
      - 1) Rectangular: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-in. wg (250-Pa) differential static pressure.
      - 2) Round: Leakage shall not exceed 0.15 cfm/in. (0.0028 L/s per mm) of perimeter blade at 4-in. wg (1000-Pa) differential static pressure.
    - b. Pressure Drop:
      - 1) Rectangular: 0.06-in. wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested according to AMCA 500-D, figure 5.3.
      - 2) Round: 0.02-in. wg (5 Pa) at 1500 fpm (7.6 m/s) across a 12-inch (300-mm) damper when tested according to AMCA 500-D, figure 5.3.

- c. Velocity:
    - 1) Rectangular: Up to 6000 fpm (30 m/s).
    - 2) Round: Up to 4000 fpm (20 m/s).
  - d. Temperature: Minus 20 to plus 185 deg F (Minus 40 to plus 85 deg C).
  - e. Pressure Rating:
    - 1) Rectangular: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
    - 2) Round: 8-in. wg (2000 Pa) for sizes through 12 inches (300 mm), 6-in. wg (1500 Pa) for larger sizes.
  - f. Damper shall have AMCA seal for both air leakage and air performance.
6. Construction:
- a. Frame:
    - 1) Rectangular select one of the following to match connecting ductwork:
      - a) ASTM B211, Alloy 6063 T5 extruded-aluminum profiles, minimum 0.07 inch (1.8 mm) thick. Hat-shaped channel with integral flange(s). Mating face shall be a minimum of 1 inch (25 mm). Width not less than 5 inches (125 mm).
      - b) ASTM A653/A653M galvanized-steel profiles, minimum 0.06 inch thick. Hat-shaped channel with integral flanges. Mating face shall be a minimum of 1 inch (25 mm). Width not less than 5 inches (125 mm).
    - 2) Round to match connecting ductwork:
      - a) Material: Galvanized or stainless steel, 0.04 in (1.0 mm) thick. Outward rolled stiffener beads positioned approximately 1 inch (25 mm) inboard of each end. Sleeve-type connection for mating to adjacent ductwork. Size Range: 4 to 24 inches (100 to 600 mm). Length not less than 7 inches (175 mm). Provide 2-inch (50-mm) sheet metal stand-off for mounting actuator.
  - b. Blades:
    - 1) Rectangular: Hollow, airfoil, extruded aluminum or galvanized-steel. Parallel or opposed blade configuration as required by application. Material: ASTM B211, Alloy 6063 T5 aluminum, 0.07 inch (1.8 mm) thick or ASTM A653/A653M galvanized steel, 0.05 inch thick. Width not to exceed 6 inches (150 mm). Length as required by close-off pressure, not to exceed 48 inches (1200 mm).
    - 2) Round: Double-thickness circular flat blades sandwiched together and constructed of galvanized or stainless steel.
  - c. Seals:

- 1) Rectangular Damper Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite. Jambs: Stainless steel, compression type.
    - 2) Round Damper Blades: Polyethylene foam seal sandwiched between two sides of blades and fully encompassing blade edge.
  - d. All blade edges and top and bottom of the frame shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. The blade seals shall provide for a maximum leakage rate of 10 cfm per square foot at 4 in. wg differential pressure. Provide air foil blades suitable for a wide-open face velocity of 1500 fpm.
  - e. Individual damper sections shall not be larger than 48 x 60 in. Provide a minimum of one damper actuator per section.
  - f. Axles: 0.5-inch- (13-mm-) diameter plated or stainless steel, mechanically attached to blades.
  - g. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze or better. Provide molded synthetic or stainless-steel sleeve mounted in frame. Where blade axles are installed in vertical position, provide thrust bearings.
  - h. Linkage: Dampers shall have exposed linkages. Constructed of aluminum and plated or stainless steel. Hardware: Stainless steel.
7. Flanges:
- a. Outward rolled with bolt holes on each end of frame for mating to adjacent ductwork.
  - b. Face: Not less than 1.25 inch (31 mm) for damper sizes through 12 inches (300 mm) in diameter, 1.5 inch (38 mm) for damper sizes 14 through 24 inches (350 through 600 mm) in diameter, and 2 inches (50 mm) for larger sizes.
8. Transition:
- a. For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
  - b. Factory mount damper in a sleeve with a close transition to mate to field connection.
  - c. Damper size and sleeve shall be connection size plus 2 inches (50 mm).
  - d. Sleeve length shall be not less than 12 inches (300 mm) for dampers without jackshafts and shall be not less than 16 inches (450 mm) for dampers with jackshafts.
  - e. Sleeve material shall match adjacent duct.
9. Airflow Measurement and Control Dampers:
- a. Where indicated, provide damper assembly with integral airflow measurement and control.
  - b. A factory-furnished and -calibrated controller shall be programmed, in nonvolatile EPROM, with application-specific airflow set point and range.

- c. The controller and actuator shall communicate to control the desired airflow.
- d. The controller shall receive a zero- to 10-V dc input signal and report a zero- to 20-mA output signal that is proportional to the airflow.
- e. Airflow measurement and control range shall be suitable for operation between 150 to 2000 fpm (0.8 to 10 m/s).
- f. Accuracy shall be within 5 percent of the actual flow rate between the range of minimum and design airflow.
- g. Ambient Operating Temperature Range: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).
- h. Ambient Operating Humidity Range: 5 to 95 percent relative humidity, non-condensing.
- i. Provide unit with control transformer rated for not less than 85 VA. Provide transformer with primary and secondary protection and primary disconnecting means. Coordinate requirements with field power connection.
- j. Provide screw terminals for interface to field wiring.
- k. Factory mount electronics within a NEMA 250, Type 12 painted steel enclosure.

**B. Control Valves:**

- 1. Determine control valve sizes and flow coefficients by ISA 75.01.01.
- 2. Control valve characteristics and rangeability shall comply with ISA 75.11.01.
- 3. Control valve shutoff classifications shall be FCI 70-2, Class IV or better unless otherwise indicated.
- 4. Control valves shall be two-way or three-way type for two-position or modulating service as shown.
- 5. Modulating two-way control valves shall have equal percentage flow-throttling characteristics unless otherwise indicated.
- 6. Modulating three-way pattern water valves shall have linear flow-throttling characteristics. The total flow through the valve shall remain constant regardless of the valve's position.
- 7. Control valves shall be suitable for operation at system operating pressure and temperature identified in associated Division 23 hydronic piping and accessories section.
- 8. Selection shall consider viscosity, flashing, and cavitation corrections.
- 9. Liquid Control Valves (Water and Glycol):
  - a. Valves shall have stable operation throughout full range of operation, from design to minimum Cv.
  - b. Rotary-type non-pressure independent control valves, such as ball and butterfly valves, shall have Cv falling between 65 and 75 degrees of valve full open position and minimum valve Cv between 15 and 25 percent of open position.
  - c. Sizing Criteria
    - 1) Two-position service: Line size unless otherwise indicated.

- 2) Two-way modulating service:
    - a) For non-pressure independent control valves pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50 percent of the pressure difference between supply and return pipe mains, or 5 psi (34.5 kPa), whichever is greater. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
    - b) For pressure independent valves, select for a differential pressure range of 5 to 50 psig (34 to 345 kPa).
  - 3) Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 5 psi (34.5 kPa) maximum.
  - 4) Close-off (differential) Pressure Rating. Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
    - a) Two-way: 150 percent of total system (pump) head.
    - b) Three-way: 300 percent of pressure differential between ports A and B at design flow or 100 percent of total system (pump) head.
10. Ball Style Control Valves:
- a. Valves NPS 1/2 inch through NPS 2 inch shall be bronze body or cast brass ANSI Class 250, spring-loaded, quick opening for two position service. Two-way valves to have replaceable composition disc or stainless steel ball.
  - b. Valves 2 1/2 inch and larger shall be cast iron ANSI Class 125.
  - c. Valve Type: Pressure Independent
  - d. Process Temperature Range: Zero to 212 deg F (Minus 18 to plus 100 deg C).
  - e. Close-off Pressure: 200 psig (1379 kPa).
  - f. Ball: Chrome-plated brass or bronze or 300 series stainless steel.
  - g. Stem and Stem Extension:
    - 1) Material to match ball.
    - 2) Blowout-proof design.
    - 3) Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.
  - h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
  - i. Flow Characteristic:
    - 1) Equal percentage.
  - j. Valves up to NPS 2:



- 1) Minimum Pressure Rating for NPS 1 (DN 25) and Smaller: Nominal 600 WOG.
  - 2) Minimum Pressure Rating for NPS 1-1/2 (DN 38) through NPS 2 (DN 50): Nominal 400 WOG.
  - 3) Body and Tail Piece: Cast bronze ASTM B61, ASTM B62, ASTM B584, or forged brass with nickel plating.
  - 4) End Connections: Threaded (NPT) ends.
  - 5) Ball Seats: Reinforced PTFE.
  - k. Valves NPS 2-1/2 and Larger:
    - 1) Pressure Rating for NPS 2-1/2 (DN 65) and larger Class 150.
    - 2) Body: Carbon or stainless steel.
    - 3) End Connections: Flanged ends.
    - 4) Ball Seat: Graphite.
  - l. Minimum Rangeability: 100:1.
  - m. Pressure Independent Valves:
    - 1) Integral Pressure Regulator: Located upstream of ball to regulate pressure, to maintain a constant pressure differential while operating within pressure range specified. Pressure regulator shall be mechanical based only. Electronic flow measurement type pressure independent control valves are not acceptable.
11. Globe Type Control Valves
- a. General Globe-Style Valve Requirements:
    - 1) Globe-style control valve body dimensions shall comply with ISA 75.08.01.
    - 2) Construct the valves to be serviceable from the top.
    - 3) For cage guided valves, trim shall be field interchangeable for different valve flow characteristics, such as equal percentage, linear, and quick opening.
    - 4) Replaceable seats and plugs.
    - 5) Furnish each control valve with a corrosion-resistant nameplate indicating the following:
      - a) Manufacturer's name, model number, and serial number.
      - b) Body and trim size.
      - c) Arrow indicating direction of flow.

- 6) Globe-type control valves shall pass the design flow required with not more than 95 percent of stem lift unless otherwise indicated.
- b. Two-Way Globe Control Valve
  - 1) Globe Style: Single port.
  - 2) NPS 2 and smaller
    - a) Body: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
    - b) End Connections: Threaded
    - c) Bonnet: Screwed.
  - 3) NPS 2-1/2 and larger
    - a) Body: Cast iron complying with ASME B61.1, Class 125.
    - b) End Connections: Flanged.
    - c) Bonnet: Bolted.
  - 4) Packing: PTFE.
  - 5) Plug: Top or bottom guided.
  - 6) Plug, Seat, and Stem: Brass or stainless steel.
  - 7) Process Temperature Range:
    - a) Liquid Service: 35 to 248 deg F (2 to 120 deg C).
    - b) Steam Service (100 psig maximum): Minus 20 to plus 337 deg F
  - 8) Ambient Operating Temperature: 35 to 150 deg F (2 to 65 deg C).
  - 9) Leakage: FCI 70-2, Class IV.
  - 10) Minimum Rangeability: 6 to 1.
  - 11) Equal percentage flow characteristic.
- c. Three-Way Globe Valves (Liquid Service Only)
  - 1) Globe Style: Mix flow pattern.
  - 2) Body:
    - a) NPS 2 and smaller: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
    - b) NPS 2-1/2 and larger: Cast iron complying with ASME B61.1, Class 125.
  - 3) End Connections:

- a) NPS 2 and smaller: Threaded.
- b) NPS 2-1/2 and larger: Flanged.
- 4) Bonnet:
  - a) NPS 2 and smaller: Screwed.
  - b) NPS 2-1/2 and larger: Bolted.
- 5) Packing: PTFE.
- 6) Plug: Top or bottom guided.
- 7) Plug, Seat, and Stem: Brass or stainless steel.
- 8) Process Temperature Range: 35 to 248 deg F.
- 9) Ambient Operating Temperature: 35 to 150 deg F.
- 10) Leakage: FCI 70-2, Class IV.
- 11) Minimum Rangeability: 6 to 1.
- 12) Linear flow characteristic.
- 12. Butterfly Control Valves - High Performance:
  - a. Performance:
    - 1) Bi-directional bubble tight shutoff at 250 psig.
    - 2) Comply with MSS SP-67 or MSS SP-68.
    - 3) Rotation: Zero to 90 degrees.
    - 4) Modified equal percentage flow characteristic.
  - b. Body: Cast iron ASTM A126, Class B, ductile iron ASTM A536 or cast steel ASTM A216/A216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
  - c. Disc: 316 stainless steel.
  - d. Shaft: 316 or 17-4 PH stainless steel.
  - e. Seat: Reinforced EPDM or reinforced PTFE with retaining ring.
  - f. Shaft Bushings: Reinforced PTFE or stainless steel.
  - g. Replaceable seat, disc, and shaft bushings.
  - h. Corrosion-resistant nameplate indicating:
    - 1) Manufacturer's name, model number, and serial number.
    - 2) Body size.

- 3) Body and trim materials.
  - 4) Flow arrow.
  - i. Arrangement for Three-Way Valve Applications: Two valves mated to a fabricated tee with interconnecting mechanical linkage.
- C. Electric damper/valve actuators:
1. The actuator shall have mechanical or electric stall protection to prevent damage to the actuator throughout the rotation of the actuator.
  2. Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing. Alternatively, an uninterruptible power supply (UPS) may be provided.
  3. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.
  4. All 24 VAC DC actuators shall operate on Class 2 wiring.
  5. All non-spring-return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 N•m (60 in.•lb) torque capacity shall have a manual crank for this purpose.
  6. Construction:
    - a. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
    - b. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
    - c. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
  7. Field Adjustment:
    - a. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
    - b. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.
  8. Two-Position Actuators: Single direction, spring return or reversing type.
  9. Modulating Actuators:
    - a. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
    - b. Control Input Signal:
      - 1) Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.

- 2) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10-V dc and 4- to 20-mA signals.
  - 3) Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
10. Programmable Multi-Function:
  - a. Control Input, Position Feedback, and Running Time: Factory or field programmable.
  - b. Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
  - c. Service Data: Include, at a minimum, number of hours powered and number of hours in motion.
11. Position Feedback:
  - a. Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
  - b. Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
  - c. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.
12. Fail-Safe:
  - a. Where indicated, provide actuator to fail to an end position.
  - b. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
  - c. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.
13. Integral Overload Protection:
  - a. Provide against overload throughout the entire operating range in both directions.
  - b. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.
14. Function properly within a range of 85 to 120 percent of nameplate voltage.
15. Sound:
  - a. Spring Return: 62 dBA.
  - b. Non-Spring Return: 45 dBA.
16. Control valve actuators:
  - a. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.
  - b. Actuators for Steam Control Valves: Shutoff against 1.5 times steam design pressure.

- c. Position indicator and graduated scale on each actuator.
  - d. Type: Motor operated, with or without gears, electric and electronic.
  - e. Voltage: 24-V ac or 120-V ac.
  - f. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
  - g. Valve Attachment:
    - 1) Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.
    - 2) Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
    - 3) Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.
  - h. Valve Actuator Stroke Time Except Where Noted Otherwise:
    - 1) Operate valve from fully closed to fully opened within adjustable range of 75 to 100 seconds.
    - 2) Operate valve from fully opened to fully closed within adjustable range of 75 to 100 seconds.
    - 3) Move valve to failed position in less than within 20 seconds.
    - 4) Select operating speed to be compatible with equipment and system operation.
17. Damper Actuators:
- a. Type: Motor operated, with or without gears, electric and electronic.
  - b. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.
  - c. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.
  - d. The total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.
  - e. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.
  - f. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.
  - g. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.

- h. Provide mounting hardware and linkages for connecting actuator to damper.
- i. Select actuators to fail in desired position in the event of a power as indicated on the drawings.
- j. Damper Attachment:
  - 1) Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
  - 2) Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
  - 3) Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.
- k. Damper Stroke Time Limits Except Where Noted Otherwise:
  - 1) Operate damper from fully closed to fully open within adjustable range of 75 to 100 seconds.
  - 2) Operate damper from fully opened to fully closed within adjustable range of 75 to 100 seconds.
  - 3) Move damper to failed position in less than 25 seconds.
  - 4) Select operating speed to be compatible with equipment and system operation.
  - 5) Actuators operating in smoke control systems comply with governing code and NFPA requirements.

**D. Digital Temperature Devices**

- 1. Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 55 deg F to 85 deg F setpoint range, 2 deg F maximum differential, and vented ABS plastic cover.
- 2. Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 55 deg F to 85 deg F setpoint range, 2 deg F maximum differential, and vented ABS plastic cover.
- 3. Low-limit thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type, with an element of 20 foot minimum length. Element shall respond to the lowest temperature sensed by any 1 foot section. The low-limit thermostat shall be manual reset only.

**E. Temperature Sensors**

- 1. Temperature sensors shall be RTD or thermistor.
- 2. Duct sensors shall be single point or averaging type. Averaging sensors shall be a minimum of 5 feet in length per 10 square feet of duct cross section.

3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.
4. Space sensors shall be equipped with setpoint adjustment, override switch, display, and/or communication port.
5. Provide matched temperature sensors for temperature differential measurement.
6. Platinum RTDs: Common Requirements:
  - a. 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
  - b. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
  - c. Performance Characteristics:
    - 1) Repeatability: Within 0.5 deg F.
    - 2) Self-Heating: Negligible.
  - d. Transmitter Requirements:
    - 1) Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.
  - e. Duct Air Temperature Sensors:
    - 1) 1000 ohms.
    - 2) Single Probe Sensors:
      - a) Probe: Single-point sensor with a stainless-steel sheath.
      - b) Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches.
    - 3) Averaging Sensors:
      - a) Multiple sensors to provide average temperature across entire length of sensor.
      - b) Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
      - c) Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch (100-mm) radius.
      - d) Length: As required by application to cover entire cross section of air tunnel.
    - 4) Outdoor Air Sensors:
      - a) Probe: Single-point sensor with a stainless-steel sheath.
      - b) Solar Shield: Stainless steel.
    - 5) Enclosure: Junction box with removable cover; NEMA 250, Type 12 for indoor applications and Type 4 for outdoor applications.



- 6) Gasket for attachment to duct or equipment to seal penetration airtight.
    - 7) Conduit Connection: 1/2-inch
  - f. Space Air Temperature Sensors:
    - 1) Sensor assembly shall include a temperature sensing element mounted under a bright white, non-yellowing, plastic or flush, brushed-aluminum cover.
    - 2) Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
    - 3) Concealed wiring connection.
- 7. Thermal Resistors (Thermistors): Common Requirements:
  - a. 10,000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C.
  - b. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
  - c. Performance Characteristics:
    - 1) Repeatability: Within 0.5 deg F (0.3 deg C).
    - 2) Drift: Within 0.5 deg F (0.3 deg C) over 10 years.
    - 3) Self-Heating: Negligible.
  - d. Transmitter contingent on compliance with end-to-end control accuracy.
  - e. Duct Air Temperature Sensors:
    - 1) Single Probe Sensors
      - a) Probe: Single-point sensor with a stainless-steel sheath.
      - b) Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches (450 mm) long).
    - 2) Averaging Sensors
      - a) Multiple sensors to provide average temperature across entire length of sensor.
      - b) Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
      - c) Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch (100-mm) radius.
      - d) Length: As required by application to cover entire cross section of air tunnel.
    - 3) Outdoor Air Temperature Sensor
      - a) Probe: Single-point sensor with a stainless-steel sheath.
      - b) Solar Shield: Stainless steel.

- 4) Enclosure: Junction box with removable cover; NEMA 250, Type 12 for indoor applications and Type 4 for outdoor applications.
    - 5) Gasket for attachment to duct or equipment to seal penetration airtight.
    - 6) Conduit Connection: 1/2- inch (16-mm) trade size.
  - f. Space Air Temperature Sensors
    - 1) Sensor assembly shall include a temperature sensing element mounted under a bright white, non-yellowing, plastic or flush, brushed-aluminum cover.
    - 2) Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
    - 3) Concealed wiring connection.
8. Air Temperature Switches
  - a. Thermostat and Switch for Low Temperature Control in Duct Applications:
    - 1) Description:
      - a) Two-position control.
      - b) Field-adjustable set point.
      - c) Manual reset.
      - d) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
    - 2) Performance:
      - a) Operating Temperature Range: 15 to 55 deg F (Minus 9 to 13 deg C).
      - b) Temperature Differential: 5 deg F (2.8 deg C), non-adjustable and additive.
      - c) Enclosure Ambient Temperature: Minus 20 to 140 deg F (Minus 11 to 60 deg C).
      - d) Sensing Element Maximum Temperature: 250 deg F (121 deg C).
      - e) Voltage: 120-V ac.
      - f) Current: 16 FLA.
      - g) Switch Type: Two SPDT snap switches operate on coldest 12-inch (300-mm) section along element length.
    - 3) Construction:
      - a) Vapor-Filled Sensing Element: Nominal 20 feet (6 m) long.
      - b) Dual Temperature Scale: Fahrenheit and Celsius visible on face.
      - c) Set-Point Adjustment: Screw.
      - d) Enclosure: Painted metal, NEMA 250, Type 12.

- e) Electrical Connections: Screw terminals.
  - f) Conduit Connection: 1/2-inch (16-mm) trade size.
9. Air Temperature RTD Transmitters
- a. Input:
    - 1) 1000-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
  - b. Span (Adjustable):
    - 1) Space: 40 to 90 deg F (4 to 32 deg C).
    - 2) Supply Air Cooling and Heating: 40 to 120 deg F (4 to 49 deg C).
    - 3) Supply Air Cooling Only: 40 to 90 deg F (4 to 32 deg C).
    - 4) Supply Air Heating Only: 40 to 120 deg F (4 to 49 deg C).
    - 5) Exhaust Air: 50 to 100 deg F (10 to 38 deg C).
    - 6) Return Air: 50 to 100 deg F (10 to 38 deg C).
    - 7) Mixed Air: Minus 40 to 140 deg F (Minus 40 to 60 deg C).
    - 8) Outdoor: Minus 40 to 140 deg F (Minus 40 to 60 deg C).
  - c. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.
  - d. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F (28 deg C).
  - e. Match sensor with temperature transmitter and factory calibrate together.
  - f. Performance Characteristics:
    - 1) Calibration Accuracy: Within 0.1 percent of the span.
    - 2) Stability: Within 0.2 percent of the span for at least 6 months.
    - 3) Combined Accuracy: Within 0.5 percent.
10. Liquid Temperature Switches for Temperature Control in Pipe Applications
- a. Description:
    - 1) Two-position control.
    - 2) Field-adjustable set point.
    - 3) Manual reset.
    - 4) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

b. Performance:

- 1) Temperature Differential Deadband: 5 to 30 deg F (3 to 17 deg C), adjustable.
- 2) Enclosure Ambient Temperature: 150 deg F (66 deg C).
- 3) Sensing Element Pressure Rating: 200 psig (1379 kPa).
- 4) Voltage: 120-V ac.
- 5) Current: 8 FLA.
- 6) Switch Type: SPDT snap switch.

c. Construction:

- 1) Vapor-Filled Immersion Element: Copper, nominal 3 inches (75 mm) long.
- 2) Temperature Scale: Fahrenheit, visible on face.
- 3) Set-Point Adjustment: Screw.
- 4) Enclosure: Painted metal, NEMA 250, Type 12.
- 5) Electrical Connections: Screw terminals.
- 6) Conduit Connection: 3/4-inch (21-mm) trade size).

F. Humidity Sensors

1. Duct and room sensors shall have a sensing range of 20 percent to 80 percent.
2. Duct sensors shall be provided with a sampling chamber.
3. Outdoor air humidity sensors shall have a sensing range of 20 percent to 95 percent rh. They shall be suitable for ambient conditions of 40 deg F to 170 deg F.
4. Humidity sensor drift shall not exceed 1 percent of full scale per year.
5. Sensors and Transmitters with Digital Display:

a. Performance:

- 1) Accuracy including non-linearity, hysteresis, and repeatability: Within 2 percent from zero to 90 percent relative humidity and within 2.5 percent from 90 to 100 percent relative humidity when operating between 60 to 77 deg F (16 to 25 deg C).
- 2) Relative Humidity Range: Zero to 100 percent.
- 3) Factory calibrated and NIST traceable with certificate included.

b. Construction:

- 1) Provide housing with integral sensor for room applications.

- 2) Provide housing with remote sensor probe for ducted applications.
      - a) Duct Sensor Body: 300 series stainless steel or chrome-plated aluminum, at least 2 inches long for duct-mounted applications.
      - b) Provide sensor with cable for field installation in conduit.
      - c) For duct-mounted applications, thread the sensor assembly for connection to a threaded mounting flange.
    - 3) Provide general-purpose humidity sensor unless application requires special requirements. Provide sensor with sintered stainless-steel filter for duct applications.
    - 4) Housing shall be ABS/PC plastic or powder-coated aluminum.
    - 5) Housing Classification: NEMA 250, Type 4 or 4X.
    - 6) Provide housing with wall-mounting plate.
  - c. Output Signal: 2-wire, 4- to 20-mA output signal with a drive capacity of at least 500 ohms at 24-V dc.
  - d. Provide unit with a digital display of relative humidity in percent.
6. Sensor and Transmitter without Display:
  - a. Performance:
    - 1) Accuracy including non-linearity, hysteresis, and repeatability: Within 2 percent from zero to 90 percent relative humidity and within 3 percent from 90 to 95 percent relative humidity when operating at 68 deg F (20 deg C).
    - 2) Hysteresis: Within 1 percent.
    - 3) Relative Humidity Range:
      - a) Duct: Zero to 100 percent.
      - b) Space: Zero to 95 percent relative.
    - 4) Factory calibrated and NIST traceable with certificate included.
  - b. Construction for Space Applications:
    - 1) Housing with integral sensor.
    - 2) Housing shall be ABS plastic or powder-coated aluminum.
    - 3) Enclosure: NEMA 250, Type 4.
    - 4) Provide housing with a wall-mounting plate.
  - c. Construction for Duct and Equipment Applications:
    - 1) Housing with integral sensor.

- 2) Duct Sensor Body: 300 series stainless steel, 6 inches (150 mm) long for duct-mounted applications.
    - 3) For outdoor and duct applications, install circuitry in a NEMA 250, Type 4 or 4X enclosure
    - 4) Provide sensor with sintered stainless-steel filter for duct applications.
    - 5) Housing shall be cast aluminum.
    - 6) Enclosure: NEMA 250, Type 4.
  - d. Output Signal:
    - 1) Two-wire, 4- to 20-mA output signal with drive capacity of at least 500 ohms at 24-V dc.
    - 2) Non-interacting zero and span adjustments.
7. Combination Humidity and Temperature Sensor and Transmitter (Dewpoint Sensor):
  - a. Description:
    - 1) Factory package consisting of humidity and temperature sensor, installation hardware, interconnecting sensor cabling, installation instructions, and operating manual.
    - 2) Each transmitter shall be individually calibrated and provided with NIST traceable calibration certifications.
    - 3) Provide a service cable for connecting to a notebook computer and Microsoft Windows compatible software.
  - b. Display for Non-Duct Mounted Applications Only:
    - 1) Alphanumeric display of the following on the face of the enclosure:
      - a) Percent relative humidity.
      - b) Absolute humidity.
      - c) Mixing ratio.
      - d) Dry-bulb temperature.
      - e) Wet-bulb temperature.
      - f) Dew point temperature.
      - g) Enthalpy.
    - 2) Visual display of measurement trends, and minimum and maximum values over a one-year period.
  - c. Electronics Enclosure:
    - 1) Integral to sensors for wall-mounted applications and remote from temperature and humidity sensors for duct and equipment applications.

- 2) NEMA 250, Type 4 or 4X.
- 3) Labeled terminal strip for field wiring connections.
- 4) 0.63-inch trade size threaded conduit connection.
- d. Programming:
  - 1) Transmitter parameters shall be field programmable through keypad on the face of the enclosure.
  - 2) Programmed parameters shall be stored in nonvolatile EEPROM.
- e. Output Signals:
  - 1) Three Analog Outputs: 4 to 20 mA or zero to 10-V dc for each output. Option to use a serial communication interface.
  - 2) Provide analog dewpoint reading output compatible with associated DDC system controller.
- f. Temperature Sensor:
  - 1) Temperature range matched to application, but not less than minus 40 to 140 deg F (minus 40 to 60 deg C).
  - 2) Within 0.5 deg F (0.3 deg C) accuracy over the temperature range of 50 to 100 deg F (10 to 38 deg C) and within 1 deg F (0.6 deg C) over the remainder of the range.
  - 3) Provide duct installation kit for duct applications.
- g. Humidity Sensor:
  - 1) Relative Humidity Measurement Range: Zero to 100 percent.
  - 2) Response time in still air within 40 seconds.
  - 3) Accuracy including non-linearity, hysteresis, and repeatability:
    - a) For Temperature Between 59 and 77 Deg F (15 to 25 Deg C) and Relative Humidity between Zero and 90 Percent: Within 1 percent.
    - b) For Temperature between 59 and 77 Deg F (15 to 25 Deg C) and Relative Humidity between 90 and 100 Percent: Within 1.7 percent.
    - c) For Temperature between Minus 4 and 104 Deg F (Minus 20 to 40 Deg C): Within 1 percent plus 0.008 times relative humidity reading.
    - d) For Temperature between Minus 40 and 356 Deg F (Minus 40 to 180 Deg C): Within 1.5 percent plus 0.015 times the relative humidity reading.
  - 4) Sintered, stainless-steel filter, protecting sensor.
  - 5) Provide duct installation kit for duct applications.

- h. Power Supply:
  - 1) Field Power: 120-V ac, 60 Hz unless otherwise required by the application.
  - 2) Internal Power: As required by transmitter.
- G. Override Timers
  - 1. Override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration as required by application. Provide 0-to-6-hour calibrated dial unless otherwise specified. Timer shall be suitable for flush mounting on control panel face and located on local control panels or where shown.
- H. Current Transmitters
  - 1. AC current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, with internal zero and span adjustment and  $\pm 1$  percent full-scale accuracy at 500 ohm maximum burden.
  - 2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UUCSA Recognized.
  - 3. Unit shall be split-core type for clamp-on installation on existing wiring.
- I. Current Transformers
  - 1. AC current transformers shall be UUCSA Recognized and completely encased (except for terminals) in approved plastic material.
  - 2. Transformers shall be available in various current ratios and shall be selected for  $\pm 1$  percent accuracy at 5 A full-scale output.
  - 3. Transformers shall be fixed-core or split-core type for installation on new or existing wiring, respectively.
- J. Voltage Sensing
  - 1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.
  - 2. Ranges shall include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, with  $\pm 1$  percent full-scale accuracy with 500 ohm maximum burden.
  - 3. Transmitters shall be UUCSA Recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1 requirements.
- K. Voltage Transformers
  - 1. AC voltage transformers shall be UUCSA Recognized, 600 VAC rated, complete with built-in fuse protection.
  - 2. Transformers shall be suitable for ambient temperatures of 4 degC to 55 deg C (40 deg F to 130 deg F) and shall provide  $\pm 0.5$  percent accuracy at 24 VAC and a 5 VA load.
  - 3. Windings (except for terminals) shall be completely enclosed with metal or plastic.
- L. Power Monitors



1. Selectable rate pulse output for kWh reading, 4-20 mA output for kW reading, N.O. alarm contact, and ability to operate with 5.0 amp current inputs or 0-0.33 volt inputs.
2. 1.0 percent full-scale true RMS power accuracy, +0.5 Hz, voltage input range 120-600 V, and auto range select.
3. Under voltage/phase monitor circuitry.
4. NEMA 1 enclosure.
5. Current transformers having a 0.5 percent FS accuracy, 600 VAC isolation voltage with 0-0.33V output. If 0-5 A current transformers are provided, a three-phase disconnect/shorting switch assembly is required.

**M. Flow Switches**

1. Flow-proving switches shall be either paddle or differential pressure type.
2. Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum) and shall have adjustable sensitivity with NEMA 1 enclosure unless otherwise specified.
3. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 2 enclosure, with scale range and differential suitable for intended application or as specified.
4. Airflow Proving Switches
  - a. Performance:
    - 1) Polymer Film Sail Switch: Suitable for applications operating at velocities up to 400 fpm (2.0 m/s). Suitable for mounting with air direction in horizontal, vertical up or down.
      - a) Normally open switch actuates at 250 fpm (1.3 m/s) and opens at 75 fpm (0.4 m/s).
      - b) Normally closed switch actuates at 75 fpm (0.4 m/s) and closes at 250 fpm (1.3 m/s).
      - c) Removable spring counterbalances sail to allow mounting in either vertical (up or down) or horizontal airflow.
    - 2) Stainless Steel Single Vane Switch: Suitable for applications operating at velocities up to 2000 fpm (10.2 m/s). Suitable for mounting with air direction in horizontal.
      - a) Field-Adjustable Velocity Set Point: 400 to 1600 fpm.
      - b) Screw setpoint adjustment.
    - 3) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
    - 4) Voltage: 24-, 120-, 240-V ac.
    - 5) Maximum Process Temperature: 170 deg F (77 deg C).
    - 6) Maximum Ambient Temperature: 125 deg F (52 deg C).

- b. Construction:
  - 1) Polyester film sail encasing a wire frame or stainless steel vane based on velocity requirements.
  - 2) Sail or vane actuates a SPDT snap switch.
  - 3) Enclosure Material: Zinc-plated steel or die-cast metal.
  - 4) Enclosure with removable cover.
  - 5) NEMA 250, Type 12 enclosure.
  - 6) Electrical Connections: Screw terminals.
  - 7) Conduit Connections: 1 inch (16-mm) trade size conduit knock outs on top and bottom.
- 5. Liquid Flow Switch (Bellows Type):
  - a. Description:
    - 1) Field-adjustable four-vane combinations.
    - 2) Field-adjustable set-point adjustment screw.
    - 3) Suitable for pipe sizes NPS 1 through NPS 8 (DN 25 through DN 200).
    - 4) Switch mounted vertically in horizontal pipe.
  - b. Performance:
    - 1) Flow Rate Actuation and De-actuation: Varies with vane combination and set-point adjustment.
    - 2) Pressure Limit: 145 psig (1000 kPa).
    - 3) Temperature Limit: 230 deg F (110 deg C).
    - 4) Electrical Rating: 10 A resistive, 3 A conductive at 250-V ac.
    - 5) Switch Type: SPDT snap switch.
  - c. Wetted Parts Construction:
    - 1) Bellows: Tin-bronze.
    - 2) Vanes: Stainless steel.
    - 3) Body: Forged brass.
    - 4) Process Connection: NPS 1 (DN 25).
  - d. Enclosure:

- 1) Die-cast aluminum alloy.
  - 2) NEMA 250, Type 4.
  - 3) Electrical Connection: Cable gland with attached wire leads.
6. Liquid Flow Switch (Magnetic Type):
- a. Description:
    - 1) Suitable for pipe sizes NPS 1/2 through NPS 20 (DN 40 to DN 500).
    - 2) Mounting Suitable for Application: Switch vertically mounted in horizontal pipe or switch horizontally mounted in vertical pipe with flow up.
    - 3) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous-environment Class I, Groups C and D; Class II, Groups E, F, and G.
  - b. Performance:
    - 1) Flow Rate Actuation and De-actuation:
      - a) NPS 2-1/2 and Larger: Varies with vane combination.
      - b) NPS 2 and Smaller: Non-Adjustable
    - 2) Pressure Limit: 1000 psig (6895 kPa) for brass body, 2000 psig (13790 kPa) for Type 316 stainless steel body.
    - 3) Pressure Limit of Tee 2 NPS and Smaller: 250 psig for brass, 1000 psig for malleable iron, and 2000 psig for forged carbon steel and stainless steel.
    - 4) Temperature Range: Minus 4 to plus 220 deg F (Minus 20 to plus 135 deg C).
    - 5) Electrical Rating: 10 A at 125/250-V ac.
    - 6) Switch Type: SPDT or DPDT snap switch.
  - c. Wetted Parts Construction:
    - 1) Vanes:
      - a) NPS 2-1/2 and Larger: Type 316 stainless steel.
      - b) NPS 2 and Smaller: Brass or Type 303 stainless steel
    - 2) Body: Brass or Type 316 stainless steel.
    - 3) Magnetic Keeper: Type 430 stainless steel or Type 316 stainless steel.
    - 4) Process Connection:
      - a) NPS 1-1/2 (DN 40) for piping NPS 2-1/2 and larger.
      - b) NPS 1/2 (DN 15) for piping NPS 2 and smaller.

- d. Enclosure:
  - 1) NPS 2-1/2 and Larger: Die-cast aluminum alloy. Threaded cover.
  - 2) NPS 2 and Smaller: Brass or Type 303 stainless steel
  - 3) NEMA 250, Type 4.
  - 4) Electrical Connection: Terminal block.
  - 5) Conduit Connection: 3/4-inch (21-mm) trade size.
- e. NPS 2 and Smaller - Integral Mounting Tee Furnished with Switch:
  - 1) Acceptable Materials: Brass, forged carbon steel, malleable iron, stainless steel.
  - 2) Size: Match adjacent pipe.
  - 3) Connection: Threaded pipe.

**N. Flow Instruments**

- 1. General Requirements for Flow Instruments
  - a. Air sensors and transmitters shall have an extended range of 10 percent above Project design flow and 10 percent below minimum Project flow to signal abnormal flow conditions and to provide flexibility for changes in operation.
  - b. Liquid and steam sensors, meters, and transmitters shall have an extended range of 10 percent above Project design flow and 10 percent below Project minimum flow to signal abnormal flow conditions and to provide flexibility for changes in operation.
  - c. Source Limitations: For flow instruments, obtain products from single source from single manufacturer.
- 2. Airflow Measurement Stations and Instruments
  - a. Performance Requirements:
    - 1) Adjustable for changes in system operational parameters.
    - 2) Manufacturer shall certify that each flow instrument indicated complies with specified performance requirements and characteristics.
      - a) Product certificates are required.
  - b. Pitot-Tube Airflow Sensor Station:
    - 1) Description: Multiple total- and static-pressure sensors positioned at the center of equal area of the station cross section and interconnected by respective averaging manifolds.
    - 2) Provide the number of independent sensors recommended by the airflow station manufacturer in written instructions based on the duct size.

- 3) Casing: Galvanized sheet steel at least 0.079 inch (2.0 mm) thick with coating complying with ASTM A653/A653M, G90 (Z275). Casings shall be stainless steel, 0.0781 inch (2.0 mm) thick, when connected to stainless duct and aluminum, 0.063 inch (1.6 mm) thick, when connected to aluminum duct.
- 4) Joints and Seams: Continuously weld. Clean galvanized areas damaged by welding and coat with aluminum paint.
- 5) Casing Depth: At least 8 inches (200 mm).
- 6) Casing Flanges: Outward flange, minimum flange face 1.5 inches (38 mm).
- 7) Casing Configuration and Size: Match shape (rectangular, round, flat oval) and same size as adjacent duct unless otherwise indicated.
- 8) Include an open parallel cell air straightener or air equalizer honeycomb mechanically fastened to casing.
- 9) Construct straightener or equalizer from Type 3003 aluminum or Type 316 stainless steel, depending on casing material. Use stainless steel for units with stainless-steel casings.
- 10) Construct pressure sensor array from drawn copper or stainless-steel tubing. Use stainless steel for units with stainless-steel casings. Copper tubing shall comply with ASTM B75 and ASTM B280. Minimum tube wall thickness shall be 0.030 inch (0.8 mm). Include internal piping and external pressure transmitter ports.
- 11) Station Labeling: Identification label on each station casing indicating model number, size, area, and application-specific airflow range.
- 12) Performance:
  - a) **Pressure Loss: 0.015-inch wg (3.8 Pa) at 1000 fpm (5 m/s), or 0.085-inch wg (22.5 Pa) at 2000 fpm (10 m/s).**
  - b) **Accuracy: Within 2 percent of actual airflow.**
  - c) **Self-Generated Sound: NC 40 and sound level within the duct shall not be amplified.**
- 13) Performance rated and tested according to AMCA 610. Each station shall bear the AMCA seal.]
- c. Pitot-Tube Fan Inlet Airflow Traverse Sensor:
  - 1) Traverse manifold designed for mounting in fan inlets.
  - 2) Contain multiple total- and static-pressure sensors placed at concentric area centers along the exterior surface of cylindrical manifold and internally connected to their respective averaging manifolds. Sensors shall not

protrude beyond the surface of the manifold nor be adversely affected by particle contamination present in airstream.

- 3) Manifold (two per inlet) shall have dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal takeoffs and fittings.
- 4) Sensors shall be capable of producing steady, non-pulsating signals of standard total- and static-pressure without need for flow corrections or factors, with an accuracy of 3 percent of actual flow over a turndown range of 6 to 1.
- 5) Manifold Materials: Copper or anodized aluminum.
- 6) Unless otherwise required by application and without affecting the fan and sensor performance, nominal diameter copper and aluminum manifolds shall be the following:
  - a) For Fan Inlets Smaller Than 20 Inches (500 mm): 0.375 inch (9 mm).
  - b) For Fan Inlets 20 Inches (500 mm) and Larger: 0.75 inch (19 mm).
- 7) Unless otherwise required by application and without affecting the fan and sensor performance, nominal diameter stainless steel manifolds shall be the following:
  - a) For Fan Inlets Smaller Than 20 Inches (500 mm): 0.375 inch (9 mm).
  - b) For Fan Inlets 20 through 48 Inches (500 through 1200 mm): 0.75 inch (19 mm).
  - c) For Fan Inlets Larger Than 48 Inches (1200 mm): 1.0 inch (25 mm).

d. Piezometer Ring Fan Inlet Airflow Sensor:

- 1) In lieu of externally mounted fan inlet airflow sensors, option to provide fans with airflow measurement integral to fan inlet cones for continuous measurement of air volume flow rate.
- 2) Multiple pressure sensor points strategically placed along the circumference of the inlet cone and internally connected to an averaging ring manifold located behind the inlet cone.
- 3) Sensor points shall not protrude beyond the surface of the inlet cone nor be adversely affected by particle contamination present in the airstream.
- 4) Sensor shall produce steady, non-pulsating signals to achieve accuracy within 5 percent of actual airflow.
- 5) Sensor shall be non-intrusive and not impact fan performance.

3. Airflow Transmitters

- a. Transmitter shall receive total- and static-pressure signals from a primary element, amplify signals, extract the square root, and scale the signals to produce 4- to 20-mA dc output signals linear to airflow.
  - b. NEMA 250, Type 12 enclosure.
  - c. Construct assembly so that shock, vibration, and pressures surges of up to 1 psig (6.9 kPa) will neither harm transmitter, nor affect its accuracy.
  - d. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals. The automatic zeroing circuit shall re-zero transmitter to within 0.1 percent of true zero.
  - e. Performance:
    - 1) Calibrated Span: Field adjustable, minus 40 percent of the range.
    - 2) Accuracy: Within 0.25 percent of natural span.
    - 3) Repeatability: Within 0.15 percent of calibrated span.
    - 4) Linearity: Within 0.2 percent of calibrated span.
    - 5) Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.
    - 6) Stability: Within one percent of span per year.
    - 7) Temperature Limits: Zero to 150 deg F.
    - 8) Compensate Temperature Limits: 40 to 150 deg F.
    - 9) Thermal Effects: 0.033 percent of full scale per degree F.
  - f. Integral digital LED or digital display for continuous indication of airflow.
4. Liquid Hydronic Flowmeters - Magnetic Flow-Tube Type Flowmeter
- a. Sensor shall be a magnetic flowmeter, which utilizes Faraday Law to measure volumetric fluid flow through a pipe. The flowmeter shall consist of two elements, the sensor and the electronics. The sensor shall generate a measuring signal proportional to the flow velocity in the pipe. The electronics shall convert this EMF into a standard current output.
  - b. Electric replacement shall not affect meter accuracy (electric units are not matched with specific sensors).
  - c. Four-wire, externally powered, magnetic type flow transmitter with adjustable span and zero, integrally mounted to flow tube. Output signal shall be a digital pulse proportional to the flow rate (to provide maximum accuracy and to handle abrupt changes in flow). Standard 4-20 mA or 0-10 Vdc outputs may be used provided accuracy is as specified.
  - d. Flow tube
    - 1) ANSI class 150 psig steel

- 2) ANSI flanges
    - 3) Protected with PTFE, PFA, or ETFE liner rated for 245 deg F minimum fluid temperature
  - e. Electrode and grounding material
    - 1) 316L stainless steel or Hastelloy C
    - 2) Electrodes shall be fused to ceramic liner and not require o-rings.
  - f. Electrical enclosure. NEMA 4X.
  - g. Approvals :
    - 1) UL or CSA
    - 2) NSF Drinking Water approval for domestic water applications
  - h. Performance:
    - 1) Accuracy for Velocities between 3.3 and 33 fps: Within 0.2 percent of reading.
    - 2) Accuracy for Velocities between 1.0 and 3.3 fps: Within 0.75 percent of reading.
    - 3) Accuracy for Velocities Less than 1.0 fps: Within 0.0075 fps.
    - 4) Ambient Temperature: Minus 4 to plus 140 deg F.
    - 5) Stability. 0.1 percent of rate over six months.
    - 6) Process Temperature: Minus 4 to 212 deg F.
    - 7) Pressure: Selected option to meet system requirements
      - a) 225 psig or 580 psig.
- 5. Liquid Pressure Differential Transmitter for Flow Measurement:
  - a. Performance:
    - 1) Range: Approximately 2 times the set point.
    - 2) Span: Adjustable plus or minus 1 mA, non-interactive.
    - 3) Accuracy: Within 0.25 percent of full scale.
    - 4) Maximum Operating Pressure: 2.5 times range.
    - 5) Temperature Limits: Zero to 175 deg F (Minus 18 to plus 79 deg C).
    - 6) Compensate Temperature Limits: 30 to 150 deg F (Minus 1 to plus 66 deg C).



- 7) Thermal Effects: 0.02 percent of full scale per degree F.
    - 8) Response Time: 30 to 50 ms.
    - 9) Shock and vibration shall not harm the transmitter.
  - b. Analog Output Current Signal:
    - 1) Two wire, 4- to 20-mA dc current source.
    - 2) Signal capable of operating into 1000-ohm load.
  - c. Operator Interface:
    - 1) Zero and span adjustments located behind cover.
    - 2) Bleed screws on side of body, two screws on low-pressure side and one screw on high-pressure side, for air in line and pressure cavity.
  - d. Construction:
    - 1) Aluminum and stainless steel enclosure with removable cover.
    - 2) Wetted parts of transmitter constructed of 17-4 PH or 300 series stainless steel.
    - 3) NPS 1/4 (DN 8) process connections on side of instrument enclosure.
    - 4) Knock out for 1/2-inch (15-mm) trade size conduit connection on side of instrument enclosure.
    - 5) Screw terminal block for wire connections.
    - 6) NEMA 250, Type 4X.
    - 7) Mounting bracket shall be suitable for installation.
  - e. Transmitter shall have three-valve manifold. Construct manifold of brass, bronze, or stainless steel. Manifold shall have NPS 1/4 (DN 8) process connections.
- O. Pressure Instruments
  - 1. Air Pressure Sensors
    - a. Duct Insertion Static Pressure Sensor:
      - 1) Insertion length shall be as recommended by the manufacturer for the duct size served.
      - 2) Sensor with four radial holes of 0.04-inch (1-mm) diameter.
      - 3) Brass or stainless-steel construction.
      - 4) Sensor with threaded end support, sealing washers and nuts.

- 5) Connection: NPS 1/4 (DN 6) compression fitting.
- 6) Suitable for flat oval, rectangular, and round duct configurations.
- b. Duct Insertion Static Pressure Sensor:
  - 1) Sensor probe with two opposing orifices designed to reduce error-associated air velocity.
  - 2) Sensor insertion length shall be as recommended by the manufacturer for the duct size served.
  - 3) Construct sensor of 6061-T6 aluminum alloy or Type 304 stainless steel.
  - 4) Connection: Threaded, NPS 1/8 (DN 6) swivel fitting for connection to copper tubing or NPS 1/4 (DN 10) barbed fitting for connection to polyethylene tubing.
  - 5) Sensor probe attached to a mounting flange with neoprene gasket and two holes for fasteners.
  - 6) Mounting flange shall suitable for flat oval, rectangular, and round duct configurations.
  - 7) Pressure Rating: 10 psig (69 kPa).
- c. Duct Traverse Static Pressure Sensor:
  - 1) Sensor shall traverse the duct cross section and have at least one pickup point every 6 inches (150mm) along length of sensor.
  - 2) Construct sensor of 18-gage Type T6063-T5 extruded and anodized aluminum.
  - 3) Sensor supported with threaded rod, sealing washer, and nut at one end and a mounting plate with gasket at other end.
  - 4) Mounting plate with threaded, NPS 3/8 (DN 12) compression fitting for connection to tubing.
  - 5) Accuracy within 1 percent of actual operating static pressure.
  - 6) Dual offset static sensor design shall provide accurate sensing of duct static pressure in the presence of turbulent and rotational airflows with a maximum 30 degree yaw and pitch.
  - 7) Suitable for velocities of 100 to 10000 fpm (0.51 to 51 m/s) and temperatures of up to 200 deg F (93 deg C).
  - 8) Sensor air resistance shall be less than 0.1 times the velocity pressure at probe-operating velocity.
  - 9) Suitable for flat oval, rectangular, and round duct configurations.

- d. Outdoor Static Pressure Sensor:
  - 1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a) Air Monitor Corporation - Static Outside Air Probe (SOAP),
    - b) Vaisala - Static Pressure Head,
    - c) Or approved equal.
  - 2) Provides average outdoor pressure signal.
  - 3) Sensor with no moving parts.
  - 4) Pressure Connection: Brass barbed fitting for NPS 1/4 (DN 10) tubing.
  - 5) Conduit fitting around pressure fitting for sensor support and protection to pressure connection.
  - 6) Include sensor, tubing and mounting hardware.
  - 7) Operation not affected and impaired by rain and snow.
  - 8) Sensing plates constructed of type 316 stainless steel or aluminum.
  - 9) Accuracy within:
    - a) 1 percent of the actual outdoor atmospheric pressure when subjected to varying horizontal radial wind velocities up to 40 mph.
    - b) 2 percent of the actual outdoor atmospheric pressure while subjected to varying radial wind velocities up to 40 mph with approach angles up to 30 degrees to horizontal.
    - c) 3 percent of the actual outdoor atmospheric pressure while subjected to varying radial wind velocities up to 40 mph with approach angles up to 60 degrees to horizontal.
- e. Space Static Pressure Sensor for Wall Mounting
  - 1) Aluminum or Stainless-steel wall plate with sensing port, perforated center or multiple sensing ports arranged to sense space static pressure. Include pressure impulse suppression chamber and airflow shielding. Exposed metal surfaces are provided with brush finish.
  - 2) Back of sensor plate fitted with brass barbed or brass union fitting for tubing connection.
  - 3) Wall plate provided with matching color screws and sized to fit standard single-gang electrical box.

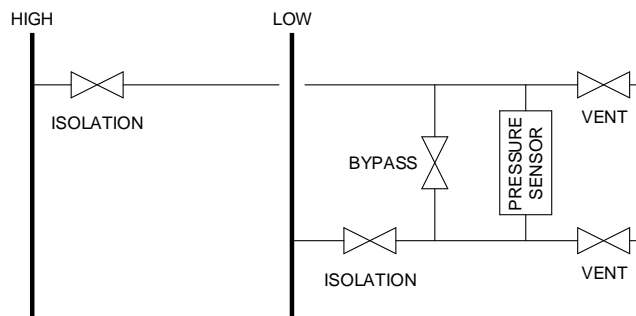
- 4) Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm (5.1 m/s) from a 360-degree radial source.
    - 5) Pressure rating: 10 psig (69kPa).
  - f. Space Static Pressure Sensor for Exposed or Suspended Mounting
    - 1) Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm (5.1 m/s) from a 360-degree radial source.
    - 2) Aluminum or stainless steel with perforations arranged to sense space static pressure. Exposed surfaces provided with brush finish.
    - 3) Sensor fitted with multiple sensing ports, pressure impulse suppression chamber, and airflow shielding.
    - 4) Surface-mounted sensor provided with solid mounting plate intended for mount to ceiling with pressure chamber exposed to view and 0.125-inch (3-mm) fitting for exposed tubing connection.
    - 5) Suspended sensor intended for pendent mount with pressure chamber exposed to view and NPS 1/2 (DN 15) fitting for exposed pipe or tubing connection.
2. Air Pressure Switches
  - a. Air-Pressure Differential Switch
    - 1) UL listed, diaphragm-operated SPDT snap-acting, with scale range and differential suitable for intended application.
      - a) Fan safety shutdown applications: Switch with manual reset.
    - 2) Electrical Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
    - 3) Enclosure Conduit Connection: Knock out or threaded connection.
    - 4) User Interface: Screw-type set-point adjustment with enclosed set-point indicator and scale.
    - 5) High and Low Process Connections: Threaded, NPS 1/8 (DN 6).
    - 6) Enclosure:
      - a) Dry Indoor Installations: NEMA 250, Type 12.
      - b) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
      - c) Hazardous Environments: Explosion proof.
    - 7) Operating Data:

- a) Electrical Rating: 15 A at 120- to 480-V ac.
  - b) Pressure Limit Continuous: 45 inches wg (11.2 kPa).
  - c) Pressure Limit Surge: 10 psig (68.9 kPa).
  - d) Temperature Limits: Minus 30 to 180 deg F (Minus 34 to 82 deg C).
  - e) Operating Range: Approximately 2 times set point.
  - f) Repeatability: Within 3 percent.
  - g) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- b. Air-Pressure Differential Indicating Switch
- 1) Combination gauge with low- and high-limit switches.
  - 2) Nominal 4-inch- (100-mm-) diameter analog indication with white dial face, graduated black markings, pointer to indicate measured value, and a separate adjustable pointer for each switch set point.
  - 3) Switch zero and set-point tamperproof adjustment screws or knobs on the dial face.
  - 4) Each switch used as a safety limit shall have a manual reset button local to switch.
  - 5) Switch Type: Each set point shall have two Form C relays, DPDT.
  - 6) Electrical Connections: Screw terminals.
  - 7) Enclosure Conduit Connection: NPS 3/4 (DN 20) threaded connection.
  - 8) High and Low Process Connections: Threaded, NPS 1/8 (DN 6).
  - 9) Enclosure:
    - a) Dry Indoor Installations: NEMA 250, Type 12.
    - b) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
    - c) Hazardous Environments: Explosion proof.
  - 10) Operating Data:
    - a) Electrical Rating: 10 A at 120- to 240-V ac.
    - b) Pressure Limits: 25 psig (172 kPa).
    - c) Temperature Limits: 20 to 120 deg F (Minus 7 to 49 deg C).
    - d) Operating Range: Approximately twice normal operating range unless otherwise required for application.
    - e) Accuracy: 4 percent for ranges through 0.5 in. wg (125 Pa), 2 percent for ranges 1 in. wg (250 Pa) and greater.
    - f) Repeatability: Within 1 percent of full scale.

- g) Switch Deadband: One pointer width and within 1 percent of full scale for each switch set point.
  - h) Power Supply: 24 or 120-V ac, 50/60 Hz.
  - i) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 3. Air Pressure Differential Transmitters
  - a. Transmitter with automatic zeroing circuit capable of automatically readjusting the transmitter to zero at predetermined time intervals. The automatic zeroing circuit shall re-zero the transmitter to within 0.1 percent of true zero.
  - b. Integral digital display for continuous indication of pressure differential
  - c. Performance:
    - 1) Range: Approximately 2 times set point or as required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
    - 2) Calibrated Span: Field adjustable, minus 40 percent of the range.
    - 3) Accuracy: Within 0.10 percent of natural span.
    - 4) Repeatability: Within 0.15 percent of calibrated span.
    - 5) Linearity: Within 0.2 percent of calibrated span.
    - 6) Hysteresis and deadband (combined): Less than 0.2 percent of calibrated span.
    - 7) Stability: Within 0.25 percent of span per year.
    - 8) Overpressure: 1 psig (69 kPa).
    - 9) Temperature Limits: Zero to 150 deg F (Minus 18 to 66 deg C).
    - 10) Compensate Temperature Limits: 40 to 135 deg F (4 to 57 deg C).
    - 11) Thermal Effects: 0.033 percent of full scale per degree F.
    - 12) Warm-up Time: Within 5 seconds.
    - 13) Response Time: 5 ms.
    - 14) Shock and vibration shall not harm the transmitter.
  - d. Output Signals:
    - 1) Analog Current Signal: 4- to 20-mA dc current source. Signal capable of operating into 800-ohm load.
  - e. Display: Four-digit digital display with minimum 0.4-inch- (10-mm-) high numeric characters.

- f. Operator Interface: Zero and span adjustments within 10 percent of full span. Potentiometer adjustments located on face of transmitter.
- g. Construction:
  - 1) Type 300 stainless-steel enclosure.
  - 2) Threaded, NPS 1/4 (DN 10) swivel fittings for connection to copper tubing or NPS 3/16 (DN 7) barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.
  - 3) Screw terminal block for wire connections.
  - 4) Vertical plane mounting.
  - 5) NEMA 250, Type 4.
  - 6) Provide mounting bracket suitable for installation.
  - 7) Reverse wiring protected.
  - 8) Calibrate to NIST-traceable standards and provide each transmitter with a certificate of calibration.
- 4. Liquid gauge Pressure Switch:
  - a. Bourdon tube or 316 stainless-steel double opposing bellows operated to actuate a SPDT snap switch.
  - b. Provide switches used in safety limiting applications with auto reset.
  - c. Wetted Materials: Brass or Type 403 stainless steel or Type 316 stainless steel.
  - d. Seal: Viton.
  - e. Electrical Connections: Screw terminal.
  - f. Enclosure Conduit Connection: Knock out or threaded connection.
  - g. User Interface: Thumbscrew set-point adjustment with enclosed set-point indicator and scale.
  - h. Process Connection: Threaded, NPS 1/4 (DN 10).
  - i. Enclosure:
    - 1) Dry Indoor Installations: NEMA 250, Type 12.
    - 2) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
    - 3) Hazardous Environments: Explosion proof.
  - j. Operating Data:
    - 1) Electrical Rating: 120-V ac.
    - 2) Pressure Limits: Equal to maximum pressure in full-scale range, but not less than system design pressure rating.

- 3) Ambient Temperature Limits: Minus 20 to 150 deg F (Minus 29 to 66 deg C).
  - 4) Process Temperature Limits: 20 to 300 deg F (Minus 7 to 149 deg C). Temperature Limits: 180 deg F (82 deg C).
  - 5) Operating Range: Approximately 2 times set point, but not less than system design pressure rating.
  - 6) Deadband: Adjustable or fixed as required by application.
  - k. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Liquid Pressure Transmitter
- a. Transmitter shall have linear output signal. Zero and span shall be field adjustable.
  - b. Transmitter sensing elements shall with-stand continuous operating conditions of positive or negative pressure 50 percent greater than calibrated span without damage.
  - c. Water pressure transmitter shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and block and bleed valves.
  - d. Water differential pressure transmitter shall have stainless-steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and five-valve manifold as shown below:



- e. Performance:
- 1) Range: Approximately 2 times the set point.
  - 2) Span: Adjustable plus or minus one milliamp, non-interactive.
  - 3) Accuracy: Within 0.25 percent of full scale.
  - 4) Hysteresis: Within 0.1 percent of full scale.
  - 5) Repeatability: Within 0.05 percent of full scale.
  - 6) Maximum Working Pressure: 250 psig (1724 kPa).



- 7) Temperature Limits: Zero to 175 deg F (Minus 18 to 79 deg C).
- 8) Compensate Temperature Limits: 30 to 150 deg F (Minus 1 to 66 deg C).
- 9) Thermal Effects: 0.02 percent of full scale per degree F.
- 10) Response Time: 30 to 50 ms.
- 11) Shock and vibration shall not harm the transmitter.

**P. Differential Pressure Type Switches (Water Service)**

1. Shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application.

**Q. Level Sensors and Switches**

1. Cooling Coil Condensate Drain Pan Water Level Sensor
  - a. Low profile, solid state, high amperage sensor to shut down unit on detection of water.
  - b. Detection level as low as 1/16 inch.
  - c. Normally open or normally closed.
  - d. Vertical and adjustable horizontal mounting.
  - e. No moving parts.
  - f. Not affected by sticky, dusty, or clingy materials that coat or build up on probe
  - g. Sensor shall be UL 508 listed,
  - h. Normally open external alarm connection.
  - i. Clip on base for cleaning and drying of sensor.
2. Liquid-Level Switch (Magnetic Type with Float)
  - a. Description:
    - 1) Mounting Suitable for Application: Horizontal or vertical switch mounting.
    - 2) Float arm with hinge design limits vertical movement to prevent sticking.
    - 3) Replaceable float with threaded connection.
    - 4) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments (Class I, Groups C and D; Class II, Groups E, F, and G).
  - b. Performance:
    - 1) Level Actuation and De-Actuation: 0.75-inch (20-mm) deadband.
    - 2) Body Pressure Limit: 1000 psig (6895kPa) for brass body; 2000 psig (13790 kPa) for Type 316 stainless-steel body.
    - 3) Float Pressure Limit: 150 psig (1034 kPa).

- 4) Temperature Range: Minus 4 to 275 deg F (Minus 20 to 135 deg C).
    - 5) Electrical Rating: 10 A at 125/250-V ac.
    - 6) Switch Type: SPDT or DPDT snap switch.
  - c. Wetted Parts Construction:
    - 1) Float and Rod: Type 316 stainless steel.
    - 2) Body: Brass or Type 316 stainless steel.
    - 3) Magnetic Keeper: Type 316 stainless steel.
    - 4) Process Connection: NPS 1-1/2 (DN 40) NPT.
    - 5) Enclosure:
      - a) Die-cast aluminum alloy.
      - b) Threaded cover.
      - c) NEMA 250, Type 4.
      - d) Electrical Connection: Terminal block.
      - e) Conduit Connection: NPS 3/4 (NPS 20) NPT.
3. Electrode-Type Liquid-Level Switches:
  - a. Description:
    - 1) Conductivity technology.
    - 2) Dual point level settings.
    - 3) No moving parts.
    - 4) Adjustable sensitivity.
  - b. Performance:
    - 1) Pressure Limit: 30 psig (207 kPa).
    - 2) Temperature Limit: 212 deg F (100 deg C).
    - 3) Power Supply: 120-V ac, 50 or 60 Hz.
    - 4) Electrical Rating: 5 A at 240-V ac.
    - 5) Switch Type: SPDT snap switch.
  - c. Probes:
    - 1) Electrodes: 0.125-inch (6-mm) diameter.
    - 2) Material: Type 316 stainless steel.

- 3) Length: To suit application up to 72 inches (1800 mm).
- 4) Process Connection: NPS 1 (DN 25) NPT.
- 5) Enclosure:
  - a) Polypropylene.
  - b) NEMA 250, Type 6.
  - c) Electrical Connection: Cable and standard octal socket.
4. RF Admittance-Type Liquid-Level Switches:
  - a. Description:
    - 1) Capacitive technology.
    - 2) No moving parts.
    - 3) Not affected by sticky, dusty, or clingy materials that coat or build up on probe.
    - 4) Immune to external radio frequency (RF) sources.
    - 5) Sensitivity: Eight selectable settings.
    - 6) Mounting: Horizontal or vertical.
  - b. Performance:
    - 1) Pressure Limit: 365 psig (2517 kPa).
    - 2) Ambient Temperature Range: Minus 40 to 185 deg F (Minus 40 to 85 deg C).
    - 3) Process Temperature Range: Minus 40 to 250 deg F (Minus 40 to 121 deg C).
    - 4) Universal Power Supply: 12- to 240-V ac and dc.
    - 5) Electrical Rating: 8 A at 120- and 240-V ac.
    - 6) Switch Type: SPDT snap switch, selectable for normally open or closed operation.
    - 7) Response Time: 0.2 seconds.
    - 8) Time Delay: Adjustable, zero to 60 seconds.
  - c. Probes:
    - 1) Material: Type 316 stainless steel.
    - 2) Insulator Material: PVDF.

- 3) Length: To suit application up to 72 inches (1800 mm).
- 4) Process Connection: NPS 1 (DN 25) NPT.
- 5) Enclosure:
  - a) NEMA 250, Type 4X.
  - b) Electrical Connection: Screw terminals on removable terminal block.
  - c) Conduit Connection: NPS 1/2 (DN 15) NPT.
5. Liquid-Level Sensor and Transmitter - RF Admittance-Type:
  - a. Description: Complete package with electronic unit, sensing element, connecting cable.
  - b. Continuous level transmitter shall produce an output signal that is proportional to level.
  - c. Measurement shall be free from effects of changes in temperature, density, or acoustic noise in vapor space above level.
  - d. Continuous measurement shall be independent of changes in material density and unaffected by presence of material clinging to sensing element.
  - e. No moving parts and no routine cleaning and recalibration necessary.
  - f. Electronic unit shall be integral to sensing element or mounted remotely up to 100 feet (30 m) away from sensor.
  - g. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments (Class I, Groups C and D; Class II, Groups E, F, and G).
  - h. Sensor:
    - 1) Material: Teflon-coated Type 304 or Type 316 stainless steel.
    - 2) Length: To suit installation.
    - 3) Connection: NPS 3/4 (NPS 20) NPT or flanged.
  - i. Electronic unit housed in NEMA 250, Type 4X enclosure.
    - 1) Calibrated Range: Varies with application. At least 10 percent beyond high- and low-level set point and alarm levels.
    - 2) Accuracy: Within 1 percent of calibrated range.
    - 3) Two wire, loop powered.
    - 4) Supply Voltage: 11.5 to 50-V dc.
    - 5) Maximum Load: 625 ohms at 24-V dc.
    - 6) Output Signal: 4 to 20 mA dc.

- 7) Response Time: 0.5 to 30 seconds, adjustable.
- 8) Temperature Range: Minus 40 to 165 deg F (Minus 40 to 74 deg C).
- 9) Zero and Span Adjustments: Non-interacting.
- 10) Visual Indication: Continuous digital display of level.
- 11) Field-changeable failsafe condition and phasing in event measurement requires changes to optimize level reading.
- 12) Free from effects of radio frequency interference.
- 13) Free from harmful effects of static electricity on sensing element with discharges of up to 10 A without damage.
- 14) Adjustable time delay (signal dampening).

**R. Position Limit Switches**

1. Description: Select type of actuating head (plunger, roller lever, or rod) to suit application.
  - a. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Performance:
  - a. Life expectancy: Not less than 30 million mechanical operations and 750,000 electrical operations.
  - b. Operating Frequency: 300 mechanical operations per minute and 30 electrical operations per minute.
  - c. Voltage: 125-, 250-, 480-, and 600-V ac or 8-, 12-, 14-, 24-, 30-, 48-, 125-, and 250-V dc, as required by application.
  - d. Current Rating: As required by application.
  - e. Temperature Rise: 50 deg C.
  - f. Ambient Temperature: 14 to 175 deg F (Minus 10 to 79 deg C).
  - g. Ambient Relative Humidity: 35 to 95 percent.
3. Construction:
  - a. NEMA 250, Type 4X enclosure.
  - b. Switch Type: SPDT or DPDT, as required by application.
  - c. Status indicator integral to switch. Field switchable to light when contacts are actuated and operating, or contacts are free and not operating.
  - d. Electrical Connection: Screw or plug-in terminals.
  - e. Conduit Connection: NPS 1/2 (DN 50).

**S. Motion Sensors**

1. Indoor Motion Sensors

- a. Description: Wall- or ceiling-mounted, solid-state units with a separate relay unit.
  - 1) Operation: Unless otherwise indicated, turn on when covered area is occupied and off when unoccupied; with a time delay for turning off, adjustable over a minimum range of 1 to 15 minutes.
  - 2) Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
  - 3) Relay Unit: Dry contacts rated for 20-A load at 120- and 277-V ac. Power supply to sensor shall be 24-V dc, 150 mA, Class 2 power source as defined by NFPA 70.
  - 4) Mounting:
    - a) Sensor: Suitable for mounting in any position on a standard outlet box.
    - b) Relay: Externally mounted through a 1/2-inch (13-mm) knock out in a standard electrical enclosure.
    - c) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
  - 5) Indicator: Digital display, to show when motion is being detected during testing and normal operation of the sensor.
  - 6) Bypass Switch: Override the on function in case of sensor failure.
- b. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in coverage area.
  - 1) Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
  - 2) Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
  - 3) Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
- c. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in coverage area.
  - 1) Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
  - 2) Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

- 3) Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
    - 4) Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
    - 5) Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
  - d. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in coverage area. A particular technology or combination of technologies that controls on-off functions shall be field selectable by operating controls on unit.
    - 1) Sensitivity Adjustment: Separate for each sensing technology.
    - 2) Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
    - 3) Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling. Apply occupancy detectors where indicated.
2. Switchbox-Mounted Motion Sensors
  - a. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
    - 1) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
    - 2) Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (zero to 49 deg C).
    - 3) Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
  - b. Wall-Switch Sensor:
    - 1) Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m).
    - 2) Sensing Technology: Dual technology - PIR and ultrasonic.
    - 3) Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."

- 4) Voltage: Match the circuit voltage; dual-technology type.
  - 5) Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
  - 6) Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
  - 7) Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
  - 8) Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
- c. Wall-Switch Sensor for Square or Near Square Spaces:
- 1) Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
  - 2) Sensing Technology: PIR.
  - 3) Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
  - 4) Voltage: Match the circuit voltage; dual-technology type.
  - 5) Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
  - 6) Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
  - 7) Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
  - 8) Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

T. Rotational Speed Switches

1. Non-Contact Type Speed Switches

a. Description:

- 1) Speed switch, sensor, and electronics housed in enclosure.
- 2) Shaft-end-mounted disc, or split collar wrap generates an alternating magnetic field sensed by the switch.
- 3) Dust, dirt, and grease proof.
- 4) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments Class I, Group D; Class II, Groups E, F, and G; and Class III.



- b. Performance:
    - 1) Field-Adjustable Range: 100 to 5000 rpm.
    - 2) Temperature Limits: Minus 40 to 140 deg F (Minus 40 to 60 deg C).
    - 3) Electrical Rating: 5 A at 115-V ac.
    - 4) Switch Type: SPDT.
    - 5) Gap Distance: Approximately 0.375 inch (9) mm).
  - c. Operator Interface: Potentiometer.
  - d. Enclosure Construction:
    - 1) Cast aluminum.
    - 2) Removable cover.
    - 3) NEMA 250, Type 4X.
    - 4) Electrical Connection: Wiring, 12 inches (300 mm) long, furnished with switch.
    - 5) Conduit Connection: 1-inch (27-mm) trade size.
    - 6) Disc, Guard, and Mounting Bracket Construction:
    - 7) Magnetic Disc: Nylon or PVC.
    - 8) Disc Guard: Stainless steel.
    - 9) Mounting Bracket: Aluminum with stainless-steel shaft.
2. Contact Type Speed Switches
- a. Description:
    - 1) Speed switch, sensor, and electronics housed in one enclosure.
    - 2) Photoelectric technology.
    - 3) Suitable for mounting in any orientation.
    - 4) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments Class I, Groups C and D; and Class II, Groups F and G.
  - b. Performance:
    - 1) Three Field-Adjustable Ranges: 0.1 to 10, 1 to 100, and 10 to 1000 rpm.
    - 2) De-Energize Set Point: 15 to 20 percent lower than energize speed range.

- 3) Repeatability: Within 2 percent of maximum speed in range.
- 4) Rotation: Clockwise or counterclockwise.
- 5) Temperature Limits: Minus 40 to 140 deg F (Minus 40 to 60 deg C).
- 6) Electrical Rating: 3 A at 120- or 240-V ac.
- 7) Switch Type: SPDT.
- c. Operator Interface: Adjustment screw.
- d. Enclosure Construction:
  - 1) Aluminum.
  - 2) Screw cover.
  - 3) NEMA 250, Type 4X.
  - 4) Electrical Connection: Screw terminals.
  - 5) Conduit Connection: Two, 3/4-inch (21-mm) trade size.

U. Current Switches

- 1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

V. Local Control Panels General Requirements

- 1. A single key shall be common to all field panels and subpanels.
- 2. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
- 3. Provide on/off power switch with overcurrent protection for control power sources to each local panel.

2.31 WIRING AND RACEWAYS

- A. General. Provide copper wiring, plenum cable, and raceways as specified in Division 26.
- B. All insulated wire to be copper conductors, UL labeled for 194 deg F minimum service.

2.32 FIBER OPTIC CABLE SYSTEM

- A. Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. The sheath shall be UL Listed OFNP in accordance with NEC Article 770. The optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125 pm.

- B. Connectors. All optical fibers shall be field-terminated with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

#### 2.33 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate the following according to industry standards for each product, and to verify DDC system reliability specified in performance requirements:
  - 1. DDC controllers.
  - 2. Gateways.
  - 3. Routers.
  - 4. Operator workstations.
- B. Product(s) and material(s) will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

#### 2.34 IDENTIFICATION

- A. Instrument Air Pipe and Tubing:
  - 1. Engraved tag shall bear the following information:
    - a. Service (Example): "Instrument Air."
    - b. Pressure Range (Example): 0 to 30 psig.
  - 2. Letter size shall be a minimum of 0.25 inch high.
  - 3. Tag shall consist of white lettering on blue background.
  - 4. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded blue with contrasting white center exposed by engraving through outer layer.
  - 5. Include tag with a brass grommet, chain and S-hook.
- B. Control Equipment, Instruments, and Control Devices:
  - 1. Laminated acrylic or melamine plastic sign bearing unique identification.
    - a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
  - 2. Letter size shall be as follows:
    - a. Operator Workstations: Minimum of 0.5 inch high.
    - b. Printers: Minimum of 0.5 inch high.
    - c. DDC Controllers: Minimum of 0.5 inch high.
    - d. Gateways: Minimum of 0.5 inch high.
    - e. Repeaters: Minimum of 0.5 inch high.
    - f. Enclosures: Minimum of 0.5 inch high.
    - g. Electrical Power Devices: Minimum of 0.25 inch high.
    - h. UPS units: Minimum of 0.5 inch high.

- i. Accessories: Minimum of 0.25 inch high.
  - j. Instruments: Minimum of 0.25 inch high.
  - k. Control Damper and Valve Actuators: Minimum of 0.25 inch high.
- 3. Legend shall consist of white lettering on black background.
- 4. Laminated acrylic or melamine plastic sign shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer and shall be fastened with drive pins.
- 5. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.
- C. Valve Tags:
  - 1. Brass tags and brass chains attached to valve.
  - 2. Tags shall be at least 1.5 inches in diameter.
  - 3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
  - 4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.
- D. Raceway and Boxes:
  - 1. Comply with requirements for identification specified in Division 26.
  - 2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.
  - 3. For raceways housing air signal tubing, add a phenolic tag labeled "HVAC Air Signal Tubing."
- E. Equipment Warning Labels:
  - 1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
  - 2. Lettering size shall be at least 14-point type with white lettering on red background.
  - 3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
  - 4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least 0.25 inch beyond white border.

## **2.35 SUPPLEMENTAL REQUIREMENTS ZONE AIRFLOW CONTROLS**

- A. Description: Except as specified otherwise, provide control components to perform zone control sequence of operations indicated on the contract drawings.

1. Zone control system shall fully communicate all monitored and controlled data with the DDC system. All alarms and setpoints shall be monitored and adjustable by the DDC system head end computer and via control system service tool.
- B. Performance Requirements: Comply with the following:
  1. Airflow control valves and terminal boxes shall be pressure independent controlled using actual airflow measurement feedback.
- C. Components
  1. Air Volume Control Terminal Box Actuators and Controllers
    - a. Provide controllers and actuators from the selected DDC system manufacturer.
    - b. Actuators shall be proportional modulating electric type directly coupled to the air volume control box damper shaft. Actuators shall be factory-mounted to the valve.
    - c. Actuators shall have a full stroke time of no greater than 95 seconds.
    - d. Actuators shall function within 85 to 110 percent of their power supply rating.
    - e. Actuators shall be provided with mounting and connecting hardware.
  2. Air Volume Terminal Box Airflow Measuring
    - a. Terminal airflow measuring shall be accomplished using terminal box manufacturer standard airflow measuring stations.
    - b. Provide control system manufacturer controller with flow measuring transmitter. Airflow station and transmitter combination shall be capable of maintaining control setpoint to terminal box minimum airflows listed in the schedules. Flow measurement station accuracy shall be +/- 5 percent of full scale down to minimum airflow shown on the drawings.
  3. Air Volume Control Valve Electronic Airflow Controller
    - a. Electronic Controller Requirements - Air volume control terminal box controllers shall have imbedded pressure transducers suitable for variable air volume control applications.
    - b. Sensors - Transmitters shall be calibrated to provide an electric or electronic output signal of 4 to 20 mA over the indicated span or range. Provide controller with electronic airflow measurement transmitter selected to match the terminal air valve flow station (where applicable) with range from 125 to 2600 fpm to match the inlet air velocity of the air volume control terminal box.

## EXECUTION

### 2.36 EXAMINATION

- A. Thoroughly examine plans for control device and equipment locations. Discrepancies, conflicts, or omissions shall be reported to the architect for resolution before rough-in work is started.
- B. Inspect the site to verify that equipment may be installed as shown. Discrepancies, conflicts, or omissions shall be reported to the architect for resolution before rough-in work is started.
- C. Examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the work of this Section and the plans and the work of others, report these discrepancies to the architect and

obtain written instructions for any changes necessary to accommodate the work of this Section with the work of others. Changes in the work of this Section made necessary by the failure or neglect to report such discrepancies shall be made by, and at the expense of this Section.

- D. Examine roughing-in for products to verify actual locations of connections before installation.
  - 1. Examine roughing-in for instruments installed in piping and duct systems to verify actual locations of connections before installation.
- E. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- F. Prepare written report with input from installers listing conditions detrimental to performance of the Work.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 2.37 PROTECTION

- A. Protect all work and material from damage. This Section shall be liable for damage caused by work or employees of this Section.
- B. This Section shall be responsible for work and equipment until finally inspected, tested, and accepted. Protect material that is not immediately installed. Close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

#### 2.38 COORDINATION

- A. Where the work will be installed in close proximity to, or will interfere with, work of other trades, assist in working out space conditions to make adjustments. If work is installed before coordinating with other trades causing interference with work of other trades, make changes to work to correct the condition without extra charge.
- B. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
- C. Test and Balance
  - 1. Furnish a single set of all tools necessary to interface to the BAS for test and balance purposes.
  - 2. Provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
  - 3. In addition, provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
  - 4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.
- D. Life Safety
  - 1. Duct smoke detectors required for air handler shutdown are supplied under Division 28 of this specification. This Section shall interlock smoke detectors to equipment (e.g. air handlers) for shutdown.
  - 2. Smoke dampers and actuators required for duct smoke isolation are provided under a Section of Division 23. This Section shall interlock these dampers to associated equipment for shutdown.

3. Fire/smoke dampers and actuators are provided under another Section of Division 23. Control of these dampers shall be by Division 28.
- E. Coordination with Controls Specified in Other Sections or Divisions; Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the BAS specified in this section. These controls shall be integrated into the system. Coordinate as follows:
  1. Provide communication media and equipment.
  2. Each supplier of a controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
  3. Coordinate and resolve incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.
  4. Provide controls described in the contract documents regardless of where within the contract documents these controls are described.
  5. Interface control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

#### 2.39 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

#### 2.40 INSTRUMENT APPLICATIONS

- A. Temperature Instruments:
  1. Provide device identified in "Input Point Displayed Accuracy and Control Accuracy" table.
- B. Humidity Sensors
  1. Sensor and transmitter with digital display or a combination humidity and temperature sensor and transmitter with display.
- C. Airflow Measurement Stations:
  1. For Air-Ducted/Plenum:
    - a. Measured Velocities Greater Than 200 fpm (1.0 m/s): Thermal airflow measurement station.)
    - b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.

2. Duct-Mounted Airflow Sensors:
    - a. Thermal airflow station.
    - b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.
  3. Damper-Mounted Airflow Sensors:
    - a. Measured Velocities 400 fpm (2.0 m/s) and Less: Thermal airflow station.
    - b. Measured Velocities Greater than 500 fpm (2.5 m/s): Damper with integral flow measurement or damper with integral flow control.
    - c. Provide a remotely mounted microprocessor-based transmitter at each measurement location.
  4. Fan Airflow Sensors:
    - a. Fan-Mounted
      - 1) Measured Velocities 500 fpm (2.5 m/s) and Less: Vortex shedding airflow station.
      - 2) Measured Velocities Greater than 500 fpm (2.5 m/s): Piezometer ring fan inlet airflow sensor.
    - b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.
  - D. Airflow Switches:
    1. Measured Velocities 400 fpm (2.0 m/s) and Less: Polymer film sail switch.
    2. Measured Velocities Greater than 400 fpm (2.0 m/s): Stainless steel single-vane switch.
  - E. Liquid Flow Meters
    1. Provide electromagnetic flow meter.
  - F. Liquid Flow Switches:
    1. Bellows or magnetic type.
  - G. Liquid Flow Transmitters:
    1. Liquid pressure differential transmitter.
- 2.41 WIRING
- A. Control and interlock wiring shall comply with national and local electrical codes and Division 26 of this specification. Where the requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.
  - B. NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway according to NEC and Division 26 requirements.
  - C. Low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.)
  - D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are



UL Listed for the intended application. For example cables used in ceiling plenums shall be UL Listed specifically for that purpose.

- E. Wiring in mechanical, electrical, or service rooms—or where subject to mechanical damage—shall be installed in raceway at levels below 10 ft.
- F. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
- G. Do not install wiring in raceway containing tubing.
- H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 10 ft intervals.
- I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire Connections shall be at a terminal block.
- K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, provide step-down transformers.
- M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- O. Size of raceway and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer recommendations and NEC requirements, except as noted elsewhere.
- P. Include one pull string in each raceway 1 in. or larger.
- Q. Use coded conductors throughout with conductors of different colors.
- R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- S. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 in. from high-temperature equipment (e.g., steam pipes or flues).
- T. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- U. Adhere to Division 26 requirements where raceway crosses building expansion joints.
- V. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
- W. Terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

- X. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 ft in length and shall be supported at each end. Flexible metal raceway less than 1/2 in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- Y. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

#### 2.42 COMMUNICATION WIRING

- A. Adhere to "Wiring" paragraphs of this Section.
- B. Cabling shall be installed in a neat and work-manlike manner. Follow manufacturer installation recommendations for all communication cabling.
- C. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- E. Verify the integrity of the entire network following the cable installation. Use test measures specific to each particular cable.
- F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer instructions.
- G. All runs of communication wiring shall be un-spliced length when that length is commercially available.
- H. All communication wiring shall be labeled to indicate origination and destination data.
- I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

#### 2.43 FIBER OPTIC CABLE INSTALLATION

- A. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer specifications.
- B. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

#### 2.44 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer recommendations.
- B. Mount sensors rigidly and adequately for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 foot of sensing element for each 1 square foot of coil area.
- G. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- H. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location
- I. Differential Air Static Pressure
  - 1. Duct Pressure Sensors
    - a. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
    - b. Return Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
    - c. Install sensors using manufacturer's recommended upstream and downstream distances.
    - d. Unless indicated on Drawings, locate sensors approximately 50 percent of distance of longest hydraulic run. Location of sensors shall be submitted and approved before installation.
    - e. Install mounting hardware and gaskets to make sensor installation airtight.
    - f. Route tubing from the sensor to transmitter.
    - g. Use compression fittings at terminations.
    - h. Install sensor in accordance with manufacturer's instructions.
    - i. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.
  - 2. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a shielded outside air probe and a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
    - a. Install roof-mounted sensor in least-noticeable location and as far away from exterior walls as possible.
    - b. Locate wall-mounted sensor in an inconspicuous location.
    - c. Submit sensor location for approval before installation.
    - d. Verify signal from sensor is stable and consistent to all connected transmitters. Modify installation to achieve proper signal.

- e. Route outdoor signal pipe full size of sensor connection to transmitters. Install branch connection of size required to match to transmitter.
  - f. Install sensor signal pipe with dirt leg and drain valve below roof penetration.
  - g. Insulate signal pipe with flexible elastomeric insulation as required to prevent condensation.
  - h. Connect roof-mounted signal pipe exposed to outdoors to building grounding system.
- 3. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
- 4. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
- 5. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.
- J. Flow Switch Installation
  - 1. Provide paddle sized specifically for the pipe diameter.
  - 2. Adjust flow switch in accordance with manufacturer instructions.
- K. Air-Pressure Differential Switches
  - 1. Install air-pressure sensor in system for each switch connection. Install sensor in an accessible location for inspection and replacement.
  - 2. A single sensor may be used to share a common signal to multiple pressure instruments.
  - 3. Install access door in duct and equipment to access sensors that cannot be inspected and replaced from outside.
  - 4. Route NPS 3/8 (DN 12) tubing from sensor to switch connection.
  - 5. Do not mount switches on rotating equipment.
  - 6. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
  - 7. Install switches in an easily accessible location serviceable from floor.
  - 8. Install switches adjacent to system control panel if within 50 feet; otherwise, locate switch in vicinity of system connection.
- L. Liquid-Pressure Differential Switches
  - 1. Where process connections are located in mechanical equipment room, install switch in convenient and accessible location near system control panel.
  - 2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate switch near system control panel.
  - 3. Where multiple switches serving same system are installed in same room, install switches by system to provide service personnel a single and convenient location for inspection and service.

4. System process tubing connection shall be full size of switch connection, but not less than NPS 3/4 (DN 20). Install stainless-steel bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to switch.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each switch connection.
8. Do not mount switches on rotating equipment.
9. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
10. Install switches in an easily accessible location serviceable from floor.

**M. Liquid Pressure Transmitters**

1. Where process connections are located in mechanical equipment room, install switch in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate switch near system control panel.
3. Where multiple switches serving same system are installed in same room, install switches by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection shall be full size of switch connection, but not less than NPS 3/4 (DN 20). Install stainless-steel bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to switch.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each switch connection.
8. Do not mount switches on rotating equipment.
9. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
10. Install switches in an easily accessible location serviceable from floor.

**2.45 ACTUATOR INSTALLATION**

**A. Mount and link control damper actuators according to manufacturer instructions.**

1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.
2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
3. Provide all mounting hardware and linkages for actuator installation.

**B. Electric/Electronic**

1. Dampers. Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degrees available for tightening the damper seals. Actuators shall be mounted following manufacturer recommendations.
2. Valves. Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer recommendations.

#### 2.46 WARNING LABELS

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the BAS.
1. Labels shall use white lettering (12-point type or larger) on a red background.
  2. Warning labels shall read as follows:

**CAUTION**

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to off position before servicing.

- B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
1. Labels shall use white lettering (12-point type or larger) on a red background.
  2. Warning labels shall read as follows:

**CAUTION**

This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

#### 2.47 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2 in. of termination with the BAS address or termination number.
- B. All pneumatic tubing shall be labeled at each end within 2 in. of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show the instrument or item served.
- D. Identify control panels with minimum 1/2 in. letters on laminated plastic nameplates.
- E. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
- F. Identify room sensors relating to terminal box or valves with nameplates.

- G. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
- H. Identifiers shall match record documents.

#### 2.48 CONTROLLER INSTALLATION

- A. In addition to zone control requirements identified, provide a separate programmable application controller for each of the following to minimize impact of a controller failure on system operation:
  - 1. Air handling unit.
  - 2. Exhaust fan.
  - 3. Chiller and directly associated pumps and towers.
  - 4. Boiler and directly associated pumps and towers.
  - 5. Each pump not directly associated with main equipment shall be on separate controllers.
- B. A BAS controller may control more than one system provided that all points associated with the system are assigned to the same BAS controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.

#### 2.49 SOFTWARE PROGRAMMING

- A. Provide internal memory capacity for the specified sequences of operation and trend logging. Provide a minimum of 25 percent of available memory free for future use.
- B. Point Naming. Request in writing project owner standard point naming convention. Where owner written response indicates no standard is available, system point names shall be modular in design, allowing easy operator interface without the use of a written point index and use the following naming convention:
  - 1. AA.BBB.CCDDE where:
    - a. AA is used to designate the location of the point within the building, such as mechanical room, wing, or level, or the building itself in a multi-building environment;
    - b. BBB is used to designate the mechanical system with which the point is associated (e.g., A01, HTG, CLG, LTG);
    - c. CC represents the equipment or material referenced (e.g., SF for supply fan, RW for return water, EA for exhaust air, ZN for zone).
    - d. D or DD may be used for clarification or for identification if more than one CC exists (e.g., SF10, ZNB);
    - e. E represents the action or state of the equipment or medium (e.g., T for temperature, H for humidity, C for control, S for status, D for damper control, I for current).
- C. Software Programming
  - 1. Provide programming for the system and adhere to the sequences of operation. Provide other system programming required for the operation of the system, but not specified in this document. Imbed into the control program comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in

the sequences of operation. Use the appropriate technique based on the following programming types:

- a. Text-based
  - 1) Must provide actions for all possible situations
  - 2) Must be modular and structured
  - 3) Must be commented
- b. Graphic-based
  - 1) Must provide actions for all possible situations
  - 2) Must be documented
- c. Parameter-based
  - 1) Must provide actions for all possible situations
  - 2) Must be documented

**D. Operator Interface**

- 1. Standard graphics: Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all points for the system. Show relevant calculated points such as setpoints.
- 2. Show terminal equipment information on a graphic summary table. Provide dynamic information for each point shown.
- 3. Provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

**2.50 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT**

**A. Communication Interface to Equipment with Integral Controls:**

- 1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
- 2. Equipment to Be Connected:
  - a. Domestic water booster pumps specified in Division 22.
  - b. Air-terminal units specified in Division 23.
  - c. Boilers specified in Division 23.
  - d. Heat wheels and heat exchangers specified Division 23.
  - e. Air-handling units specified in Division 23.
  - f. Roof-top units specified in Division 23.



- g. Dedicated outdoor-air units specified in Division 23.
- h. Terminal units including but not limited to computer room units, fan coil units and unit heaters specified in Division 23.
- i. Humidifiers specified in Division 23.
- j. Dehumidification units specified in Division 23.
- k. Switchboards specified in Division 26.
- l. Motor-control centers specified in Division 26.
- m. Variable-frequency controllers specified in Division 26.
- n. Emergency engine generators specified in Division 26.
- o. UPS specified in Division 26.
- p. Refrigerant monitoring.

**B. Communication Interface to Other Building Systems:**

- 1. DDC system shall have a communication interface with systems having a communication interface.
- 2. Systems to Be Connected:
  - a. Elevators and escalators specified in Division 14.
  - b. Automated water treatment systems specified in Division 23.
  - c. Power monitoring specified in Division 26.
  - d. Lighting controls specified in Division 26.
  - e. Fire-alarm system specified in Division 28.
  - f. Access controls specified in Division 28.
  - g. Intrusion detection specified in Division 28.
  - h. Perimeter security specified in Division 28.

**2.51 DDC SYSTEM INTERFACE WITH EXISTING SYSTEMS**

**A. Interface with Existing Systems:**

- 1. DDC systems shall interface existing systems to achieve integration.
- 2. Monitoring and Control of DDC System by Existing Control System:
  - a. DDC system performance requirements shall be satisfied when monitoring and controlling DDC system by existing control system.
  - b. Operator of existing system shall be able to upload, download, monitor, trend, control and program every input and output point in DDC system from existing control system using existing control system software and operator workstations.
  - c. Remote monitoring and control from existing control system shall not require operators of existing control system to learn new software.
  - d. Interface of DDC system into existing control system shall be transparent to operators of existing control system and allow operators to program, monitor, and

control DDC system from any operator workstation connected to existing control system.

3. Integration of Existing Control System into DDC System:
  - a. Existing control system performance requirements shall be satisfied when monitoring and controlling existing control system through DDC system.
  - b. Operator shall be able to upload, download, monitor, alarm, report, trend, control and program every input and output point in existing system from DDC system using operator workstations and software provided. The combined systems shall share one database.
  - c. Interface of existing control system I/O points into DDC system shall be transparent to operators. All operational capabilities shall be identical regardless of whether I/O already exists or I/O is being installed.

## 2.52 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in this Section, to installers for field installation.
- B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
  1. DDC control dampers.
  2. Airflow sensors and switches.
  3. Duct pressure sensors.
- C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.
  1. DDC control valves.
  2. Pipe-mounted flow meters.
  3. Pipe-mounted sensors, switches and transmitters.
  4. Tank-mounted sensors, switches and transmitters.
  5. Pipe- and tank-mounted thermowells.

## 2.53 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION

- A. Deliver the following to air-handling unit manufacturer for factory installation. Include installation instructions to air-handling unit manufacturer and supervise installation for compliance with requirements.
  1. Programmable application controller.
  2. Unit-mounted DDC control dampers and actuators.
  3. Unit-mounted airflow sensors, switches and transmitters.
  4. Unit-mounted gas sensors and transmitters.
  5. Unit-mounted leak-detection switches.
  6. Unit-mounted speed sensors, switches and transmitters.
  7. Unit-mounted pressure sensors, switches and transmitters.

8. Unit-mounted temperature sensors, switches and transmitters.
9. Relays.
- B. Deliver the following to terminal unit manufacturer for factory installation. Include installation instructions to terminal unit manufacturer.
  1. Programmable application controller.
  2. Electric damper actuator.
  3. Unit-mounted flow and pressure sensors, transmitters and transducers.
  4. Unit-mounted temperature sensors.
  5. Relays.
- C. Deliver the following to fan-coil unit manufacturer for factory installation. Include installation instructions to fan-coil unit manufacturer.
  1. Programmable application controller.
  2. Unit-mounted temperature sensors.
  3. Flow and pressure switches.
  4. Leak-detection switches.
  5. Relays.

#### 2.54 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment.
- D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Division 07.
- G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Division 07.
- H. Welding Requirements:
  1. Restrict welding and burning to supports and bracing.
  2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
  3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
  4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.

- I. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  - 3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.
- J. Install products in locations that are accessible and that will permit calibration, service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.
- K. Corrosive Environments:
  - 1. Avoid or limit use of materials in corrosive airstreams and environments, including, but not limited to, the following:
    - a. Laboratory exhaust-air streams.
    - b. Process exhaust-air streams.
  - 2. When conduit is in contact with a corrosive airstream and environment, use Type 316L stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Division 26.
  - 3. Where instruments are located in a corrosive airstream and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

## 2.55 WORKSTATION INSTALLATION

- A. Desktop Workstations Installation:
  - 1. Install workstation(s) at location(s) directed by Owner.
  - 2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single duplex electrical power receptacle.
  - 3. Install software on workstation(s) and verify software functions properly.
  - 4. Develop Project-specific graphics, trends, reports, logs and historical database.
  - 5. Power each workstation through a dedicated UPS unit. Locate UPS adjacent to workstation.

## 2.56 POT INSTALLATION

- A. Install two portable operator terminal(s).
- B. Turn over POTs to Owner at Substantial Completion.
- C. Install software on each POT and verify that software functions properly.]

## 2.57 GATEWAY INSTALLATION

- A. Install gateways if required for DDC system communication interface requirements indicated.
  - 1. Install gateway(s) required to suit indicated requirements.

- B. Test gateway to verify that communication interface functions properly.

## 2.58 ROUTER INSTALLATION

- A. Install routers if required for DDC system communication interface.
- B. Test router to verify that communication interface functions properly.

## 2.59 CONTROLLER INSTALLATION

- A. Install controllers in enclosures to comply with indicated requirements.
- B. Connect controllers to field power supply and to UPS units.
- C. Install controller with latest version of applicable software and configure to execute requirements indicated.
- D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.
- E. Installation of Network Controllers:
  - 1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
  - 2. Install controllers in a protected location that is easily accessible by operators.
  - 3. Top of controller shall be within 72 inches of finished floor.
- F. Installation of Programmable Application Controllers:
  - 1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
  - 2. Install controllers in a protected location that is easily accessible by operators.
  - 3. Top of controller shall be within 72 inches of finished floor.
- G. Application-Specific Controllers:
  - 1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
  - 2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

## 2.60 INSTALLATION OF WIRELESS ROUTERS FOR OPERATOR INTERFACE

- A. Install wireless routers to achieve optimum performance and best possible coverage.
- B. Mount wireless routers in a protected location that is within 60 inches of floor and easily accessible by operators.
- C. Connect wireless routers to field power supply and to UPS units if network controllers are powered through UPS units.
- D. Install wireless router with latest version of applicable software and configure wireless router with WPA2 security and password protection. Create access password with not less than 12 characters consisting of letters and numbers and at least one special character. Document password in operations and maintenance manuals for reference by operators.

- E. Test and adjust wireless routers for proper operation with portable workstation and other wireless devices intended for use by operators.'

## 2.61 ENCLOSURES INSTALLATION

- A. Install the following items in enclosures, to comply with indicated requirements:
  - 1. Gateways.
  - 2. Routers.
  - 3. Controllers.
  - 4. Electrical power devices.
  - 5. UPS units.
  - 6. Relays.
  - 7. Accessories.
  - 8. Instruments.
  - 9. Actuators
- B. Attach wall-mounted enclosures to wall using the following types of steel struts:
  - 1. For NEMA 250, Type 2 and Type 12 Enclosures: Use painted steel, galvanized-steel or corrosion-resistant-coated steel strut and hardware.
  - 2. For NEMA 250, Type 4 and Type 4X Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.
  - 3. Install plastic caps on exposed cut edges of strut.
- C. Align top or bottom of adjacent enclosures of like size.
- D. Install floor-mounted enclosures located in mechanical equipment rooms on concrete housekeeping pads. Attach enclosure legs using galvanized- or stainless-steel anchors.
- E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireway used for application shall have protection equal to NEMA 250 rating of connected enclosures.

## 2.62 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

- A. Mounting Location:
  - 1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
  - 2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
  - 3. Install liquid and steam flow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
  - 4. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.

5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
  6. Install instruments in steam, liquid, and liquid-sealed-piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
  7. Install instruments in dry gas and non-condensable-vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.
  8. Install transmitters for gas associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
  9. Install gas switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
- B. Mounting Height:
1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
  2. Mount switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
    - a. Make every effort to mount at 60 inches.
- C. Special Mounting Requirements
1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.
  2. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.
- D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.
- E. Space Temperature Sensor Installation
1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
  2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
  3. In finished areas, recess electrical box within wall.
  4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.

5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.
- F. Outdoor Temperature Sensor Installation
1. Mount sensor in a discrete location facing north.
  2. Protect installed sensor from solar radiation and other influences that could impact performance.
  3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.
- G. Single-Point Duct Temperature Sensor Installation
1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches (610 mm) in sensor length.
  2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
  3. Rigidly support sensor to duct and seal penetration airtight.
  4. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.
- H. Averaging Duct Temperature Sensor Installation
1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. (1.86 sq. m) and larger.
  2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
  3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
  4. If required to have transmitter, mount transmitter in an accessible and serviceable location.
- I. Low-Limit Air Temperature Switch Installation
1. Install multiple low-limit switches to maintain coverage over entire cross-sectional area of air tunnel.
  2. Fasten and support sensing element with manufacturer-furnished clips to keep element taut throughout entire length.
  3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.
  4. Install on entering side of cooling coil unless otherwise indicated on Drawings.
- J. Liquid Temperature Sensor Installation
1. Assembly shall include sensor, thermowell and connection head.



2. For pipe NPS 4 (DN 100) and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.
3. For pipe smaller than NPS 4 (DN 100):
  - a. Install reducers to increase pipe size to NPS 4 (DN 100) at point of thermowell installation.
  - b. For pipe sizes NPS 2-1/2 and NPS 3 (DN 65 and DN 80), thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
  - c. Minimum insertion depth shall be 2-1/2 inches (65 mm).
4. Install matching thermowell.
5. Fill thermowell with heat-transfer fluid before inserting sensor.
6. Tip of spring-loaded sensors shall contact inside of thermowell.
7. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.
8. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.
9. For applications with transmitters, mount transmitter remote from sensor in an accessible and serviceable location from floor, service platform or catwalk.

## 2.63 FLOW INSTRUMENTS INSTALLATION

### A. Airflow Sensors:

1. Install sensors in straight sections of duct with manufacturer-recommended straight duct upstream and downstream of sensor.
2. Installed sensors shall be accessible for visual inspection and service. Install access door(s) in duct or equipment located upstream of sensor, to allow service personnel to hand clean sensors.

### B. Liquid and Steam Sensors:

1. Install sensors in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
2. Alert manufacturer where installation cannot accommodate recommended clearance, and solicit recommendations for field modifications to installation, such as flow straighteners, to improve condition.
3. Install pipe reducers for in-line sensors smaller than line size. Position reducers at distance from sensor to avoid interference and impact on accuracy.
4. Install in-line sensors with flanges or unions to provide drop-in and -out installation.

### C. Liquid Flow Meters:

1. Install meters in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
2. Install pipe reducers for in-line meters smaller than line size. Install reducers at distance from meter to avoid interference and impact on accuracy.

3. Install in-line meters with flanges or unions to provide drop-in and -out installation.
4. Insertion Meters:
  - a. Install system process connections full size of meter connection, but not less than NPS 1. Provide stainless steel bushing if required to mate to system connection.
  - b. Install meter in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
  - c. In applications where top-dead-center location is not possible due to field constraints, install meter at location along top half of pipe if acceptable by manufacturer for mounting orientation.

D. Liquid Switches:

1. Install system process connection full size of switch connection, but not less than NPS 1. Install stainless steel bushing if required to mate switch to system connection.
2. Install switch in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
3. In applications where top-dead-center location is not possible due to field constraints, install switch at location along top half of pipe if switch is acceptable by manufacturer for mounting orientation.

E. Transmitters:

1. Install airflow transmitters serving an air system in a single location adjacent to or within system control panel.
2. Install liquid flow transmitters, not integral to sensors, in vicinity of sensor. Where multiple flow transmitters serving same system are located in same room, co-locate transmitters by system to provide service personnel a single and convenient location for inspection and service.

F. Airflow Direction Indicators:

1. The HVAC system must be operational with a proper directional minimum differential pressure of 0.01 inches of water column prior to the installation and testing of the indicators.
2. The installing contractor shall mount and test every indicator for proper operation. The installation shall be per the manufacturer Installation Instructions and the Operation and Maintenance Manual. Turn over the pitch levels and installation documents to the Owner during job start-up. Provide 8 hours of training to the Owner for field orientation and operation of a typical indicator.
3. For units provided with local alarm device, provide an NEC and local code conforming wiring and service disconnect to each controller.

2.64 CARBON-MONOXIDE MONITORING SYSTEM

- A. Install sample points in monitored area to provide accurate measurement of gas concentration.
- B. Install exposed sampling points with a finished appearance consistent with other materials in space. Submit proposed products to be installed for review and approval.
- C. Individually install each sample point to the carbon-monoxide monitoring system.
- D. Install tubing in a minimum size of **NPS 3/8**.

- E. Use compression fittings at connections to equipment.
- F. If not indicated on Drawings, locate carbon-monoxide monitoring system in a secured and serviceable location accessible to authorized personnel.
- G. Support carbon-monoxide monitoring system from floor or wall. Support floor-mounted systems using a structural channel frame. Provide mounting brackets.]

## 2.65 ELECTRIC POWER CONNECTIONS

- A. Connect electrical power to DDC system products requiring electrical power connections. All power wiring and connections required to operate the DDC system and all control components shall be provided by this Section. Provide normal and standby power wiring to all devices to perform sequences outlined. As a minimum the DDC system (all control panels, workstations or host computers) shall be connected to standby power source. Power circuits for all DDC system component shall be dedicated only to the DDC system and components. All wiring from and including dedicated circuit breakers to the point of use shall be provided by this Section.
- B. Work shall comply with NFPA 70 and other requirements indicated.
- C. Comply with requirements in Division 26 for electrical power circuit breakers.
- D. Comply with requirements in Division 26 for electrical power conductors and cables.
- E. Comply with requirements in Division 26 for electrical power raceways and boxes.

## 2.66 IDENTIFICATION

- A. Install laminated acrylic or melamine plastic signs with unique identification on face for each of the following:
  - 1. Operator workstation.
  - 2. Printer.
  - 3. Gateway.
  - 4. Router.
  - 5. Protocol analyzer.
  - 6. DDC controller.
  - 7. Enclosure.
  - 8. Electrical power device.
  - 9. UPS unit.
  - 10. Accessory.
- B. Install unique instrument identification on face of each instrument connected to a DDC controller.
- C. Install engraved phenolic nameplate with valve identification on control damper and valve and on face of ceiling directly below valves concealed above ceilings connected to a DDC controller.
- D. Where product is installed above accessible tile ceiling, also install matching identification on face of ceiling grid located directly below.

- E. Where product is installed above an inaccessible ceiling, also install identification on face of access door directly below.
- F. Warning Labels and Signs:
  - 1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
  - 2. Shall be located in highly visible location near power service entry points.
- G. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Division 26.

## 2.67 NETWORK INSTALLATION

- A. Install optical fiber cable when connecting between the following network devices and when located in different buildings on campus and when required to meet communication speeds specified:
  - 1. Operator workstations.
  - 2. Operator workstations and network controllers.
  - 3. Network controllers.
- B. Install balanced twisted pair or optical fiber cable when connecting between the following network devices located in same building while meeting communication speeds specified:
  - 1. Operator workstations.
  - 2. Operator workstations and network controllers.
  - 3. Network controllers.
- C. Install balanced twisted pair or copper cable when connecting between the following:
  - 1. Gateways.
  - 2. Gateways and network controllers or programmable application controllers.
  - 3. Routers.
  - 4. Routers and network controllers or programmable application controllers.
  - 5. Network controllers and programmable application controllers.
  - 6. Programmable application controllers.
  - 7. Programmable application controllers and application-specific controllers.
  - 8. Application-specific controllers.
- D. Install cable in continuous raceway.
  - 1. Cable trays may be used for copper cable in lieu of conduit.

## 2.68 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices.
- B. ASHRAE 135 Networks:
  - 1. MAC Address:

- a. Every network device shall have an assigned and documented MAC address unique to its network.
  - b. Ethernet Networks: Document MAC address assigned at its creation.
  - c. ARCNET or MS/TP networks: Assign from 00 to 64.
2. Network Numbering:
  - a. Assign unique numbers to each new network.
  - b. Provide ability for changing network number through device switches or operator interface.
  - c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.
3. Device Object Identifier Property Number:
  - a. Assign unique device object identifier property numbers or device instances for each device network.
  - b. Provide for future modification of device instance number by device switches or operator interface.
  - c. LAN shall support up to 4,194,302 unique devices.
4. Device Object Name Property Text:
  - a. Device object name property field shall support 32 minimum printable characters.
  - b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.
    - 1) Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."
    - 2) Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".
5. Object Name Property Text for Other Than Device Objects:
  - a. Object name property field shall support 32 minimum printable characters.
  - b. Assign object name properties with plain-English names descriptive of application.
    - 1) Example 1: "Zone 1 Temperature."
    - 2) Example 2 "Fan Start and Stop."
6. Object Identifier Property Number for Other Than Device Objects:
  - a. Object identifier property numbers may be assigned at Installer discretion but must be approved by Owner in advance, be documented and be unique for like object types within device.

## **2.69 PIPING AND TUBING INSTALLATION**

### **A. Above-Grade Piping and Tubing Installation:**

1. Material Application:

- a. Install copper tubing, except as follows:
  - 1) Tubing Exposed to View: Polyethylene tubing installed in raceways may be used in lieu of copper tubing.
  - 2) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when concealed behind accessible ceilings and concealed in walls and connecting wall-mounted instruments with recessed connections.
  - 3) Control-Air Tubing for Smoke Control and Pressurization Systems:
    - a) Control-air tubing shall be of sufficient size to meet the required response times. Tubing shall be flushed clean and dry prior to final connections. Tubing shall be adequately supported and protected from damage. Tubing passing through concrete or masonry shall be sleeved and protected from abrasion and electrolytic action.
    - b) Control-air tubing shall be hard-drawn copper, Type L, ACR in accordance with ASTM B42, ASTM B43, ASTM B68, ASTM B88, ASTM B251 and ASTM B280. Fittings shall be wrought copper or copper alloy, solder type in accordance with ASME B16.18 or ASME B16.22. Changes in direction shall be made with appropriate tool bends. Copper-alloy compression-type fittings shall be used at final connection to devices; other joints shall be brazed using a BCuP5 brazing alloy with solidus above 1,100°F (593°C) and liquidus below 1,500°F (816°C). Brazing flux shall be used on copper-to-copper alloy joints only.
    - c) Nonmetallic tubing used within control panels and at the final connection to devices provided all of the following conditions are met: Combustible pneumatic tubing exposed within a plenum shall be listed and labeled as having a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread distance not greater than 5 feet (1524 mm) when tested in accordance with UL 1820; Tubing and connected device shall be completely enclosed within a galvanized or paint-grade steel enclosure having a minimum thickness of 0.0296 inch (0.7534 mm) (No. 22 gauge). Entry to the enclosure shall be by copper tubing with a protective grommet of Neoprene or Teflon or by suitable brass compression to male barbed adapter; Tubing shall be identified by appropriately documented coding; Tubing shall be neatly tied and supported within the enclosure. Tubing bridging cabinets and doors or movable devices shall be of sufficient length to avoid tension and excessive stress. Tubing shall be protected against abrasion. Tubing connected to devices on doors shall be fastened along hinges.
- b. Install copper tubing, unless other accessible materials are indicated, for air signals to instruments including, but not limited to, the following:
  - 1) Sensors.
  - 2) Switches.

- 3) Transmitters.
  - c. Install drawn-temper copper tubing, except within 36 inches of device terminations tubing shall be annealed-tempered copper tubing.
  - d. Install compression fittings to connect copper tubing to instruments, control devices, and accessories.
  - e. Install barbed or compression fittings to connect polyethylene tubing to instruments, control devices, and accessories.
- 2. Routing:
  - a. Do not expose tubing in finished spaces, such as spaces with ceilings; occupied spaces, offices, and conference rooms, unless expressly approved in writing by Architect. Tubing may be exposed in areas without ceilings.
  - b. Where tubing is installed in finished occupied spaces, install the tubing in surface metal raceway with appropriate fittings only where not feasible to conceal in wall, above ceiling or behind architectural enclosures or covers.
  - c. Install piping and tubing plumb and parallel to and at right angles with building construction.
  - d. Install multiple runs of tubing or piping in equally spaced parallel lines.
  - e. Piping and tubing shall not interfere with access to valves, equipment, duct and equipment access doors, or obstruct personnel access and passageways of any kind.
  - f. Coordinate with other trades before installation to prevent proposed piping and tubing from interfering with pipe, duct, terminal equipment, light fixtures, conduit and cable tray space. If changes to Shop Drawings are necessary due to field coordination, document changes on record Drawings.
  - g. Install vibration loops in copper tubing when connecting to instrument and actuators that vibrate.
- 3. Support:
  - a. According to MSS SP-69, Table 3, except support spacing shall not exceed 60 inches.
  - b. Support copper tubing with copper hangers, clips, and tube trays.
  - c. Do not use tape for support or dielectric isolation.
  - d. Install supports at each change in direction and at each branch take off.
  - e. Attached supports to building structure independent of work of other trades. Support from ducts, pipes, cable trays, and conduits is prohibited.
  - f. Attached support from building structure with threaded rods, structural shapes, or channel strut.
  - g. Install and brace supports to carry static load plus a safety margin, which will allow tubing to be serviced.
  - h. Brace supports to prevent lateral movement.
  - i. Paint steel support members that are not galvanized or zinc coated.

- j. Support polyethylene tubing same as copper tubing.
- 4. Do not attach piping and tubing to equipment that may be removed frequently for maintenance or that may impart vibration and expansion from temperature change.
- 5. Protect exposed tubing in mechanical equipment rooms from mechanical damage within 96 inches above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.
- 6. Joining and Makeup:
  - a. Where joining and mating dissimilar metals where galvanic action could occur, install dielectric isolation.
  - b. Make threaded joints for connecting to instrument equipment with connectors with a compression tubing connector on one end and threaded connection on other end.
  - c. Make tubing bends with a tube-bending tool. Hard bends, wrinkled or flattened bends are unacceptable.
  - d. Install tube fittings according to manufacturer written instructions.
  - e. Do not make tubing connections to a fitting before completing makeup of the connection.
  - f. Align tubing with the fitting. Avoid springing tube into position, as this may result in excessive stress on both tubing and fitting with possible resulting leaks.
  - g. Do not install fittings close to a bend. A length of straight tubing, not deformed by bending, is required for a proper connection.
  - h. Check tubing for correct diameter and wall thickness.
  - i. Tube ends shall be cut square and deburred. Exercise care during cutting to keep tubing round.
  - j. Thread pipe on a threading machine. Ream inner edges of pipe ends, file and grind to remove burrs.
  - k. Wrap pipe threads of fittings on pneumatic lines with a single wrap of PTFE tape.
  - l. Protect piping and tubing from entrance of foreign matter.
- 7. Conduit in which nonmetallic tubing is installed shall not exceed 50 percent fill. Support conduit according to NFPA 70 unless otherwise indicated.
- B. Below-Grade Piping and Tubing Installation:
  - 1. Install tubing below grade in a continuous 4-inch, Schedule 80, PVC conduit.
  - 2. Install at a depth of at least 24 inches below finished grade.
  - 3. Install tubing in raceways dedicated to tubing. Do not combine electrical conductors and tubing in raceways.
- C. Identify piping and tubing as follows:
  - 1. Every 50 feet of straight run.
  - 2. At least once for each branch within 36 inches of main tee.
  - 3. At each change in direction.
  - 4. Within 36 inches of each ceiling, floor, roof and wall penetration.



5. Where exposed to and where concealed from view, including above ceiling plenums, shafts, and chases.
6. At each valve.
7. Mark each instrument tube connection with a number-coded identification. Each unique tube shall have same unique number at instrument connection and termination at opposite end of tube.

**D. Isolation Valves Installation:**

1. Install valves full size of piping and tubing.
2. Install at the following locations:
  - a. At each branch.
3. Valves shall be located to be readily accessible from floor.

**2.70 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION**

**A. Comply with NECA 1.**

**B. Wire and Cable Installation:**

1. Comply with installation requirements in Division 26 and 27.
2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
  - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
3. Terminate wiring in a junction box.
  - a. Clamp cable over jacket in junction box.
  - b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
4. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
5. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
6. Use shielded cable to transmitters.
7. Use shielded cable to temperature sensors.
8. Perform continuity and meager testing on wire and cable after installation.

**C. Conduit Installation:**

1. Comply with Division 26 for control-voltage conductors.
2. Comply with Division 27 for balanced twisted pair cabling and optical fiber installation.

**2.71 OPTICAL FIBER CABLE SYSTEM INSTALLATION**

**A. Comply with installation requirements in Division 27.**

2.72 CONTROL VALVE INSTALLATION

- A. Liquid (water and glycol) controls valves:
  - 1. In liquid systems, use characterized v-notch ball, pressure-independent (PICV) or globe-style control valves for valves NPS 6 and smaller and high performance butterfly style for valves for larger than NPS 6.
  - 2. Liquid control valves shall fail normally open or closed, as indicated on plans, or as follows:
    - a. Chilled Water: Closed.
    - b. Condenser Water: Closed.
    - c. Heat Recovery: Closed.
    - d. Heating Hot Water in Air Handlers: Open.
    - e. Heating Hot Water Reheat: Closed.
    - f. Other applications—as shown or as required by sequences of operation.
- B. Steam Control Valves:
  - 1. In steam systems, use globe-style control valves.
  - 2. Fail positions unless otherwise indicated: Steam: Last position.
- C. Valve submittals shall be coordinated for listed type, quantity, size, and piping configuration to ensure compatibility with pipe design.
- D. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.
- E. Valves shall be installed in accordance with the manufacturer recommendations.
- F. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
- G. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screw-type control valves.
- H. Provide tags for all control valves indicating service and number. Tags shall be brass, 1-1/2 in. in diameter, with 1/4 in. high letters. Securely fasten with chain and hook. Match identification numbers as shown on approved controls shop drawings.
- I. Support instruments, tubing, piping, wiring, and conduits.
- J. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

- K. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- L. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.
- M. Install flanges or unions to allow drop-in and -out valve installation.
- N. Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing manual throttling valve in bypass pipe. Install drain valves in piping upstream and downstream of each three-valve bypass control valve assembly.
- O. Install drain valves in piping upstream and downstream of each control valve larger than NPS 2 (DN 50).
- P. Install pressure temperature taps in piping upstream and downstream of each control valve.
- Q. Valve Orientation:
  - 1. Install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
  - 2. Install valves in a position to allow full stem movement.
  - 3. Install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.
- R. Clearance:
  - 1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
  - 2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.
- S. Threaded Valves:
  - 1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
  - 2. Align threads at point of assembly.
  - 3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
  - 4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.
- T. Flanged Valves:
  - 1. Align flange surfaces parallel.
  - 2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

## 2.73 CONTROL DAMPER INSTALLATION

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.

- B. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure 1/4 in. larger than damper dimensions and shall be square, straight, and level.
- C. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 1/8 in. of each other.
- D. Follow the manufacturer instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- E. Install extended shaft or jackshaft according to manufacturer instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
- F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- G. Provide a visible and accessible indication of damper position on the drive shaft end.
- H. Support ductwork in area of damper when required to prevent sagging due to damper weight.
- I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.
- J. Install smooth transitions, not exceeding 15 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
- K. Clearance:
  - 1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
  - 2. Install dampers with at least 24 inches (600 mm) of clear space on sides of dampers requiring service access.
- L. Service Access:
  - 1. Dampers and actuators shall be accessible for visual inspection and service.
  - 2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Division 23.
- M. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
- N. Attach actuator(s) to damper drive shaft.
- O. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

**2.74 SMOKE AND FIRE-SMOKE DAMPER INSTALLATION**

- A. Coordinate smoke and fire-smoke damper installation, wiring, and checkout to ensure that these dampers function properly and that they respond to the proper fire alarm system general, zone, and/or detector trips. Report discrepancies to the architect no less than two weeks prior to inspection by the code authority having jurisdiction.
- B. Obtain complete submittal data for smoke and fire-smoke dampers and coordinate duct smoke detector interface to HVAC systems.

**2.75 DUCT SMOKE DETECTION**

- A. Coordinate duct smoke detector installation with Division 27. Connect to dry-contact alarm output in the same room as the HVAC equipment to be controlled.

**2.76 FIELD QUALITY CONTROL**

- A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1, "General," of this specification.
- B. Continually monitor the field installation for code compliance and quality of workmanship.
- C. Have work inspected by local and/or state authorities having jurisdiction over the work.
- D. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- E. Manufacturer Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.
- F. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- G. Testing:
  - 1. Perform pre-installation, in-progress, and final tests, supplemented by additional tests.
  - 2. Pre-installation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
  - 3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
  - 4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.

5. Test Equipment: Use an optical fiber time domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

## 2.77 DDC SYSTEM CHECKOUT – GENERAL

- A. Start-up Testing. Testing listed in this article shall be performed and shall make up part of the necessary verification of an operating BAS. This testing shall be completed before the owner representative is notified of the system demonstration.
  1. Furnish labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
  2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
  3. Enable the BAS and verify calibration of all input devices individually. Perform calibration procedures according to manufacturer recommendations.
  4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
  5. Verify that all analog output devices (modulating actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. Check all control valves and automatic dampers to ensure proper action and closure. Make adjustments to valve stem and damper blade travel.
  6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum start/stop routines.
  7. Alarms and Interlocks:
    - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
    - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
    - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.
- B. Start up, check out, and test all hardware and software and verify communication between all components.
  1. Verify control wiring is properly connected and free of all shorts and ground faults. Verify terminations are tight.
  2. Verify analog and binary input/ output points read properly.
  3. Verify alarms and interlocks. Verify operation of the integrated system.

## 2.78 DDC SYSTEM I/O CHECKOUT PROCEDURES

- A. Check installed products before continuity tests, leak tests and calibration.
- B. Check instruments for proper location and accessibility.

- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.
- E. Control Damper Checkout:
  - 1. Check installed products before continuity tests, leak tests, and calibration.
  - 2. Check dampers for proper location and accessibility.
  - 3. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
  - 4. Verify that control dampers are installed correctly for flow direction.
  - 5. Verify that proper blade alignment, either parallel or opposed, has been provided.
  - 6. Verify that damper frame attachment is properly secured and sealed.
  - 7. Verify that damper actuator and linkage attachment are secure.
  - 8. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
  - 9. Verify that damper blade travel is unobstructed.
- F. Control Valve Checkout:
  - 1. Verify that control valves are installed correctly for flow direction.
  - 2. Verify that valve body attachment is properly secured and sealed.
  - 3. Verify that valve actuator and linkage attachment is secure.
  - 4. Verify that actuator wiring is complete, enclosed and connected to correct power source.
  - 5. Verify that valve ball, disc or plug travel is unobstructed.
  - 6. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.
- G. Instrument Checkout:
  - 1. Check out installed products before continuity tests, leak tests, and calibration.
  - 2. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
  - 3. Check instruments for proper location and accessibility.
  - 4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
  - 5. Verify that attachment is properly secured and sealed.
  - 6. Verify that conduit connections are properly secured and sealed.
  - 7. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
  - 8. Inspect instrument tag against approved submittal.

9. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
10. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
11. For temperature instruments:
  - a. Verify sensing element type and proper material.
  - b. Verify length and insertion.

**2.79 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:**

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
- C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration shall comply with instrument manufacturer written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
- F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
- H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
- I. Comply with field testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- J. Analog Signals:
  1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
  2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
  3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- K. Digital Signals:
  1. Check digital signals using a jumper wire.
  2. Check digital signals using an ohmmeter to test for contact making or breaking.
- L. Control Dampers:
  1. Stroke and adjust control dampers following manufacturer recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.



2. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
3. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

**M. Control Valves:**

1. Stroke and adjust control valves following manufacturer recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
3. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

**N. Meters:** Check sensors at zero, 50, and 100 percent of Project design values.

**O. Sensors:** Check sensors at zero, 50, and 100 percent of Project design values.

**P. Switches:** Calibrate switches to make or break contact at set points indicated.

**Q. Transmitters:**

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

**2.80 DDC SYSTEM CONTROLLER CHECKOUT**

**A. Verify power supply.**

1. Verify voltage, phase and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.

**B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.**

**C. Verify that spare I/O capacity is provided.**

**2.81 DDC CONTROLLER I/O CONTROL LOOP TESTS**

**A. Testing:**

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify operation is stable and accurate.

4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:
  - a. Upper quarter of range.
  - b. Lower quarter of range.
  - c. At midpoint of range.
8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

## 2.82 DDC SYSTEM VALIDATION TESTS

- A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
- B. After approval of Test Plan, execute all tests and procedures indicated in plan.
- C. After testing is complete, submit completed test checklist.
- D. Pretest Checklist: Submit the following list with items checked off once verified:
  1. Detailed explanation for any items that are not completed or verified.
  2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
  3. HVAC equipment motors operate below full-load amperage ratings.
  4. Required DDC system components, wiring, and accessories are installed.
  5. Installed DDC system architecture matches approved Drawings.
  6. Control electric power circuits operate at proper voltage and are free from faults.
  7. Required surge protection is installed.
  8. DDC system network communications function properly, including uploading and downloading programming changes.
  9. Using BACnet protocol analyzer, verify that communications are error free.
  10. Each controller programming is backed up.
  11. Equipment, products, tubing, wiring cable and conduits are properly labeled.
  12. All I/O points are programmed into controllers.

13. Testing, adjusting and balancing work affecting controls is complete.
14. Dampers and actuators zero and span adjustments are set properly.
15. Each control damper and actuator goes to failed position on loss of power.
16. Valves and actuators zero and span adjustments are set properly.
17. Each control valve and actuator goes to failed position on loss of power.
18. Meter, sensor and transmitter readings are accurate and calibrated.
19. Control loops are tuned for smooth and stable operation.
20. View trend data where applicable.
21. Each controller works properly in standalone mode.
22. Safety controls and devices function properly.
23. Interfaces with fire-alarm system function properly.
24. Electrical interlocks function properly.
25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
26. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 20 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.
  - a. Verify analog I/O points at operating value.
  - b. Make adjustments to out-of-tolerance I/O points.
    - 1) Identify I/O points for future reference.
    - 2) Simulate abnormal conditions to demonstrate proper function of safety devices.
    - 3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.

3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
  4. After 24 Hours following Initial Validation Test:
    - a. Re-check I/O points that required corrections during initial test.
    - b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
  5. After 24 Hours of Second Validation Test:
    - a. Re-check I/O points that required corrections during second test.
    - b. Continue validation testing until I/O point is normal on two consecutive tests.
  6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
  7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.
- G. DDC System Response Time Test:
1. Simulate HLC.
    - a. Heavy load shall be an occurrence of 50 percent of total connected binary COV, one-half of which represent an "alarm" condition, and 50 percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.
  2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
  3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
  4. Purpose of test is to demonstrate DDC system, as follows:
    - a. Reaction to COV and alarm conditions during HLC.
    - b. Ability to update DDC system database during HLC.
  5. Passing test is contingent on the following:
    - a. Alarm reporting at printer beginning no more than two seconds after the initiation (time zero) of HLC.
    - b. All alarms, both binary and analog, are reported and printed; none are lost.
    - c. Compliance with response times specified.
  6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.
- H. DDC System Network Bandwidth Test:
1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
  2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

**2.83 DDC SYSTEM WIRELESS NETWORK VERIFICATION**

- A. DDC system Installer shall design wireless DDC system networks to comply with performance requirements indicated.
- B. Installer shall verify wireless network performance through field testing and shall document results in a field test report.
- C. Testing and verification of all wireless devices shall include, but not be limited to, the following:
  - 1. Speed.
  - 2. Online status.
  - 3. Signal strength.

**2.84 FINAL REVIEW**

- A. Submit written request to Architect and Construction Manager when DDC system is ready for final review. Written request shall state the following:
  - 1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
  - 2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
  - 3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
  - 4. DDC system is complete and ready for final review.
- B. Review by Architect and Construction Manager shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.
- E. Prepare and submit closeout submittals when no deficiencies are reported.
- F. A part of DDC system final review shall include a demonstration to parties participating in final review.
  - 1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
  - 2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
  - 3. Demonstration shall include, but not be limited to, the following:
    - a. Accuracy and calibration of (10) I/O points randomly selected by the Architect. If review finds that some I/O points are not properly calibrated and not satisfying

performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.

- b. HVAC equipment and system hard wired and software safeties and life-safety functions are operating according to sequence of operation. Up to (20) I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
- c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
- d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
- e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
- f. Trends, summaries, logs and reports set-up for Project.
- g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
- h. Software ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
- i. Software ability to edit control programs off-line.
- j. Data entry to show Project-specific customizing capability including parameter changes.
- k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
- l. Execution of digital and analog commands in graphic mode.
- m. Spreadsheet and curve plot software and its integration with database.
- n. Online user guide and help functions.
- o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
- p. System speed of response compared to requirements indicated.
- q. For Each Network and Programmable Application Controller:
  - 1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.
  - 2) Operator Interface: Ability to connect directly to each type of digital controller with a portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer technical literature.

- 3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
  - 4) Electric Power: Ability to disconnect any controller safely from its power source.
  - 5) Wiring Labels: Match control drawings.
  - 6) Network Communication: Ability to locate a controller location on network and communication architecture matches Shop Drawings.
  - 7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.
- r. For Each Operator Workstation:
- 1) I/O points lists agree with naming conventions.
  - 2) Graphics are complete.
  - 3) UPS unit, if applicable, operates.
- s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability. Requirements must be met even if only one manufacturer equipment is installed.
- 1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
  - 2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
  - 3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated. Modifications are made with messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.
  - 4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
  - 5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with approved privileges are permitted.
  - 6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.

- 7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with approved privilege.
- 8) Archival Storage of Data: Data archiving is handled by operator workstation and local trend archiving and display is accomplished.
- 9) Modification of Trend Log Object Parameters: Operator with approved privilege can change logged data points, sampling rate, and trend duration.
- 10) Device and Network Management:
  - a) Display of network device status.
  - b) Display of BACnet Object Information.
  - c) Silencing devices transmitting erroneous data.
  - d) Time synchronization.
  - e) Remote device re-initialization.
  - f) Backup and restore network device programming and master database(s).
  - g) Configuration management of routers.

#### 2.85 ADJUSTING

- A. Occupancy Adjustments: When requested within (12) months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

#### 2.86 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by DDC system manufacturer authorized service representative. Include monthly preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration and adjusting for proper operation. Parts and supplies shall be manufacturer authorized replacement parts and supplies.

#### 2.87 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for one year.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
  1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.



2.88 DEMONSTRATION

- A. Prior to acceptance, the BAS shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after completion of the installation, startup of the system, and successful performance of preliminary testing by this Section.
- B. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process. The architect will be present to observe and review these tests. The architect shall be notified at least ten days in advance of the start of the testing procedures.
- C. The demonstration process shall follow approved checklists and forms. Checklists and forms shall be completed for all systems as part of the demonstration.
- D. Provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by this Section.
- E. As each control input and output is checked, a log shall be completed showing the date, technician initials, and any corrective action taken or needed.
- F. Demonstrate compliance with sequences of operation through all modes of operation.
- G. Demonstrate complete operation of operator interface.
- H. Additionally, the following items shall be demonstrated:
  - 1. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop response to a change in setpoint, which represents a change of actuator position of at least 25 percent of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the setpoint, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by this Section.
  - 2. Demand limiting. Supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting setpoint, and the status of sheddable equipment outputs.
  - 3. Optimum start/stop. Supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
  - 4. Interface to the building fire alarm system.
  - 5. Operational logs for each system that indicate all setpoints, operating points, valve positions, mode, and equipment status shall be submitted to the architect. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
- I. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. Provide repairs or revisions to the hardware or software to successfully complete all tests.

2.89 ACCEPTANCE

- A. All tests described in this specification shall have been performed to the satisfaction of both the architect and owner prior to the acceptance of the BAS as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the owner. Such tests shall then be performed as part of the warranty.
- B. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

2.90 CLEANING

- A. Clean up debris resulting from daily work. Remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.
- D. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
- E. Wash and shine glazing.
- F. Polish glossy surfaces to a clean shine.

2.91 TRAINING

- A. Provide a minimum of four on-site or classroom training sessions, two days each, throughout the contract period for personnel designated by the owner.
- B. Provide two additional training sessions at 6 and 12 months following building turnover. Each session shall be three days in length and must be coordinated with the building owner.
- C. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated
- D. Train the designated staff of owner representative and owner to enable them to do the following:
  - 1. Day-to-day Operators:
    - a. Basic operation of system. Proficiently operate the system
    - b. Understand BAS architecture and configuration
    - c. Understand system components. Understanding each unique product type installed including performance and service requirements for each.
    - d. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine

- e. Operate the workstation and peripherals
- f. Log on and off the system
- g. Access graphics, point reports, and logs
- h. Adjust and change system setpoints, time schedules, and holiday schedules
- i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
- j. Understand system drawings and Operation and Maintenance manual
- k. Understanding physical location and placement of DDC controllers and I/O hardware
- l. Access data from controllers and ASCs
- m. Operate portable operator terminals
- n. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
- o. Running each specified report and log.
- p. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
- q. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
- r. Executing digital and analog commands in graphic mode.
- s. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
- t. Demonstrating DDC system performance through trend logs and command tracing.
- u. Demonstrating scan, update, and alarm responsiveness.
- v. Demonstrating spreadsheet and curve plot software, and its integration with database.
- w. Demonstrating on-line user guide, and help function and mail facility.
- x. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
- y. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
  - 1) Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.
  - 2) For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.

- 3) Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.
  - 4) Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
  - 5) Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
  - 6) Each control loop responds to set point adjustment and stabilizes within time period indicated.
  - 7) Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.
2. Advanced Operators:
- a. Make and change graphics on the workstation
  - b. Create, delete, and modify alarms, including annunciation and routing of these
  - c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
  - d. Create, delete, and modify reports
  - e. Add, remove, and modify system physical points
  - f. Create, modify, and delete programming
  - g. Adding DDC controllers and other network communication devices such as gateways and routers
  - h. Add panels when required
  - i. Add operator interface stations
  - j. Create, delete, and modify system displays, both graphical and others
  - k. Perform DDC field checkout procedures
  - l. Perform DDC controller unit operation and maintenance procedures
  - m. Perform workstation and peripheral operation and maintenance procedures
  - n. Perform DDC diagnostic procedures
  - o. Configure hardware including PC boards, switches, communication, and I/O points
  - p. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
  - q. Adjust, calibrate, and replace system components
3. System Managers/Administrators:
- a. Maintain DDC software and prepare backups
  - b. Interface with job-specific, third-party operator software

- c. Uploading, downloading and off-line archiving of all DDC system software and databases.
  - d. Understanding password and security procedures.
  - e. Adding new operators and making modifications to existing operators.
  - f. Operator password assignments and modification.
  - g. Operator authority assignment and modification.
  - h. Workstation data segregation and modification.
- E. These objectives will be divided into three logical groupings. Participants may attend one or more of these, depending on level of knowledge required.
  - 1. Day-to-day Operators.
  - 2. Advanced Operators.
  - 3. System Managers/Administrators.
- F. Provide course outline and materials. The instructor(s) shall provide one copy of training material per student.
- G. The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- H. Classroom training shall be done using a network of working controllers, representative of the installed hardware.
- I. Training Schedule:
  - 1. Schedule training with Owner 20 business days before expected Substantial Completion.
  - 2. Schedule training to provide Owner with at least 10 business days of notice in advance of training.
  - 3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session shall be split in half with 15-minute break between sessions. Morning and afternoon sessions shall be separated by 30-minute lunch period. Training, including breaks and excluding lunch period, shall not exceed eight hours per day.
  - 4. Provide staggered training schedule as requested by Owner.
- J. Training Attendee List and Sign-in Sheet:
  - 1. Request from Owner in advance of training a proposed attendee list with name, phone number and e-mail address.
  - 2. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
  - 3. Preprinted sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
  - 4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.

5. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.
- K. Attendee Training Manuals:
1. Provide each attendee with a color hard copy of all training materials and visual presentations.
  2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
  3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.
- L. Instructor Requirements:
1. One or multiple qualified instructors to provide training.
  2. Instructors shall have not less than five years of providing instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.
- M. Training Outline:
1. Submit training outline for Owner review at least 10 business day before scheduling training.
  2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.
- N. On-Site Training:
1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
  2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
  3. Provide as much of training located on-site as deemed feasible and practical by Owner.
  4. On-site training shall include regular walk-through tours to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
  5. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.
- O. Off-Site Training:
1. Provide conditioned training rooms and workspace with ample tables, desks or tables, chairs, power and data connectivity for each attendee.
  2. Provide a workstation for use by each attendee.
- P. Video of Training Sessions:
1. Provide a digital video and audio recording of each training session. Create a separate recording file for each session.
  2. Stamp each recording file with training session number, session name and date.

3. Provide Owner with two copies of digital files on DVDs or flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

END OF SECTION

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## SECTION 232100 - HYDRONIC PIPING DISTRIBUTION SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes:
  - 1. Hydronic system pumps
  - 2. Hydronic piping materials and fittings
  - 3. Hydronic system valves and accessories
  - 4. Hydronic piping system air control devices.
  - 5. Hydronic system meters and gauges
  - 6. Hydronic piping specialties and components
- B. Requirements apply to the following hydronic systems:
  - 1. Hot-water heating piping.
  - 2. Glycol cooling or heating-water piping.
  - 3. Makeup-water piping.
  - 4. Condensate-drain piping.
  - 5. Blowdown-drain piping.
  - 6. Air-vent piping.
  - 7. Safety-valve-inlet and -outlet piping.

#### 1.3 DEFINITIONS

- A. ECM: Electronically commutated motor.
- B. WP: Cold working pressure.
- C. EPDM: Ethylene propylene copolymer rubber.
- D. EPR: Ethylene propylene rubber.
- E. ERW: Electric resistance welded steel piping.
- F. FKM: Fluoroelastomer polymer.



- G. HI: Hydraulic Institute.
- H. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- I. NRS: Non-rising stem.
- J. OS&Y: Outside screw and yoke.
- K. RS: Rising stem.
- L. PTFE: Polytetrafluoroethylene
- M. TFE: Tetrafluoroethylene

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
  - 1. Hydronic pumps
    - a. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
    - b. Indicate pump's operating point on curves.
  - 2. Pipe, fittings and joining materials.
  - 3. Bypass chemical feeder.
  - 4. Expansion joints, alignment guides, and anchors.
  - 5. Thermometers, thermowells, pressure gauges, and test plugs
  - 6. Ball valves, butterfly valves, check valves, and globe valves
  - 7. Strainers
  - 8. Suction diffusers
  - 9. Hydronic specialty valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
    - a. Calibrated balancing valves
    - b. Automatic flow control valves
  - 10. Pressure reducing valves
  - 11. Triple duty valves
  - 12. Chainwheel operators
  - 13. Air-control devices.
  - 14. Flexible connectors and expansion fittings.
  - 15. Sleeves
  - 16. Sleeve-seal systems.
  - 17. Grout
  - 18. Escutcheons.

- B. Shop Drawings: For each pump.
  - 1. Show pump layout and connections.
  - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
  - 3. Include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal:
  - 1. Design calculations and detailed fabrication and assembly of hangers and supports for multiple pipes and attachments of the same to the building structure.
  - 2. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
  - 3. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.
  - 4. Expansion fittings and loops: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
    - a. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections. Design and prepare drawings and calculations for restraint of pipe expansion loops, joints, pipe alignment guides, and pipe anchors, supports and attachments of the same to the building structure. Include seal and signature of Registered Engineer, licensed in jurisdiction where Project is located, certifying compliance with specifications. Submit maximum anchor reaction loads for review and approval to the Structural Engineer.
    - b. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
    - c. Alignment Guide Details: Detail field assembly and attachment to building structure.
    - d. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
    - e. Locations: Indicate locations of pipe anchors, alignment guides, and expansion joints and loops.
- D. Wiring Diagrams: For power, signal, and control wiring.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Other building services.
  - 3. Structural members.
- B. Qualification Data: For Installer.
- C. Welding certificates.

- D. Field quality-control reports.
- E. Product Certificates:
  - 1. For each type of expansion joint, from manufacturer.
  - 2. For each type of meter and gauge, from manufacturer.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
  - 1. For pumps to include in emergency, operation, and maintenance manuals.
  - 2. For expansion joints to include in maintenance manuals.
  - 3. For meters and gauges to include in operation and maintenance manuals.
  - 4. For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.
  - 5. Differential pressure meter: For each type of balancing valve and automatic flow control valve, include flow meter, probes, hoses, flow charts, and carrying case.
- B. Maintenance Materials
  - 1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
    - a. Mechanical Seals: One mechanical seal(s) for each pump.

#### 1.7 QUALITY ASSURANCE

- A. All welding processes (including, but not limited to, procedures and welding operator qualifications) shall be in strict accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code (edition, including any addenda, in effect at the time of contract execution). On butt weld joints, provide full penetration welds. On socket weld fittings it is required that the toe of weld blends smoothly with no undercut in pipe wall.
- B. Installations, equipment and material provided shall comply with federal, state and local laws, regulations, codes, specifications and standards. In the event of any apparent conflict among standards, codes or this specification, refer conflict to the Owner for written resolution. If work is performed or installation is completed in variance with applicable codes and regulations, remove and replace work to rectify the installation.
- C. Welding of stanchions, brackets, anchors and other welding not performed on pipe joints shall be in accordance with requirements of AWS specifications and requirements.
- D. Welder Qualification:
  - 1. Test welders to demonstrate ability to make acceptable welds. Tests conducted for qualification of welder for work under one Division or Section shall not qualify welder for work under another Division or Section.
    - a. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
    - b. Pipe Welding Qualifications: Qualify procedures and personnel according to Section IX ASME Boiler and Pressure Vessel Code.

2. Records of tests shall be as follows: Each welder shall be assigned an identifying number, letter or symbol. Identifying mark shall be stamped adjacent to welds made by this welder. Identification shall be at top of horizontal piping and at front of vertical piping.
  3. Maintain record of welders employed, showing dates and results of tests and identifying mark assigned to each welder. Certify records and make them accessible to Owner's project representative and/or project manager. Before completion of project, one copy of records
  4. No qualification shall be older than three years when welder commences work on this project. If welder has not welded in required welding process for a period of six months, he shall be re-certified.
- E. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- F. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- G. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  2. ASME B31.1 for power piping valves.
  3. ASME B31.9 for building services piping valves.

#### 1.8 PIPING AND VALVE DELIVERY STORAGE AND HANDLING

- A. Packing, shipping, handling, unloading of piping and valves:
1. Ship pipe with capped ends. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Storage and Protection
1. Store pipe, tube, fittings and valves on site in accordance with manufacturer recommendations.
  2. Place materials indoors and on elevated platforms in a dry location away from construction activity that may cause damage or contamination.
  3. Maintain packaging, caps and seals on all materials until ready for immediate installation.
- C. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
  2. Protect threads, flange faces, grooves, and weld ends.
  3. Set angle and globe valves closed to prevent rattling.
  4. Set ball and plug valves open to minimize exposure of functional surfaces.
  5. Set butterfly valves closed or slightly open.
  6. Block check valves in either closed or open position.
  7. Use the following precautions during storage:
    - a. Maintain valve end protection.

- b. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- 8. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

## 1.9 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Refer to Part 3 for system pressure rating requirements for all components.
- B. System design temperatures:
  - 1. Hot-water heating piping.
    - a. Maximum Temperature = 200 deg F
  - 2. Glycol heating-water or heat recovery piping.
    - a. Minimum Temperature = 32 deg F
    - b. Maximum Temperature = 100 deg F
- C. Expansion fittings and loops:
  - 1. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
  - 2. Capability: Products to absorb 100 percent of maximum axial movement between anchors.
  - 3. For field fabricated expansion loops, design shall be based on 2016 ASHRAE Systems and Equipment Handbook Chapter 46. Allowable stress ( $S_A$ ) shall not exceed 2016 ASHRAE Handbook recommended limit of 15,000 psi.
    - a. Design for heating hot water or glycol heating-water piping system loops shall be based on 0 deg F initial pipe temperature and 200 deg F final temperature.
  - 4. Basis of design expansion loops for copper piping are based on brazed or high temperature solder joints only. Where press joints are selected, use only factory fabricated expansion joints and loops (stainless steel hose) for expansion compensation.
  - 5. Basis of design expansion loops for steel piping are based on welded fittings only. Where grooved fittings are selected, modify layout (may require relocation of anchors or loops) to meet grooved coupling manufacturer written installation instructions.

- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.2 HYDRONIC DISTRIBUTION PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
  - 1. Armstrong Pumps, Inc.,
  - 2. Aurora Pump; Pentair Ltd,
  - 3. Bell & Gossett a Xylem Brand,
  - 4. Grundfos Pumps Corporation,
  - 5. ITT Goulds Pumps,
  - 6. Peerless Pump Company,
  - 7. Taco Comfort Solutions, Inc,
  - 8. Or approved equal.
- B. General Requirements:
  - 1. Source Limitations: Except automatic condensate pump units, obtain pumps from single source from single manufacturer.
  - 2. Description: Factory-assembled and -tested, centrifugal, pump as defined in HI-1.1, HI-1.2 and HI-1.3.
  - 3. Pump Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23.
    - a. Enclosure Type: Refer to schedules.
    - b. NEMA Premium Efficient motors as defined in NEMA MG 1.
    - c. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor.
    - d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
    - e. Variable-speed motor. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
    - f. Electrical Characteristics: Refer to schedules on drawings.
- C. Inline Pumps:
  - 1. Pump Type: Match scheduled equipment pump type.
    - a. Close-coupled in-line pumps shall be designed for installation with pump and motor shafts mounted horizontally or vertically.
    - b. Split-coupled pumps shall be designed for installation pump and motor shafts mounted vertically.
    - c. Maximum Operating Conditions: 225 deg F and 175 psig working pressure.
  - 2. Pump Construction:

- a. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet, and threaded companion-flange connections.
  - b. Impeller: Cast bronze or stainless-steel; statically and dynamically balanced, and keyed to shaft.
  - c. Pump Shaft: Carbon or alloy steel, with copper-alloy shaft sleeve.
  - d. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat rated for a minimum of 250 deg F.
  - e. Pump Bearings: Permanently lubricated ball bearings.
  - f. Shaft Coupling: Molded rubber insert with interlocking spider or interlocking frame with interconnecting springs capable of absorbing vibration.
  - g. Provide integral pump motor variable-speed controller.
- D. End Suction Pumps, Base Mounted:
- 1. General
    - a. The pump internals shall be capable of being serviced without disturbing piping connections, electrical motor, connections or pump to motor alignment. Pump shall be designed to allow for true back pull-out allowing access to the pump's working components for ease of maintenance.
    - b. The pumps shall be composed of three separable components a motor, bearing assembly, and pump end (wet end). The motor shaft shall be connected to the pump shaft via a replaceable flexible coupling.
    - c. Maximum Operating Conditions: 225 deg F and 175 PSIG working pressure.
    - d. Base plate shall be of structural steel or fabricated steel channel with fully open grouting area (for field grouting). The minimum base plate stiffness shall conform to ANSI/HI 1.3.8-2019 for grouted Horizontal Baseplate Design standards.
  - 2. Pump Type: Match scheduled equipment pump type
    - a. Flex-coupled pumps shall be designed for installation with pump and motor shafts mounted horizontally.
  - 3. Pump Construction:
    - a. Casing: Vertically split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gauge tappings at inlet and outlet, and flanged connections.
      - 1) Pump volute shall be of a cast iron design with integrally cast pedestal volute support with integral cast iron flanges. Volute shall include gauge ports at nozzles, and vent and drain ports.
    - b. Impeller: Cast bronze or stainless-steel; statically and dynamically balanced to ANSI/HI 9.6.4-2016, balance grade G6.3, keyed to shaft, and secured with a stainless-steel locking cap screw or nut.
    - c. Pump Shaft and Sleeve: The pump shall incorporate a dry shaft design to prevent the circulating fluid from contacting the shaft. The pump shaft shall be of carbon or stainless steel with field replaceable bronze or stainless-steel sleeve covering all wetted areas under the sleeve. Shaft sleeve shall be slip on (press on not allowable) and must be easily replaced in the field.

- d. Pump Stub Shaft: Where manufacturer uses a stub shaft, shaft shall be type 304 stainless steel.
- e. Coupling: Capable of absorbing torsional vibration, between the pump and motor. Pumps for variable speed application shall be provided with a manufacturer recommended coupling sleeve. Coupling shall allow for removal of pump wetted end without disturbing pump volute or movement of the pump motor and electrical connections.
  - 1) An ANSI and OSHA rated coupling guard shall shield the coupling during operation. Coupling guard shall be dual rated ANSI B15.1 and OSHA 1910.219 compliant and contain viewing windows for inspection of the coupling. No more than 0.25 inches of either rotating assembly shall be visible beyond the coupling guard.
- f. A bearing assembly shall support the shaft via two heavy-duty re-greaseable ball bearings or permanently sealed bearings with an L10 life of 60,000 hours. Bearing assembly shall be replaceable without disturbing the system piping and shall have foot support at the coupling end. Pump bearings shall be re-greaseable without removal of the bearings from the bearing assembly.
- g. Thermal expansion of the shaft toward the impeller shall be prevented via an inboard thrust bearing.
- h. Seal: Manufacturer recommended mechanical seal selected to meet pressure and temperature rating based on system fluid (water or glycol). Seal shall consist of rotating ring against a seat held by a stainless-steel spring, bellows and seat gasket. Include water slinger on shaft between motor and seal.
- i. Pump shall be equipped with either an internally flushed mechanical seal assembly installed in an enlarged tapered seal chamber or manufacturer optional external seal flush line assembly.
  - 1) For pumps used on open systems (cooling towers) include manufacturer recommended replaceable cartridge filter or separator with shut-off isolation valve installed in the seal flushing line. The filter shall have the ability to remove particles down to five microns in size.

**E. Automatic Condensate Pump Units**

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
  - a. Beckett Corporation,
  - b. Crane Pumps & Systems,
  - c. Grundfos Pumps Corporation,
  - d. Hartell Pumps; Milton Roy,
  - e. Little Giant Pump Co.,
  - f. Or approved equal.
- 2. Source Limitations: Obtain pump units from single source from single manufacturer.
- 3. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Collects and removes condensate from fan coil units, air handling



units, condensing boilers, and similar components. Include factory- or field-installed check valve and 72-inch- minimum, electrical power cord with plug.

4. Capacities and characteristics as scheduled on drawings.
  - a. For condensate pumps mounted in plenum applications, pumps shall be hard wired and shall be UL 2043 listed for the application.

## 2.3 HYDRONIC PIPING MATERIALS AND FITTINGS

### A. Copper Tube and Fittings

1. Drawn-Temper Copper Tubing Above Ground: ASTM B 88, Type L.
2. Brazed Joint Fittings
  - a. Wrought-Copper Fittings, Unions and Couplings: ASME B16.22
3. Press Joint Fittings (125 psig pressure rated systems only):
  - a. Manufacturer: Subject to compliance with requirements, provide products by one of the following, or approved equal:
    - 1) Anvil International,
    - 2) NIBCO,
    - 3) Viega ProPress,
    - 4) Apollo,
    - 5) Or approved equal.
  - b. Wrought-Copper Fittings, Unions and Couplings: ASME B16.51
  - c. EPDM Gasket: Manufacturer standard O-rings for specific application. Provide O-ring and indicator lubricant. Manufacturer shall verify water quality at the site will not negatively affect O-ring or lubricant.

### B. Steel Pipe and Fittings

1. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping, Specialty and Valve Applications" Article.
2. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping, Specialty and Valve Applications" Article.
3. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping, Specialty and Valve Applications" Article.
4. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping, Specialty and Valve Applications" Article.
5. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping, Specialty and Valve Applications" Article.
6. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
7. Wrought Cast and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

- a. Material Group: 1.1.
  - b. End Connections: Butt welding.
  - c. Facings: Raised face.
8. Grooved Mechanical-Joint Fittings and Couplings:
- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - 1) Anvil International, Inc.,
    - 2) Star Pipe Products,
    - 3) Victaulic Company,
    - 4) Or approved equal.
  - b. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
  - c. Couplings: Ductile- or malleable-iron housing and EPDM gasket rated for minimum 230 deg F and of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings. Couplings used for expansion compensation including loops shall be flexible type couplings.
9. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

C. Joining Materials

1. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - 1) Grafoil,
    - 2) Flexitallic,
    - 3) Or approved equal.
  - b. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
    - 1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - 2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
3. Solder Filler Metals: ASTM B 32, lead-free silver alloys. Include water-flushable flux according to ASTM B 813.

4. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
  5. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
    - a. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.
- D. Transition Fittings
1. Plastic-to-Metal Transition Fittings:
    - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
      - 1) Charlotte Pipe and Foundry Company,
      - 2) IPEX Inc.,
      - 3) KBI (King Bros. Industries),
      - 4) Or approved equal.
    - b. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.
  2. Plastic-to-Metal Transition Unions:
    - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
      - 1) Charlotte Pipe and Foundry Company,
      - 2) IPEX Inc.,
      - 3) KBI (King Bros. Industries),
      - 4) NIBCO INC; Model #T/S-1710,
      - 5) Or approved equal.
    - b. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.
- E. Flexible Hose Connectors - Maximum Pipe Size 1 inch NPS.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. IMI Flow Design,
    - b. Macon,
    - c. Nexus,
    - d. Or approved equal.
  2. Minimum Operating Pressure Rating: 225 psig at 230 deg F.
  3. 304 stainless steel braided hose with EPDM core.

4. End connections: Match piping and equipment connections.
  5. Maximum length: 18 inches unless noted otherwise.
- F. Dielectric Fittings
1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
  2. Dielectric Unions:
    - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
      - 1) A.Y. McDonald Mfg. Co.,
      - 2) Capitol Manufacturing Company,
      - 3) Central Plastics Company,
      - 4) Hart Industries International, Inc,
      - 5) Jomar International, Ltd,
      - 6) Matco-Norca,
      - 7) Watts Regulator Co,
      - 8) Zurn Industries, LLC; AquaSpec Commercial Faucet Products,
      - 9) Or approved equal.
    - b. Description:
      - 1) Standard: ASSE 1079.
      - 2) Refer to Part 3 for pressure and temperature rating.
    - c. End Connections: Solder-joint copper alloy and threaded ferrous.
      - 1) Fittings in "Dielectric Flanges" Paragraph below are available in NPS 1-1/2 to NPS 4 (DN 40 to DN 100).
  3. Dielectric Flanges:
    - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
      - 1) Capitol Manufacturing Company,
      - 2) Central Plastics Company,
      - 3) Matco-Norca,
      - 4) Watts Regulator Co,
      - 5) Zurn Industries, LLC; AquaSpec Commercial Faucet Products,
      - 6) Or approved equal.
    - b. Description:
      - 1) Standard: ASSE 1079.

- 2) Factory-fabricated, bolted, companion-flange assembly.
    - 3) Refer to Part 3 for pressure and temperature rating.
    - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
  4. Dielectric Nipples:
    - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
      - 1) Elster Perfection Corporation,
      - 2) Grinnell G-Fire by Johnson Controls Company,
      - 3) Matco-Norca,
      - 4) Precision Plumbing Products,
      - 5) Victaulic Company,
      - 6) Or approved equal.
    - b. Description:
      - 1) Standard: IAPMO PS 66.
      - 2) Electroplated steel nipple, complying with ASTM F 1545.
      - 3) End Connections: Male threaded or grooved.
      - 4) Lining: Inert and noncorrosive, propylene.
  5. Dielectric-Flange Insulating Kits:
    - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
      - 1) Advance Products & Systems, Inc,
      - 2) Calpico, Inc,
      - 3) Central Plastics Company,
      - 4) Or approved equal.
    - b. Description:
      - 1) Nonconducting materials for field assembly of companion flanges.
      - 2) Refer to Part 3 for pressure and temperature rating.
      - 3) Gasket: Neoprene or phenolic.
      - 4) Bolt Sleeves: Phenolic or polyethylene.
      - 5) Washers: Phenolic with steel backing washers.
- G. Bypass Chemical Feeder
1. Provide bypass feeder(s) with a 5-gallon capacity. The feeder shell and tank heads shall be constructed of steel.

2. Bypass feeder at a minimum shall be rated at same pressure and temperature as system served.
3. The tank shall have a wide mouth, to allow chemical addition without the need of a funnel. The bypass feeder shall have a continuous threaded closure requiring multiple turns to close and seal. Closures using partial threads or lugs shall not be considered.
4. Cap shall be constructed of cast iron with manufacturer recommended treatment of underside to prevent corrosion. Provide with gasket seal.
5. Bypass feeder shall be provided with legs to elevate the feeder off the floor. The legs shall have holes to allow mounting by anchor bolts.

H. Expansion Loops, Joints, Swing Connections, Alignment Guides and Anchors

1. Field Fabricated Expansion Loops: Fabricate expansion loops using piping materials and fittings to dimensions shown on the approved shop drawings. Sizes must be confirmed using actual field location of anchors and guides .
2. Factory Fabricated Expansion Joints and Loops (Stainless Steel Hose)
  - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - 1) Flex-Hose Co., Inc,
    - 2) Hyspan,
    - 3) Linetics Noise Control,
    - 4) Metraflex, Inc,
    - 5) Or approved equal.
  - b. U-shaped or V-shaped subject to meeting expansion requirements and space limitations of the project.
  - c. Connections to match system.
  - d. Class: 150
  - e. 300 Series Stainless Steel or Bronze Hose and Braid
  - f. 90 and 180 degree turns: Carbon steel schedule 40
3. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
4. Type: Circular, externally pressurized corrugated bellows.
5. Refer to Part 3 for pressure and temperature rating.
6. Configuration: Single joint class(es) unless otherwise indicated.
7. Expansion Joints for Copper Tubing: Multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
  - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint.
8. Expansion Joints for Steel Piping: Multi-ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
  - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.

- b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged or Weld.
- 9. Alignment Guides and Anchors
  - a. Alignment Guides:
    - 1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
      - a) Adscio Manufacturing LLC,
      - b) Advanced Thermal Systems, Inc,
      - c) Flex-Hose Co., Inc,
      - d) Flexicraft Industries,
      - e) Flex-Weld, Inc,
      - f) Hyspan Precision Products, Inc,
      - g) Metraflex, Inc,
      - h) Senior Flexonics Pathway,
      - i) Unisource Manufacturing, Inc,
      - j) U.S. Bellows, Inc,
      - k) Or approved equal.
    - 2) Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.
    - 3) Anchor Materials:
      - a) Steel Shapes and Plates: ASTM A 36/A 36M.
      - b) Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
      - c) Washers: ASTM F 844, steel, plain, flat washers.
      - d) Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, with tension and shear capacities appropriate for application.
      - e) Stud: Threaded, zinc-coated carbon steel.
      - f) Expansion Plug: Zinc-coated steel.
      - g) Washer and Nut: Zinc-coated steel.
  - b. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - c. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
  - d. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.

- e. Washer and Nut: Zinc-coated steel.

## 2.4 HYDRONIC SYSTEM METERS AND GAUGES

### A. Liquid-in-glass Thermometers

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - a. Flo Fab Inc,
  - b. Miljoco Corporation,
  - c. Palmer Wahl Instrumentation Group,
  - d. Tel-Tru Manufacturing Company,
  - e. Trerice, H. O. Co,
  - f. Weiss Instruments, Inc,
  - g. Winters Instruments - U.S.,
  - h. Or approved equal.
2. Standard: ASME B40.200.
3. Case: Cast aluminum or plastic; 9-inch nominal size unless otherwise indicated.
4. Case Form:
  - a. When mounted between 3 and 7 feet above the floor: straight.
  - b. When mounted at all other heights: adjustable angle
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass or plastic.
8. Stem: Aluminum, brass, or stainless steel and of length to suit installation.
  - a. Design for Air-Duct Installation: With ventilated shroud.
  - b. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

### B. Thermowells

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES or CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.



6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: Mixture of graphite and glycerin.

**C. Pressure gauges**

1. Direct-Mounted, Metal-Case, Dial-Type Pressure gauges:
  - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - 1) Ernst Flow Industries,
    - 2) Flo Fab Inc,
    - 3) Marsh Bellofram,
    - 4) Trerice, H. O. Co.,
    - 5) Watts Regulator Co.; a div. of Watts Water Technologies, Inc,
    - 6) Weiss Instruments, Inc,
    - 7) Or approved equal.
  - b. Standard: ASME B40.100.
  - c. Case: Liquid-filled Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
  - d. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
  - e. Pressure Connection: Brass, with NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
  - f. Movement: Mechanical, with link to pressure element and connection to pointer.
  - g. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
  - h. Pointer: Dark-colored metal.
  - i. Window: Glass.
  - j. Ring: Metal.
  - k. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

**D. Gage Attachments**

1. Snubbers: ASME B40.100, brass; with NPS 1/2, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.

2. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/2 pipe threads.
3. Valves: Brass or stainless-steel needle, with NPS 1/2, ASME B1.20.1 pipe threads.

E. Test Plugs

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - a. Flow Design, Inc,
  - b. Miljoco Corporation,
  - c. National Meter, Inc,
  - d. Peterson Equipment Co., Inc,
  - e. Sisco Manufacturing Company, Inc,
  - f. Trerice, H. O. Co.,
  - g. Watts Regulator Co.; a div. of Watts Water Technologies, Inc,
  - h. Weiss Instruments, Inc,
  - i. Or approved equal.
2. Description: Test-station fitting made for insertion into piping tee fitting.
3. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
4. Thread Size: NPS 1/2, ASME B1.20.1 pipe thread.
5. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
6. Core Inserts: Chloro-sulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.5 HYDRONIC SYSTEMS VALVES AND ACCESSORIES

A. General Valve Requirements

1. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures. Valves shall have name of manufacturer and guaranteed working pressure cast or stamped on bodies. Gaskets and packings shall not contain asbestos.
2. Valve Sizes: Same as upstream piping unless otherwise indicated.
3. Valve Actuator Types:
  - a. Gear Actuator: For quarter-turn valves NPS 8 and larger.
  - b. Handwheel: For valves other than quarter-turn types.
  - c. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
  - d. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
  - e. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

4. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
    - a. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
    - b. Butterfly Valves: With extended neck.
  5. Valve-End Connections:
    - a. Flanged: With flanges according to ASME B16.1 for iron valves.
    - b. Threaded: With threads according to ASME B1.20.1.
  6. Valve Bypass and Drain Connections: MSS SP-45.
- B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. Cannon,
    - b. Conbraco Industries, Inc.; Apollo Valves,
    - c. Crane Co.; Crane Valve Group; Crane Valves,
    - d. Grinnell,
    - e. Hammond Valve,
    - f. Kitz,
    - g. Milwaukee Valve Company,
    - h. NIBCO INC,
    - i. Rockwell,
    - j. Stockham,
    - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc,
    - l. Or approved equal.
  2. Description:
    - a. Standard: MSS SP-110.
    - b. Stem: Stainless steel.
    - c. Ball: Stainless steel, vented.
    - d. Refer to schedules in Part 3 for specific application requirements.
- C. Cast Steel Ball Valves, Flanged (2.5 inch and larger)
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. Apollo: 88A-200 Series,
    - b. Bray,

- c. Keckley,
    - d. Or approved equal.
  - 2. Description:
    - a. Class: 150.
    - b. Stem: Carbon Steel
    - c. Ball: Stainless steel, vented.
    - d. Seal: PTFE
    - e. Refer to schedules in Part 3 for specific application requirements.
- D. Iron General Service Butterfly Valves
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc,
    - b. Centerline,
    - c. Conbraco Industries, Inc.; Apollo Valves,
    - d. Crane Co.; Crane Valve Group; Stockham Division,
    - e. DeZurik Water Controls,
    - f. Grinnell,
    - g. Hammond Valve,
    - h. Jomar,
    - i. Keystone,
    - j. Milwaukee Valve Company,
    - k. NIBCO INC,
    - l. Watts Regulator Co.; a division of Watts Water Technologies, Inc,
    - m. Or approved equal.
  - 2. Description:
    - a. Standard: MSS SP-67, Type I
    - b. Stem: One- or two-piece stainless steel.
    - c. Disc: Aluminum bronze.
    - d. Refer to schedules in Part 3 for specific application requirements.
- E. Carbon Steel High-Performance Butterfly Valves
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc,
    - b. Bray Controls; a division of Bray International,

- c. DeZurik Water Controls,
    - d. Flowseal,
    - e. Jomar,
    - f. Keystone,
    - g. NIBCO INC,
    - h. Posi-Seal,
    - i. Or approved equal.
  - 2. Description:
    - a. Standard: MSS SP-68
    - b. Stem: Stainless steel; offset from seat plane.
    - c. Disc: 316 stainless steel.
    - d. Service: Bidirectional.
    - e. Refer to schedules in Part 3 for specific application requirements.
- F. Bronze Globe Valves
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. Crane Co.; Crane Valve Group; Crane Valves,
    - b. Crane Co.; Crane Valve Group; Stockham Division (Class 125),
    - c. Grinnell,
    - d. Hammond Valve,
    - e. Jomar,
    - f. Milwaukee Valve Company,
    - g. NIBCO INC,
    - h. Walworth,
    - i. Or approved equal.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 1 (Class 125).
    - b. Standard: MSS SP-80, Type 2 (Class 150)
    - c. Packing: Asbestos free.
    - d. Handwheel: Malleable iron or bronze.
    - e. Refer to schedules in Part 3 for specific application requirements.
- G. Iron Globe Valves
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

- a. Crane Co.; Crane Valve Group; Crane Valves,
    - b. Crane Co.; Crane Valve Group; Jenkins Valves,
    - c. Crane Co.; Crane Valve Group; Stockham Division,
    - d. Grinnell,
    - e. Hammond Valve,
    - f. Milwaukee Valve Company,
    - g. NIBCO INC. (Class 125),
    - h. Walworth,
    - i. Or approved equal.
  - 2. Description:
    - a. Standard: MSS SP-85, Type I
    - b. Packing and Gasket: Asbestos free.
    - c. Refer to schedules in Part 3 for specific application requirements.
- H. Eccentric Plug Valves
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. DeZurik Water Controls,
    - b. Mueller,
    - c. Rockwell,
    - d. Stockham,
    - e. Walworth,
    - f. Or approved equal.
  - 2. Description:
    - a. Standard: MSS SP-108.
    - b. Bearings: Oil-impregnated bronze or stainless steel.
    - c. Stem-Seal Packing: Asbestos free.
    - d. Plug, Resilient-Seating Material: Suitable for potable-water service unless otherwise indicated.
    - e. Refer to schedules in Part 3 for specific application requirements.
- I. Bronze Silent Check Valves (Pump Discharge)
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. Crane Co.; Crane Valve Group; Crane Valves,
    - b. Crane Co.; Crane Valve Group; Jenkins Valves,

- c. Crane Co.; Crane Valve Group; Stockham Division,
    - d. Milwaukee Valve Company,
    - e. Mueller Steam Specialty; a division of SPX Corporation,
    - f. Or approved equal.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 1.
    - b. Disc: BUNA/TFE.
    - c. Refer to schedules in Part 3 for specific application requirements.
- J. Iron, Globe Silent Check Valves (Pump Discharge)
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. Crane Co.; Crane Valve Group; Crane Valves,
    - b. Crane Co.; Crane Valve Group; Jenkins Valves,
    - c. Crane Co.; Crane Valve Group; Stockham Division,
    - d. Milwaukee Valve Company,
    - e. Mueller Steam Specialty; a division of SPX Corporation,
    - f. Or approved equal.
  - 2. Description:
    - a. Standard: MSS SP-125.
    - b. Disc: Bronze.
    - c. Refer to schedules in Part 3 for specific application requirements.
- K. Bronze Swing Check Valves
  - 1. Bronze Swing Check Valves with Nonmetallic Disc:
    - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
      - 1) Crane Co.; Crane Valve Group; Crane Valves,
      - 2) Crane Co.; Crane Valve Group; Jenkins Valves,
      - 3) Crane Co.; Crane Valve Group; Stockham Division,
      - 4) Hammond Valve,
      - 5) Kitz Corporation,
      - 6) Milwaukee Valve Company,
      - 7) NIBCO INC,
      - 8) Watts Regulator Co.; a division of Watts Water Technologies, Inc,
      - 9) Or approved equal.

- b. Description:
    - 1) Standard: MSS SP-80, Type 4.
    - 2) Body Design: Horizontal flow.
    - 3) Disc: PTFE unless indicated otherwise in table.
    - 4) Refer to schedules in Part 3 for specific application requirements.
- 2. Bronze Swing Check Valves with Bronze Disc:
  - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - 1) Crane Co.; Crane Valve Group; Crane Valves,
    - 2) Crane Co.; Crane Valve Group; Jenkins Valves,
    - 3) Crane Co.; Crane Valve Group; Stockham Division,
    - 4) Kitz Corporation,
    - 5) Milwaukee Valve Company,
    - 6) NIBCO INC,
    - 7) Or approved equal.
  - b. Description:
    - 1) Standard: MSS SP-80, Type 3.
    - 2) Body Design: Horizontal flow.
    - 3) Refer to schedules in Part 3 for specific application requirements.
- L. Iron Swing Check Valves
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. Crane Co.; Crane Valve Group; Crane Valves,
    - b. Crane Co.; Crane Valve Group; Jenkins Valves,
    - c. Crane Co.; Crane Valve Group; Stockham Division,
    - d. Hammond Valve,
    - e. Kitz Corporation (Class 125),
    - f. Legend Valve (Class 125),
    - g. Milwaukee Valve Company,
    - h. NIBCO INC,
    - i. Powell Valves (Class 125),
    - j. Or approved equal.
  - 2. Description:
    - a. Standard: MSS SP-71, Type I.



- b. Body Design: Clear or full waterway.
- c. Gasket: Asbestos free.
- d. Refer to schedules in Part 3 for specific application requirements.

**M. Strainers**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - a. Sarco,
  - b. Mueller,
  - c. Watts,
  - d. Armstrong,
  - e. Jomar,
  - f. Or approved equal.
2. Description:
  - a. For water service, strainers shall be full size of entering pipe size and have a maximum clean pressure drop of one psi.
  - b. Pump start up strainer screens shall be used for cleaning and removed afterwards.
  - c. Provide blow-off valve on each strainer.
    - 1) Provide bronze strainers with end cap with threaded connection for blow off valve.
    - 2) Provide iron valves with bolted cover with threaded connection for blow off valve.
  - d. Refer to schedules in Part 3 for specific application requirements.

**N. Suction Diffusers**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - a. Armstrong,
  - b. Bell & Gossett,
  - c. Mueller,
  - d. Watts,
  - e. Or approved equal.
2. Suction diffuser/strainers shall have 200 psi cast iron body and stainless-steel sleeve with 5/32" perforations. Units shall include flanged connections, removable gasketed cover and straightening vanes.
3. Provide 16 mesh start-up strainer.
4. Provide blow off tapping on bottom of unit.

5. Provide full pipe size inlet and outlet (reducing suction diffusers are not acceptable).
- O. Hydronic Specialty Valves
  1. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23.
  2. Brass or Bronze, Calibrated-Orifice, Balancing Valves:
    - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
      - 1) Armstrong Pumps, Inc,
      - 2) Bell & Gossett Domestic Pump,
      - 3) Flow Design Inc,
      - 4) Gerand Engineering Co,
      - 5) Griswold Controls,
      - 6) Macon,
      - 7) NuTech Hydronic Specialty Products,
      - 8) Nexus Valve, Inc,
      - 9) Taco,
      - 10) Tour & Andersson; available through Victaulic Company,
      - 11) Or approved equal.
    - b. Valves shall perform the following functions:
      - 1) Flow balancing
      - 2) Flow measurement
      - 3) Positive shut-off
    - c. Valves type shall be one of the following:
      - 1) Ball or plug type with calibrated orifice or venturi.
      - 2) Y-pattern globe style.
    - d. Body: Brass, bronze or copper alloy.
    - e. Ball: Brass or stainless steel.
    - f. Plug: Resin.
    - g. Seat: PTFE, stainless steel or cast copper alloy.
    - h. End Connections: Threaded or socket.
    - i. Pressure gauge Connections: Integral seals for portable differential pressure meter.
    - j. Handle Style: Lever or knob, with memory stop to retain set position.
    - k. Provide removable pre-formed insulation to permit access for balancing and readouts.
    - l. Refer to Part 3 for pressure and temperature rating.

3. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
  - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - 1) Armstrong Pumps, Inc,
    - 2) Bell & Gossett Domestic Pump,
    - 3) Flow Design Inc,
    - 4) Gerand Engineering Co,
    - 5) Griswold Controls,
    - 6) Macon,
    - 7) NuTech Hydronic Specialty Products,
    - 8) Nexus Valve, Inc,
    - 9) Taco,
    - 10) Tour & Andersson,
    - 11) Or approved equal.
  - b. Valves shall perform the following functions:
    - 1) Flow balancing
    - 2) Flow measurement
    - 3) Positive shut-off
  - c. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
  - d. Ball: Brass or stainless steel.
  - e. Stem Seals: EPDM O-rings.
  - f. Disc: Manufacturer standard construction.
  - g. Seat: PTFE or EPDM.
  - h. End Connections: Flanged.
  - i. Pressure gauge Connections: Integral seals for portable differential pressure meter.
  - j. Handle Style: Lever or knob, with memory stop to retain set position.
  - k. Provide removable pre-formed insulation to permit access for balancing and readouts.
  - l. Refer to Part 3 for pressure and temperature rating.
4. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
  - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - 1) AMTROL, Inc,

- 2) Armstrong Pumps, Inc,
    - 3) Bell & Gossett Domestic Pump,
    - 4) Conbraco Industries, Inc,
    - 5) Spence Engineering Company, Inc,
    - 6) Watts Regulator Co,
    - 7) Or approved equal.
  - b. Body: Bronze or brass.
  - c. Disc: Glass and carbon-filled PTFE.
  - d. Seat: Brass.
  - e. Stem Seals: EPDM O-rings.
  - f. Diaphragm: EPT.
  - g. Low inlet-pressure check valve.
  - h. Inlet Strainer: 304 or 316 stainless steel, removable without system shutdown.
  - i. Valve Seat and Stem: Noncorrosive.
  - j. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
5. Diaphragm-Operated Safety Valves: ASME labeled.
- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - 1) AMTROL, Inc,
    - 2) Armstrong Pumps, Inc,
    - 3) Bell & Gossett Domestic Pump,
    - 4) Conbraco Industries, Inc,
    - 5) Spence Engineering Company, Inc,
    - 6) Watts Regulator Co,
    - 7) Or approved equal.
  - b. Body: Bronze or brass.
  - c. Disc: Glass and carbon-filled PTFE.
  - d. Seat: Brass.
  - e. Stem Seals: EPDM O-rings.
  - f. Diaphragm: EPT.
  - g. Wetted, Internal Work Parts: Brass and rubber.
  - h. Inlet Strainer: 304 or 316 stainless steel, removable without system shutdown.
  - i. Valve Seat and Stem: Non-corrosive.

- j. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV for heating hot water boilers and piping up to 160 psig and Section VIII for heat exchangers and higher-pressure applications, selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- 6. Automatic Flow-Control Valves:
  - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - 1) Flow Design Inc,
    - 2) Griswold Controls,
    - 3) Hays Fluid Controls,
    - 4) Macon,
    - 5) NuTech Hydronic Specialty Products,
    - 6) Nexus Valve, Inc.,
    - 7) Or approved equal.
  - b. Body: Brass, bronze or ferrous metal.
  - c. Flow Limiting Assembly: Corrosion resistant stainless-steel piston/spring or elastomeric diaphragm, tamper proof, self-cleaning, and removable.
  - d. Combination Assemblies: Include bronze or brass ball valve.
  - e. Identification Tag: Marked with zone identification, valve number, and flow rate.
  - f. Size: Same as pipe in which installed.
  - g. Performance: Maintain constant flow, plus or minus 10 percent over system pressure fluctuations.
  - h. Factory set range: 2 to 80 psid.
  - i. Refer to Part 3 for pressure and temperature ratings.
- 7. Triple Duty Valves:
  - a. Angle or straight pattern.
  - b. 175-psig (1204-kPa) pressure rating, cast or ductile-iron body, pump-discharge fitting.
  - c. Valve with multi-turn stem and memory stop to allow valve to be returned to its original position after shutoff.
  - d. Brass valve disc with EPDM rubber seat.
  - e. Type 304 stainless steel valve stem.
  - f. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
  - g. Brass gauge ports with integral check valve and orifice for flow measurement.

## 2.6 HYDRONIC PIPING SYSTEM AIR-CONTROL DEVICES

### A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - a. AMTROL, Inc,
  - b. Armstrong Pumps, Inc,
  - c. Bell & Gossett Domestic Pump,
  - d. Nexus Valve, Inc,
  - e. NuTech Hydronic Specialty Products,
  - f. Taco, Inc,
  - g. Or approved equal.
2. Body: Brass or stainless steel.
3. Internal Parts: Non-ferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Refer to Part 3 for pressure and temperature rating.

### B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - a. AMTROL, Inc,
  - b. Armstrong Pumps, Inc,
  - c. Bell & Gossett Domestic Pump,
  - d. Nexus Valve, Inc,
  - e. Taco, Inc,
  - f. Or approved equal.
2. Body: Brass, stainless steel or cast iron.
3. Internal Parts: Non-ferrous.
4. Operator: Non-corrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Refer to Part 3 for pressure and temperature rating.

### C. Bladder-Type Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

- a. AA Tanks,
  - b. AMTROL, Inc,
  - c. Armstrong Pumps, Inc,
  - d. Bell & Gossett Domestic Pump,
  - e. Taco, Inc,
  - f. Or approved equal.
2. Tank: Welded steel. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
  3. Refer to Part 3 Piping and Specialty for system pressure and temperature rating required.
  4. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
  5. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
- D. In-Line Air Separators:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. AMTROL, Inc,
    - b. Armstrong Products, Inc,
    - c. Bell & Gossett Domestic Pump,
    - d. Taco, Inc,
    - e. Or approved equal.
  2. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
  3. Refer to Part 3 for pressure and temperature rating.

## 2.7 HYDRONIC PIPING SPECIALTIES

- A. Stainless-Steel Bellow, Flexible Connectors:
1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
  2. End Connections: Threaded or flanged to match equipment connected.
  3. Performance: Capable of 3/4-inch misalignment.
  4. Refer to Part 3 for pressure and temperature rating.
- B. Spherical, Rubber, Flexible Connectors:
1. Body: Fiber-reinforced rubber body.
  2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
  3. Performance: Capable of misalignment.
  4. Refer to Part 3 for pressure and temperature rating.

**C. Sleeves**

1. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
2. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
3. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - a. Underdeck Clamp: Clamping ring with set screws.

**D. Sleeve Seal Systems**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - a. Advance Products & Systems, Inc,
  - b. CALPICO, Inc,
  - c. Metraflex Company (The),
  - d. Pipeline Seal and Insulator, Inc,
  - e. Proco Products, Inc,
  - f. Or approved equal.
2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
  - a. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - b. Pressure Plates: Carbon steel, plastic, or stainless steel.
  - c. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating or stainless steel of length required to secure pressure plates to sealing elements.

**E. Grout**

1. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Non-shrink; recommended for interior and exterior applications.
3. Design Mix: 5000-psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

**F. Escutcheons**

1. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
3. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.



4. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.
5. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
6. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PUMP INSTALLATION**

- A. Comply with HI 1.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
- E. Equipment Mounting: Install base-mounted pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases specified in Division 03. Comply with requirements for vibration isolation devices specified in Division 23.
  1. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
  2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of concrete base.
  3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  6. Install on 4-inch- high concrete base.
- F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and of size required to support weight of in-line pumps. Provide vibration isolators specified in Division 23.

1. Comply with requirements for seismic-restraint devices specified in Division 23.
2. Comply with requirements for hangers and supports specified in Division 23.

**G. Alignment**

1. Engage a factory-authorized service representative to perform alignment service.
2. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
3. Comply with pump and coupling manufacturers' written instructions.
4. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with non-shrink, non-metallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

**H. Pump Connections**

1. Comply with requirements for piping specified in Division 23 for steam and condensate heating piping. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Where installing piping adjacent to pump, allow space for service and maintenance.
3. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
4. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
5. Install check, shutoff, and throttling valves or triple-duty valve on discharge side of pumps as indicated on drawings.
6. Install Y-type strainer or suction diffuser and shutoff valve on suction side of pumps as indicated on the drawings.
7. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
8. Install pressure gauges on pump suction and discharge or at integral pressure-gage tapping, or install single gauge with multiple-input selector valve.
9. Install check valve and gate or ball valve on each condensate pump unit discharge.
10. Ground equipment according to Division 26, Grounding and Bonding for Electrical Systems.
11. Connect wiring according to Division 26, Low-Voltage Electrical Power Conductors and Cables.

**3.3 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Piping locations and arrangements indicated were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Verify final equipment locations for roughing-in.
- C. Installation of piping must allow for expansion using offsets, loops, swing joints or expansion joints to prevent undue strain.

1. Mains and risers with loops or offsets shall be securely anchored to structure so as to impart expansion towards loops or offsets. Anchors shall be constructed of heavy forged wrought iron, secured to pipe and to structure. Provide vibration isolation.
  2. Provide pipe alignment guides to guide expanding pipe to move freely from anchor points toward expansion joints, offsets, etc.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
  - E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
  - F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
  - G. Install piping to permit valve servicing.
  - H. Install piping at indicated slopes.
  - I. Install piping free of sags and bends.
  - J. Install fittings for changes in direction and branch connections.
  - K. Install piping to allow application of insulation.
  - L. Select system components with pressure rating equal to or greater than specified system pressure rating.
  - M. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
  - N. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
  - O. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
  - P. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
  - Q. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
  - R. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
  - S. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
  - T. Install shutoff valve immediately upstream of each dielectric fitting.
  - U. Comply with requirements in Division 23 for HVAC piping and equipment identification.
  - V. Install expansion loops and expansion loops.

### 3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

- C. Align components. No strain shall be placed on weld during welding. No part of pipe shall be offset more than 20 percent of thickness. Set flanges and branches properly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- A. Pressed Joints: Assemble joints in strict accordance with manufacturer written instructions including but not limited to cutting pipe to square the end, removal of burrs from cut inside and outside, restoration of full inside diameter and a smooth, chamfered exterior surface, marking of insert depth on the pipe, inspection of gasket to ensure proper seating all prior to clamping and pressing. Maintain manufacturer minimum distance between press type fittings and brazed fittings. Press-connect joints shall be made using a press-connect tool and jaws approved for use for the manufacturer's specific fitting configuration.
- B. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts in accordance with manufacturer written instructions. Cut or roll grooves in ends of pipe based on pipe wall thickness per coupling installation instructions. Use grooved-end fittings and grooved-end-pipe couplings. Grooved couplings used at expansion devices shall be flexible type, all others shall be rigid type.

### 3.5 CORE DRILLING

- A. Core drilling shall be avoided in new construction. Set sleeves prior to installation of structure for passage of pipes, conduit and ducts. Where core drilling is unavoidable (e.g. when individual sleeves are not installed or incorrectly located) or required by renovation projects, locate required openings prior to coring and submit locations for review.
- B. Coordinate openings with other Divisions.
- C. Do not disturb existing systems. Protect areas from damage.
- D. Thoroughly investigate existing conditions in vicinity of required opening prior to coring.

### 3.6 PIPING, SPECIALTIES AND VALVE APPLICATIONS

- A. Hydronic piping components and installation shall be rated for the following minimum pressures and temperatures unless otherwise indicated:

HOT WATER/GLYCOL AND DUAL TEMPERATURE PIPING AND SPECIALTIES - Table 1 of 2 Minimum Component Rating <sup>2</sup> - 125 psig at 250 deg F for NPS 1/2 - NPS 24			
Size	Pipe Material	Joints	Fittings
NPS 2	Type L, drawn-temper copper tubing	Brazed or high temperature silver soldered	Wrought copper
	Schedule 40 steel, Grade B, Seamless	Threaded	Class 125 cast-iron
NPS 2-1/2 NPS 12	Schedule 40 steel, Grade B, ERW	Welded	Wrought steel
		Flanged	Class 150 Wrought-cast or forged-steel
		Flanged	Class 125 cast-iron
NPS 12	Standard weight steel, Grade B, ERW	Welded	Wrought steel
		Flanged	Class 150 Wrought-cast or forged-steel
		Flanged	Class 125 cast-iron
NPS 14 - and larger	Standard weight steel, Grade B, ERW	Welded	Wrought steel
		Flanged	Class 150 Wrought-cast or forged-steel
<div>1. Minimum rating for all piping specialties shall be 125 psig at 250 deg F (121 deg C). Piping specialties include: dielectric unions; dielectric flanges; test plugs; packless expansion joints; brass or bronze, calibrated orifice, balancing valves; cast iron or steel, calibrated orifice, balancing valves; automatic flow control valves; manual air vents; automatic air vents; air separators; expansion tanks, stainless-steel bellows flexible connectors; spherical, rubber, flexible connectors.</div> <div>2. For copper piping, press-joints and fittings meeting system pressure and temperature requirements may be used in lieu of brazed or high temperature solder and threaded joints.</div> <div>3. Where grooved mechanical joint fittings and joints are specified in Part 2, grooved mechanical joint fittings and joints meeting system pressure and temperature requirements may be used in lieu of welded or flanged joints <b>ONLY IN ACCESSIBLE LOCATIONS</b>. Locations prohibited from using grooved joints of any type include shafts, chases, and above ANY ceiling installations (regardless of type).</div>			

HOT WATER/ GLYCOL AND DUAL TEMPERATURE SYSTEM VALVES- Table 2 of 2 Maximum 250 deg F and 125 psig for NPS 1/2 - NPS 24						
Specialty	Application	Type	Size (inches)	Body/Seat, Body/Trim	Connection	Minimum Rating <sup>1,2</sup>
Ball Valve	Isolation (with locking handle) and Modulation	Full Port 2 pc.	1/2 - 2	Bronze/Teflon	Threaded	400 psig WOG
Globe Valve	ATC Modulation	Control Valve	1/2 - 2	Bronze/Metal	Threaded	400 psig WOG
			2-1/2 - 6	Bronze/Metal	Flanged	400 psig WOG
Butterfly Valve	Isolation and Modulation	General Service	2-1/2 - 6	Ductile Iron/EPDM	Threaded Lug	200 psig CWP 200 psig bi-directional shutoff 200 psig dead end service
		High Performance	8 - 24	Ductile Iron/EPDM	Threaded Lug	150 psig CWP 150 psig bi-directional shutoff 150 psig dead end service
Check Valve	Pumps	Silent	1/2 - 2	Bronze/Bronze	Threaded	200 psig WOG
		Silent Globe	2-1/2 - 24	Iron/Bronze	Flanged	Class 125
	Piping	Y-Pattern Swing	1/2 - 2	Bronze/Bronze	Threaded	200 psig WOG
			2-1/2 - 24	Iron/Bronze	Flanged	Class 125
Strainer	Control Valves and Flow Meters	Y-Type	1/2 - 2	Bronze/Stainless (1/16" dia.)	Threaded	200 psig WOG
			2-1/2 - 4	Iron/Stainless (1/16" dia.)	Flanged	Class 125
			5 - 24	Iron/Stainless (1/8" dia.)	Flanged	Class 125
	Pump Suction	In-Line Y-Type	1/2 - 2	Bronze/Stainless (1/16" dia.)	Threaded	200 psig WOG
			2-1/2 - 4	Iron/Stainless (3/16" dia.) <sup>3</sup>	Flanged	Class 125
			5 - 24	Iron/Stainless (1/4" dia.) <sup>3</sup>	Flanged	Class 125
		Angle Suction Diffuser End Suction	2 - 12	Iron/Stainless (3/16" dia.) <sup>3</sup> Start Up Strain-	Flanged	Class 125

		Pumps		er = 16 Mesh Bronze		
<ol style="list-style-type: none"> <li>1. These are minimum ratings for ASTM A126, Class B and ASTM B-61 and 62. For higher pressures and temperatures, adjust these values to include static head plus 1.1 times pressure relief valve setting plus pump shutoff head pressure. For actual maximum allowable valve and strainer ratings, refer to "Pressure-Temperature Ratings - Non Shock" tables and "Adjusted Pressure Ratings" for copper tube, soldered end valves and strainers.</li> <li>2. CWP=Cold Water Working Pressure; WOG=Water, Oil or Gas; Class=ANSI Standard; Use 1/8 inch diameter for plate heat exchanger application.</li> <li>3. For copper piping, press-joint valves manufactured by the press-joint fitting manufacturer meeting system project specifications and pressure/temperature requirements may be used in lieu of sweat or threaded valves.</li> <li>4. Where grooved mechanical joint fittings and joints are specified in Part 2, grooved mechanical joint fittings and joints meeting system pressure and temperature requirements may be used in lieu of welded or flanged joints <b>ONLY IN ACCESSIBLE LOCATIONS</b>. Locations prohibited from using grooved joints of any type include shafts, chases, and above ANY ceiling installations (regardless of type).</li> </ol>						

HOT WATER/ GLYCOL AND DUAL TEMPERATURE PIPING AND SPECIALTIES - Table 1 of 2 Minimum Rating <sup>2</sup> 225 psig at 250 deg F for NPS 1/2 - NPS 24			
Size	Pipe Material	Joints	Fittings
NPS 2	Type L, drawn-temper copper tubing	Brazed or high temperature silver soldered	Wrought copper
	Schedule 40 steel, Grade B, ERW	Threaded	Class 300 malleable iron
NPS 2-1/2 - NPS 10	Schedule 40 steel, Grade B, ERW	Welded	Wrought-steel
		Flanged	Class 250 cast iron
		Flanged	Class 300 Wrought-cast or forged-steel
NPS 12 - and larger	Standard weight steel, Grade B, ERW	Welded	Wrought-steel
		Flanged	Class 250 Cast iron
<div>1. Minimum rating for all piping specialties shall be 225 psig at 250 deg F. Piping specialties include: dielectric unions; dielectric flanges; test plugs; packless expansion joints; brass or bronze, calibrated orifice, balancing valves; cast iron or steel, calibrated orifice, balancing valves; automatic flow control valves; manual air vents; automatic air vents; air separators; expansion tanks, stainless-steel bellows flexible connectors; spherical, rubber, flexible connectors.</div> <div>2. For copper piping, press-joints and fittings meeting system pressure and temperature requirements may be used in lieu of brazed or high temperature solder and threaded joints.</div> <div>3. Where grooved mechanical joint fittings and joints are specified in Part 2, grooved mechanical joint fittings and joints meeting system pressure and temperature requirements may be used in lieu of welded or flanged joints <b>ONLY IN ACCESSIBLE LOCATIONS</b>. Locations prohibited from using grooved joints of any type include shafts, chases, and above ANY ceiling installations (regardless of type).</div>			



HOT WATER/ GLYCOL AND DUAL TEMPERATURE SYSTEM VALVES - Table 2 of 2						
Maximum 225 deg F and 250 psig NPS 1/2 NPS 24						
Specialty	Application	Type	Size (inches)	Body/Seat, Body/Trim	Connection	Minimum Rating <sup>1,2</sup>
Ball Valve	Isolation (with locking handle) and Modulation	Full Port 2 pc.	1/2 - 2	Bronze/Teflon	Threaded	400 psig WOG
		Full Port	2.5 - 8	Carbon Steel /PTFE	Flanged	Class 150
Globe Valve	ATC Modulation	Control Valve	1/2 - 2	Bronze/Metal	Threaded	400 psig WOG
			2-1/2 - 6	Bronze/Metal	Flanged	600 psig WOG
Butterfly Valve	Isolation and Modulation	High Performance	10- 24	Carbon Steel/PTFE	Threaded Lug	285 psig CWP
Check Valve	Pumps	Silent	1 - 2	Bronze/Bronze	Threaded	Class 250
		Silent Globe	2-1/2 - 24	Iron/Bronze	Flanged	Class 250
	Piping	Y-Pattern Swing	1 - 2	Bronze/Bronze	Threaded	Class 250
			2-1/2 - 24	Iron/Bronze	Flanged	Class 250
Strainer	Control Valves and Flow Meters	Y-Type	1/2 - 2	Bronze/Stainless (20 mesh)	Threaded	400 psi WOG
			2-1/2 - 4	Iron/Stainless (1/16" dia.)	Flanged	Class 250
			5 - 24	Iron/Stainless (1/8" dia.)	Flanged	Class 250
	Pump Suction	In-Line Y-Type	1/2 - 2	Bronze/Stainless (1/16" dia.)	Threaded	400 psig WOG
			2-1/2 - 4	Iron/Stainless (3/16" dia.) <sup>3</sup>	Flanged	Class 250
			5 - 24	Iron/Stainless (¼" dia.) <sup>3</sup>	Flanged	Class 250
			Angle Suction Diffuser End Suction Pumps	2 - 12	Iron/Stainless (3/16" dia.) <sup>3</sup> Start Up Strainer = 16 Mesh Bronze	Flanged
<div>1. These are minimum ratings for ASTM A126, Class B and ASTM B-61 and 62. For higher pressures and temperatures, adjust these values to include static head plus 1.1 times pressure relief valve setting plus pump shutoff head pressure. For actual maximum allowable valve and strainer ratings, refer to "Pressure-Temperature Ratings - Non Shock" tables and "Adjusted Pressure Ratings" for copper tube, soldered end valves and strainers.</div> <div>2. CWP=Cold Water Working Pressure; WOG=Water, Oil or Gas; Class=ANSI Standard</div> <div>3. Use 1/8 inch diameter for plate heat exchanger application.</div> <div>4. For copper piping, press-joint valves manufactured by the press-joint fitting manufacturer meeting system project specifications and pressure/temperature requirements may be used in lieu of sweat or threaded valves.</div>						

5. Where grooved mechanical joint fittings and joints are specified in Part 2, grooved mechanical joint fittings and joints meeting system pressure and temperature requirements may be used in lieu of welded or flanged joints **ONLY IN ACCESSIBLE LOCATIONS**. Locations prohibited from using grooved joints of any type include shafts, chases, and above ANY ceiling installations (regardless of type).

B. Miscellaneous Piping and Valve Applications

1. Makeup-water piping shall be the following:
  - a. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or high temperature soldered joints.
  - b. System Rating: 125 psig at 150 deg F
2. Condensate-Drain Piping: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or high temperature soldered joints.
  - a. System Rating: 125 psig at 150 deg F
3. Humidifier-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
  - a. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
  - b. System Rating: 125 psig at 150 deg F
4. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
  - a. System Rating: 125 psig at 150 deg F
5. Air-Vent Piping:
  - a. Inlet: Same as service where installed according to piping manufacturer's written instructions.
  - b. Outlet: Type L, annealed-temper copper tubing with soldered or flared joints.
  - c. System Rating: 125 psig at 150 deg F
6. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed according to valve manufacturer's written instructions.

3.7 VALVE EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

- E. Do not attempt to repair defective valves; replace with new valves.

### 3.8 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for ball, butterfly, and globe valves NPS 3 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install check valves for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
  - 2. Silent Check Valves: In horizontal or vertical position, between flanges.

### 3.9 VALVE ADJUSTMENT

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### 3.10 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. Valves on condenser water, chilled water, hot water and glycol services shall be as shown in the above application tables. If valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball or butterfly valves
  - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type
  - 3. Modulating Service: Globe valves
  - 4. Pump-Discharge Check Valves:
    - a. NPS 2 and Smaller: Spring wafer check valve with bronze disc.
    - b. NPS 2-1/2 and Larger: Iron, center-guided, metal -seat check valves.
- B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.
- C. Select valves with end connections as indicated in the tables. For applications not listed in the tables select valves, except wafer types, with the following end connections
- D. For Copper Tubing, NPS 2 and Smaller: Threaded ends
- E. For Steel Piping, NPS 2 and Smaller: Threaded ends
- F. For Steel Piping, NPS 2-1/2 and larger: Flanged ends.

### 3.11 VALVE APPLICATIONS

- A. Install shut off-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

- B. Install calibrated-orifice, balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere required by ASME Boiler and Pressure Vessel Code. Pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

### 3.12 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 and larger: Use dielectric flanges or dielectric flange kits.

### 3.13 HYDRONIC PIPING HANGERS AND SUPPORTS

- A. Comply with requirements in Division 23 for hanger, support, anchor devices and vibration isolation. Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:

Nominal Pipe Size (inches)	Maximum Horizontal Span (feet)	Minimum Rod Size (inches)	Hanger Type
1/2	5	0.375	Clevis Hanger
3/4	5	0.375	Clevis Hanger
1	6	0.375	Clevis Hanger
1.25	7	0.375	Clevis Hanger
1.5	8	0.375	Clevis Hanger
2	8	0.375	Clevis Hanger
2.5	11	0.5	Clevis Hanger
3	12	0.5	Clevis Hanger
4	12	0.625	Single Rod Roller Hanger
5	12	0.625	Single Rod Roller Hanger
6	12	0.75	Single Rod Roller Hanger
8 to 12	12	Two at 0.875	Dual Rod Roller Hanger
14 to 18	12	Two at 1	Dual Rod Roller Hanger
20	12	Two at 1.25	Dual Rod Roller Hanger
24	12	Two at 1.5	Dual Rod Roller Hanger

- C. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- D. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
- E. Provide spring hangers to support vertical runs. Vertical supports shall be spaced to prevent the pipe from being overstressed from the combination of all loading effects including the entire weight of the riser, and adjacent piping, hydrostatic test load conditions, line temperature, other

live load conditions, and available supporting structure. On a riser subject to expansion, only one support of the rigid type shall be used.

- F. Riser clamps shall have a positive means of engagement (i.e. shear lugs) between the pipe and the clamp.
- G. Rigid riser clamps, when used for deadweight purposes, shall be sized for two times the calculated load.

### 3.14 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections.
- E. For local terminal units with rotating components (e.g. fan coils, heat pumps, fan powered boxes) and where indicated on drawings, provide flexible hose connectors between unit and supply and return valve assemblies. Connector length shall no longer than 12 inches for chilled beam applications or 18 inches for other applications.

### 3.15 EXPANSION JOINT AND LOOP INSTALLATION

- A. Install expansion joints and loops of sizes matching sizes of piping in which they are installed.
- B. Install expansion loops in accordance with approved delegated design submittal.
- C. Install manufactured flexible hose loops and joints in accordance with manufacturer installation instructions.
- D. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- E. Install rubber packless expansion joints according to FSA-NMEJ-702.
- F. Install grooved-joint expansion joints to grooved-end steel piping

### 3.16 PIPING SWING CONNECTION INSTALLATION

- A. Connect risers and branch connections to mains with at least three elbows.
- B. Connect risers and branch connections to terminal units with at least three elbows.
- C. Connect mains and branch connections to terminal units with at least three elbows.

### 3.17 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install one guide on each side of pipe expansion fittings and loops. Per ASHRAE Handbook, distance for guides is "2H" for expansion loops and "L" for Z-bends. At expansion joints, alignment guide locations shall be in accordance with joint manufacturer recommendations.
- C. Attach guides to pipe and secure guides to building structure.

- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
- F. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- G. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
- H. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.
- I. Concrete inserts shall be iron or steel of type to receive machine bolt head or nut after installation. Inserts shall permit adjustment of bolt in one horizontal direction and shall develop strength of bolt when installed in properly cured concrete.

### 3.18 SLEEVE INSTALLATION

#### A. General

- 1. Lay out penetration and sleeve openings in advance, to permit provision in work. Coordinate work carefully with architectural and structural work. Set sleeves and conduit in forms before concrete is poured. Provide remedial work where sleeves and conduits are omitted or improperly placed. Remedial work includes core drilling (see requirements below) for penetrations if walls are poured, or otherwise constructed, without required sleeves. Provide core drilling (see requirements below) of existing construction. Do not penetrate structural members without Structural Engineer's/Architect's written approval.
- 2. Provide sleeves and packing materials at penetrations of foundations, walls, basement floors, slabs (except on grade), partitions and floors. Sleeve installation shall meet NFPA 101 requirements, UL rated assembly requirements, and materials requirements of these specifications. Submit a list of the UL listed details that the Contractor intends on using on this project in all rated assemblies.
- 3. Sleeves that penetrate outside walls, basement slabs, footings and beams shall be waterproof. Sleeves that penetrate floors shall be fireproof and waterproof.
- 4. Sleeves for insulated pipe and duct in non-fire rated construction shall accommodate continuous insulation without compression. Sleeves and/or penetrations in fire rated construction that do not require fire dampers shall be packed with fire rated material that shall maintain the fire rating of the wall. Seal ends of penetrations to provide continuous vapor barrier where insulation is interrupted. Where fire dampers are required, install sleeve and damper assembly in accordance with damper listing.
- 5. Where pipes passing through openings are exposed in finished rooms, finishes of filling materials shall match and be flush with adjoining floor, ceiling, and wall finishes.
- 6. Identify unused sleeves and slots for future installation. Fill slots, sleeves and other openings in floors or walls if not used. Fill spaces in openings after installation of pipe, duct, conduit or cable. Fill for floor penetrations shall prevent passage of water, smoke, fire, and fumes. Fill shall be fire resistant in fire floors and walls, and shall prevent passage of air, smoke and fumes.
- 7. Do not support piping risers or conduit on sleeves.

8. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 for materials.
9. Verify final equipment locations for roughing-in.
10. Installation Testing, Listings and Approvals
  - a. Installation of sleeves, fill and packing shall meet material manufacturer's recommendations exactly, particularly as regards safety, ventilation, removal of foreign materials and other details of installation. Dam openings as recommended. Remove flammable materials used for damming and forming seals in fire-rated construction.
  - b. Sleeve penetration methods shall be water- and gas-tight and shall meet requirements of ASTM E-119 Standard Methods of Fire Tests of Building Construction and Materials.
  - c. Fire-stop penetration seal methods and materials shall be FM-approved and UL-listed as applicable. They shall have the same rating as the structure penetrated. Submit manufacturer's detail sheet indicating assembly rating.
    - 1) Inspect foamed sealants to ensure manufacturer's optimum cell structure and color ranges.
    - 2) Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07.
- B. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- C. Sleeves are not required for slab-on-grade floors.
- D. Sleeves are required for core-drilled holes on any floor.
- E. Install sleeves in new walls and slabs as new walls and slabs are constructed.
- F. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
- G. Cut sleeves to length for mounting flush with both surfaces.
  1. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab to secure clamping ring if ring is specified.
- H. Install sleeves that are large enough to provide 0.25-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
  1. Steel Pipe Sleeves: For pipes smaller than NPS 6.
  2. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
  3. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashings and Trim" for flashing.
    - a. Seal space outside of sleeve fittings with grout.

4. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
5. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07, Joint Sealants.
- I. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 for materials and installation.
- J. Install sleeve seals for piping penetrations of exterior concrete walls and slabs.
- K. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  1. Install steel pipe for sleeves smaller than 6 inches in diameter.
  2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
  3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.19 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### 3.20 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  1. Exterior Concrete Walls above Grade: Galvanized-steel-pipe sleeves.
  2. Exterior Concrete Walls below Grade: Galvanized-steel-pipe sleeves with sleeve-seal system.
    - a. Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
  3. Concrete Slabs-on-Grade:
    - a. Galvanized-steel-pipe sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
  4. Concrete Slabs above Grade:



- a. Galvanized-steel-pipe sleeves.
- 5. Interior Partitions:
  - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
  - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

### 3.21 ESCUTCHEON INSTALLATION

- A. Install escutcheons at piping penetrations of walls, ceilings, and finished floors exposed to view in finished spaces (not required in utility spaces or mechanical rooms).
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. New Piping: Use the following:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type.
    - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type.
    - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type.
  - 2. Existing Piping: Use the following:
    - a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
    - b. Insulated Piping: Split-plate, stamped-steel type hinge
    - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
    - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
    - e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type.
    - f. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
    - g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

### 3.22 METER AND GAUGE INSTALLATION

- A. Install all meters and gauges in locations readable from the floor without the use of a ladder.
- B. Install meters and gauges where indicated on plans and details.
- C. Install thermowells with socket extending 2 inches into fluid or one-third of pipe diameter, whichever is shorter. Socket shall be installed in vertical position in piping tees.
- D. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- E. Install thermowells with extension on insulated piping.
- F. Fill thermowells with heat-transfer medium.

- G. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- H. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
- I. Install remote-mounted pressure gauges on panel.
- J. Install valve and snubber in piping for each pressure gauge for fluids.
- K. Install test plugs in piping tees.
- L. Install flow indicators in piping systems in accessible positions for easy viewing.
- M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
  - 1. Install flowmeter elements in accessible positions in piping systems.
  - 2. Install flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
  - 3. Install permanent indicators on walls or brackets in accessible and readable positions.
  - 4. Install connection fittings in accessible locations for attachment to portable indicators.
  - 5. .
- N. Install thermometers in the following locations:
  - 1. Inlet and outlet of each hydronic zone.
  - 2. Inlet and outlet of each major hydronic coil bank (10 gpm or more)
  - 3. Inlet and outlet of each hydronic boiler.
  - 4. Two inlets and two outlets of each chiller.
  - 5. Inlet and outlet of each hydronic coil in air-handling units.
  - 6. Two inlets and two outlets of each hydronic heat exchanger.
  - 7. Inlet and outlet of each thermal-storage tank.
  - 8. At inlet and outlet of each bridge in primary/secondary systems.
- O. Install pressure gauges in the following locations:
  - 1. Inlet and outlet of each major hydronic coil bank (10 gpm or more)
  - 2. Discharge of each pressure-reducing valve.
  - 3. Inlet and outlet of each chiller chilled-water and condenser-water connection.
  - 4. Suction and discharge of each pump.
  - 5. Expansion tank connections.
  - 6. Makeup water connections.
- P. Meter and gauge Connections
  - 1. Install meters and gauges adjacent to machines and equipment to allow service and maintenance of meters, gauges, machines, and equipment.
  - 2. Connect flowmeter-system elements to meters.
  - 3. Connect flowmeter transmitters to meters and DDC system.

4.

Q. Meter and gauge Adjustment

1. After installation, calibrate meters according to manufacturer's written instructions.
2. Adjust faces of meters and gauges to proper angle for best visibility.

3.23 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.
- B. Scale Range for Heating, Hot-Water and Dual Temperature Piping: 30 to 240 deg F.

3.24 PRESSURE-GAGE SCALE-RANGE SCHEDULES

- A. Scale Range for Chilled-Water Piping: 0 to 100 psi.
- B. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

3.25 FLOW METER SCHEDULE

- A. Flow Meters for Chilled-Water Piping: Full-bore Magnetic type.
- B. Flow Meters for Heating Hot-Water and Dual Temperature Piping: Full-bore Magnetic type.

3.26 HYDRONIC PIPING SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install piping from boiler air outlet, air separator, to expansion tank with a 2 percent upward slope toward tank.
- D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- E. Install expansion tanks. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
  1. Install tank fittings that are shipped loose.
  2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
- F. Vent and purge air from hydronic system.

3.27 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
  1. Leave joints, including welds, uninsulated and exposed for examination during test.
  2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
  4. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
  2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
  3. Isolate expansion tanks and determine that hydronic system is full of water.
  4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
  5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
  6. Prepare written report of testing.
- C. Provide a complete flushing and cleaning of each piping system.
1. Coordinate requirements with selected water treatment provider. Request recommended cleaning solutions, passivation chemicals and dosages to be used from the treatment vendor to ensure system is acceptable for water treatment provided.
  2. Provide temporary connections to allow cleaning, purging and circulating water through the system. Provide temporary bypasses at each coil and heat exchanger during cleaning.
  3. After testing is completed, systems shall be flushed with chemical cleaner and degreaser to remove deposits such as pipe dope, loose rust, mill scale and other materials in the piping system. Chemicals shall be circulated through the entire system while bypassing end use equipment. System will then be drained, refilled and flushed until no foreign matter is observed and alkalinity of water is equal to or better than makeup water.
  4. Use temporary pumps for circulation. Where permanent pumps are proposed for use for circulating cleaning solution, provide minimum 2 year extended pump warranty from date of substantial completion including all parts and labor. Request written approval from owner before using permanent pumps for flushing.
  5. Provide the following:
    - a. Initial clear water flush: Fill the piping system with clean water and circulate through the system to loosen debris and flush to draining points.
    - b. Cleaning and passivation: Refill and flush system and add cleaning and passivation chemicals. Circulate through the system at a minimum 3 fps velocity. Water treatment vendors shall review report to confirm acceptable results.

- c. Final clear water flush: Drain system containing cleaning and passivation chemicals and refill with fresh makeup water.
- 6. Once final clear water flush is completed, the water treatment vendor shall inject recommended water treatment chemicals. Do not allow system to stagnate before final chemical treatment is provided.
- D. Perform the following before operating the system:
  - 1. Open manual valves fully.
  - 2. Inspect pumps for proper rotation.
  - 3. Set makeup pressure-reducing valves for required system pressure.
  - 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
  - 5. Set temperature controls so all coils are calling for full flow.
  - 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
  - 7. Verify lubrication of motors and bearings.
- E. Replace broken and damaged escutcheons using new materials.

### 3.28 PUMP STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Check piping connections for tightness.
  - 3. Clean strainers on suction piping.
  - 4. Perform the following startup checks for each pump before starting:
    - a. Verify bearing lubrication.
    - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    - c. Verify that pump is rotating in the correct direction.
  - 5. Prime pump by opening suction valves and closing drains and prepare pump for operation.
  - 6. Start motor.
  - 7. Open discharge valve slowly.

### 3.29 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION

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## SECTION 232300 - REFRIGERANT PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-32:
  - 1. Suction Lines for Air-Conditioning Applications:
  - 2. Suction Lines for Heat-Pump Applications:
  - 3. Hot-Gas and Liquid Lines:
- B. Line Test Pressure for Refrigerant R-454b:
  - 1. Suction Lines for Air-Conditioning Applications:
  - 2. Suction Lines for Heat-Pump Applications:
  - 3. Hot-Gas and Liquid Lines:

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
  - 1. Thermostatic expansion valves.
  - 2. Solenoid valves.
  - 3. Hot-gas bypass valves.
  - 4. Filter dryers.
  - 5. Strainers.
  - 6. Pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: 1/4 inch equals 1 foot.
2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control test reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

#### 1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

#### 1.8 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

#### 1.9 COORDINATION

- A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07, Roof Accessories.

### PART 2 - PRODUCTS

#### 2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:



1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

## 2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; Type, Grade, and wall thickness as selected in Part 3 piping applications articles.
- B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.
- C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.
- D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- E. Flanged Unions:
  1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3. Apply rust-resistant finish at factory.
  2. Gasket: Fiber asbestos free.
  3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
  4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
  5. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
  6. Pressure Rating: Factory test at minimum 400 psig.
  7. Maximum Operating Temperature: 330 deg F.
- F. Flexible Connectors:
  1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
  2. End Connections:
    - a. NPS 2 and Smaller: With threaded-end connections.
    - b. NPS 2-1/2 and Larger: With flanged-end connections.
  3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
  4. Pressure Rating: Factory test at minimum 500 psig.
  5. Maximum Operating Temperature: 250 deg F.

## 2.3 VALVES AND SPECIALTIES

### A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

### B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

### C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

### D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

- E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
  - 1. Body and Bonnet: Plated steel.
  - 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
  - 3. Seat: Polytetrafluoroethylene.
  - 4. End Connections: Threaded.
  - 5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
  - 6. Working Pressure Rating: 400 psig.
  - 7. Maximum Operating Temperature: 240 deg F.
- F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
  - 1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
  - 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
  - 3. Seat Disc: Polytetrafluoroethylene.
  - 4. End Connections: Threaded.
  - 5. Working Pressure Rating: 400 psig.
  - 6. Maximum Operating Temperature: 240 deg F.
- G. Thermostatic Expansion Valves: Comply with ARI 750.
  - 1. Body, Bonnet, and Seal Cap: Forged brass or steel.
  - 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
  - 3. Packing and Gaskets: Non-asbestos.
  - 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
  - 5. Suction Temperature: 40 deg F.
  - 6. Superheat: Adjustable.
  - 7. Reverse-flow option (for heat-pump applications).
  - 8. End Connections: Socket, flare, or threaded union.
  - 9. Working Pressure Rating: 450 psig.
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
  - 1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
  - 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
  - 3. Packing and Gaskets: Non-asbestos.
  - 4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
  - 5. Seat: Polytetrafluoroethylene.
  - 6. Equalizer: Internal.

7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
  8. End Connections: Socket.
  9. Throttling Range: Maximum 5 psig.
  10. Working Pressure Rating: 500 psig.
  11. Maximum Operating Temperature: 240 deg F.
- I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
  2. Screen: 100-mesh stainless steel.
  3. End Connections: Socket or flare.
  4. Working Pressure Rating: 500 psig.
  5. Maximum Operating Temperature: 275 deg F.
- J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
  2. Drain Plug: Brass hex plug.
  3. Screen: 100-mesh monel.
  4. End Connections: Socket or flare.
  5. Working Pressure Rating: 500 psig.
  6. Maximum Operating Temperature: 275 deg F.
- K. Moisture/Liquid Indicators:
1. Body: Forged brass.
  2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
  3. Indicator: Color coded to show moisture content in ppm.
  4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
  5. End Connections: Socket or flare.
  6. Working Pressure Rating: 500 psig.
  7. Maximum Operating Temperature: 240 deg F.
- L. Permanent Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell.
  2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
  3. Desiccant Media: Activated alumina or charcoal.
  4. End Connections: Socket.
  5. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.

6. Maximum Pressure Loss: 2 psig.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 240 deg F.

M. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

N. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

O. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

## 2.4 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.
5. Or approved equal.

B. ASHRAE 34, R-32: Difluoromethane/Difluoromethylene.

C. ASHRAE 34, R-454b: Difluoromethane/2,3,3,3-Tetrafluoropropene

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS FOR REFRIGERANT R-32

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Suction Lines NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- C. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- D. Hot-Gas and Liquid Lines: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- E. Hot-Gas and Liquid Lines:
  - 1. NPS 1 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
  - 2. NPS 1-1/4 to NPS 2: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
  - 3. NPS 4: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.
- F. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.
- G. Safety-Relief-Valve Discharge Piping: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.
- H. Safety-Relief-Valve Discharge Piping:
  - 1. NPS 1 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
  - 2. NPS 1-1/4 to NPS 2: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
  - 3. NPS 4: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

### 3.2 PIPING APPLICATIONS FOR REFRIGERANT R-454B

- A. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.
- B. Hot-Gas and Liquid Lines: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

### 3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Division 23 for instrumentation and control and sequence of operations for HVAC controls for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08, if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Install traps and double risers to entrain oil in vertical runs.
  - 4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- R. Identify refrigerant piping and valves according to Division 23.

- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 for hydronic piping distribution systems.
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 for hydronic piping distribution systems.

### 3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
  - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
- E. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
- G. Welded Joints: Construct joints according to AWS D10.12/D10.12M.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

### 3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 23.
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
  - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:



1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
  2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
  3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
  4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  2. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
  3. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
  4. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
- E. Support multi-floor vertical runs at least at each floor.

### 3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
1. Comply with ASME B31.5, Chapter VI.
  2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
  3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    - a. Fill system with nitrogen to the required test pressure.
    - b. System shall maintain test pressure at the manifold gauge throughout duration of test.
    - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

### 3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

### 3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  1. Open shutoff valves in condenser water circuit.
  2. Verify that compressor oil level is correct.
  3. Open compressor suction and discharge valves.
  4. Open refrigerant valves except bypass valves that are used for other purposes.
  5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

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## SECTION 232500 - HVAC WATER TREATMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following HVAC water-treatment systems:
  - 1. Bypass chemical-feed equipment and controls.
  - 2. Biocide chemical-feed equipment and controls.
  - 3. Chemical treatment test equipment.
  - 4. HVAC water-treatment chemicals.
  - 5. Makeup water softeners.
  - 6. Water filtration units for HVAC makeup water.

#### 1.3 DEFINITIONS

- A. EEPROM: Electrically erasable, programmable read-only memory.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. PPB: Parts per billion.
- D. PPM: Parts per million.
- E. RO: Reverse osmosis.
- F. TDS: Total dissolved solids.
- G. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.
- H. UV: Ultraviolet.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
  - 1. Bypass feeders.
  - 2. Water meters.

3. Inhibitor injection timers.
4. pH controllers.
5. Biocide feeder timers.
6. Chemical solution tanks.
7. Injection pumps.
8. Chemical test equipment.
9. Chemical material safety data sheets.
10. Glycol makeup system.
11. Inhibited ethylene glycol.
12. Inhibited propylene glycol.
13. Water softeners.
14. RO units.
15. Multimedia filters.
16. Centrifugal separators.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Wiring Diagrams: Power and control wiring.

#### 1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

B. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article.
2. Water Analysis: Illustrate water quality available at Project site. At a minimum, measure the following five (5) parameters and document concentration levels.
  - a. Hardness (Ca as  $\text{CaCO}_3$ )
  - b. Total alkalinity
  - c. Silicon Dioxide ( $\text{SiO}_2$ )
  - d. Chloride
  - e. Conductivity

#### 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - 1. Anderson Chemical Co, Inc.
  - 2. Aqua-Chem, Inc.; Cleaver-Brooks Div.
  - 3. Barclay Chemical Co.; Water Management, Inc.
  - 4. Boland Trane Services.
  - 5. Cascade Water Services, Inc.
  - 6. Earthwise Environmental Inc.
  - 7. H-O-H Chemicals, Inc.
  - 8. Metro Group. Inc. (The); Metropolitan Refining Div.
  - 9. Nalco; an Ecolab company.
  - 10. Sonitec-Vortisand Inc.
  - 11. Suez Water Technologies (Formerly GE Water).
  - 12. Watcon, Inc.
  - 13. Or approved equal.

2.2 PERFORMANCE REQUIREMENTS

- A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Coordinate requirements for piping system cleaning with Division 23. Provide recommendation for cleaning and passivation chemicals including dosages needed to provide system cleanliness consistent with recommended final water treatment.

- D. Closed hydronic systems, including hot-water heating and glycol heating/energy recovery, shall meet recommendations of the water treatment provider and shall have the following minimum water qualities:
1. pH: Maintain a value within 7.0 to 9.0.
  2. Scale Control: Provide softened water for initial fill and makeup. Where softened water is not used, provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.
  3. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.
  4. Microbiological Limits:
    - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
    - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
    - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
    - d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
    - e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

## 2.3 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
1. Capacity: 5 gal..
  2. Minimum Working Pressure: 125 psig.

## 2.4 AUTOMATIC CHEMICAL-FEED EQUIPMENT

- A. Water Meter, Turbine Type, Flanged:
1. AWWA C701, turbine-type, totalization meter.
  2. Body: Bronze or Epoxy-coated cast iron.
  3. Minimum Working-Pressure Rating: 150 psig.
  4. Maximum Pressure Loss at Design Flow: 3 psig.
  5. Registration: Gallons or cubic feet.
  6. End Connections: Flanged.
  7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
  8. Provide an electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Division 23. Low-voltage signal must be capable of transmitting 1000 feet (305 m).
- B. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
  2. Molded cover with recess for mounting pump.
  3. Capacity: 50 gal..
- C. Chemical Solution Injection Pumps:
1. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
  2. Adjustable flow rate.
  3. Metal and thermoplastic construction.
  4. Built-in relief valve.
  5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Division 23.
- D. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.
- E. Injection Assembly:
1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
  2. Ball Valve: Two-piece, stainless steel as described in "Stainless-Steel Pipes and Fittings" Article below; and selected to fit quill.
  3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
  4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

## 2.5 STAINLESS-STEEL PIPES AND FITTINGS

- A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.
- B. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.
- C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig SWP and 600-psig CWP ratings.

## 2.6 CHEMICAL TREATMENT TEST EQUIPMENT

- A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.
- B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
1. Two-station rack for closed-loop systems.

## 2.7 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in "Performance Requirements" Article.
- B. Chemicals for direct steam injection humidification and for steam used in direct contact with food to be FDA approved and safe for these uses.

## 2.8 INHIBITED PROPYLENE GLYCOL

### A. Inhibited Propylene Glycol:

- 1. Propylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon-steel, brass, copper, stainless steel, and cast-iron piping and fittings.
- 2. Inhibitor creates a passive layer on all surfaces that contact propylene glycol to prevent corrosion and stabilizes fluid pH, to compensate for acids formed from glycol degradation.
- 3. Operating Temperature Range: minus 50 deg F (minus 46 deg C) to 250 deg F (121 deg F)
- 4. Concentrated inhibited propylene glycol is to be 95.5 percent propylene glycol by weight and 4.5 percent performance additives.
- 5. Concentrated inhibited propylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to minus 20 deg F (minus 29 deg C). Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at the time of installation. Use only deionized water for mixing.
- 6. Provide only propylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

## 2.9 GLYCOL MAKEUP SYSTEM

- A. Glycol makeup system shall be comprised of solution tank, fill pump and accessories and may be provided as separate components and control or may be a packaged system. System shall include the following:
  - 1. Tank and pump base.
  - 2. Polyethylene or steel, minimum 50-gallon storage solution tank with removable lid.
  - 3. Visible solution level gauge with readings in gallons and liters.
  - 4. System fill pump with Y-strainer, isolation valves, silent check valve on pump discharge, open drip proof 115 volt/1 phase/60 Hz motor, motor contactor, balancing valve, expansion tank, discharge pressure gauge.
  - 5. Interconnecting piping.
  - 6. Controls shall include green power indicator light and pressure controls to activate pump on pressure drop below setpoint. Include a red indicator light and alarm contacts to indicate low reservoir level. Include low level cut out sensor and high-level alarm.



7. Capacity 10 gpm at 30 psig.

## 2.10 FILTRATION EQUIPMENT

### A. Multimedia Filters:

1. Description: Factory-fabricated and -tested, simplex, multimedia filter system of filter tank, media, strainer, circulating pump, piping, and controls for removing particles from water.
  - a. Filter Tank: Corrosion resistant with distribution system and media.
    - 1) Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
    - 2) Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
    - 3) Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
    - 4) Steel Tank Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
    - 5) FRP Tank Pipe Connections NPS 2-1/2 and Larger: Type A, integral; Designation E, 125-psig or F, 150-psig pressure category flanges of grade same as tank material according to ASTM D 5421.
  - b. Motorized Valves: Flanged or grooved-end, ductile-iron butterfly type with EPDM valve seat and stem seal; with ASTM B 148 aluminum bronze disc.
  - c. Strainer: Basket type mounted on pump suction.
  - d. Piping: ASTM B 88, Type L copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
  - e. Safety Valves: Automatic pressure relief.
  - f. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.
    - 1) Casing: Radially split, cast iron.
    - 2) Pressure Rating: 125 psig minimum.
    - 3) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
    - 4) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
    - 5) Seal: Mechanical.
    - 6) Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Division 23.
  - g. Controls: Automatic control of circulating pump and tank backwash; factory wired for single electrical connection.
    - 1) Panel: NEMA 250, Type 4 enclosure with time clock and pressure gauges.
    - 2) Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.

- 3) Backwash: Automatic; with time clock and differential pressure switch.
  - 4) Backwash Valve: Tank mounted with valves interlocked to single actuator.
  - h. Support: Skid mounting.
- B. Centrifugal Separators:
- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a. Culligan International.
    - b. Griswold Controls.
    - c. LAKOS; a div. of Claude Laval Corporation.
    - d. PEP Filters, Inc.
    - e. Puroflux Corporation.
    - f. Rosedale Products, Inc.
    - g. Or approved equal.
  - 2. Description: Simplex separator housing with baffles and chambers for removing particles from water by centrifugal action and gravity.
  - 3. Housing: With manufacturer's proprietary system of baffles and chambers.
    - a. Construction: Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
    - b. Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.
    - c. Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.
    - d. Collection Chamber: Designed to hold separated particles.
    - e. Outlet: Near top of unit.
    - f. Purge: At bottom of collection chamber.
    - g. Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
    - h. Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606. Provide stainless-steel flanges if tank is stainless steel.
  - 4. Motorized Purge Valve: Gate or plug pattern valve.
    - a. Motorized Valves: Butterfly-type, flanged or grooved-end, ductile-iron body, with EPDM valve seat and stem seal; with ASTM B 148 aluminum bronze disc.
  - 5. Strainer: Stainless-steel basket type mounted on pump suction.
  - 6. Piping: ASTM B 88, Type L copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
  - 7. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.
    - a. Casing: Radially split, cast iron.

- b. Pressure Rating: 125 psig minimum.
  - c. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
  - d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
  - e. Seal: Mechanical.
  - f. Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Division 23.
  - g. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
8. Controls: Automatic control of circulating pump and separator purge; factory wired for single electrical connection.
- a. Panel: NEMA 250, Type 4 enclosure.
  - b. Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
  - c. Separator Purge: Automatic and manual.
  - d. TDS Controller Interlock: Open separator purge valve with bleed-off control.
9. Support: Skid mounting.

### **PART 3 - EXECUTION**

#### **3.1 WATER ANALYSIS**

- A. Perform an analysis of supply water to determine quality of water available at Project site.

#### **3.2 INSTALLATION**

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install water testing equipment on wall near water chemical application equipment.
- C. Install interconnecting control wiring for chemical treatment controls and sensors.
- D. Mount sensors and injectors in piping circuits.
- E. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, and equipped with the following:
  - 1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
  - 2. Install water meter in makeup water supply.
  - 3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
5. Install a swing check on inlet after the isolation valve.
- F. Install automatic chemical-feed equipment for steam boiler and steam condensate systems and include the following:
  1. Install makeup water softener.
  2. Install water meter in makeup water supply.
  3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
    - a. Pumps shall operate for timed interval when contacts close at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.
  4. Install test equipment and furnish test-kit to Owner.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23.
- D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23.
- E. Refer to Division 22 for backflow preventers required in makeup water connections to potable-water systems.
- F. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
- G. Ground equipment according to Division 26.
- H. Connect wiring according to Division 26.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Tests and Inspections:
  1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
  2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.

3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
  4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
  5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
  7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
  8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- C. Remove and replace malfunctioning units and retest as specified above. Equipment will be considered defective if it does not pass tests and inspections.
- D. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. Sample boiler water at eight-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.
- E. At eight-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.
- F. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
  2. Steam System: ASTM D 1066.
  3. Acidity and Alkalinity: ASTM D 1067.
  4. Iron: ASTM D 1068.
  5. Water Hardness: ASTM D 1126.
- G. Prepare test and inspection reports.
- 3.5 MAINTENANCE SERVICE
- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion, scale formation, and biological growth for heating, hot-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
1. Initial water analysis and HVAC water-treatment recommendations.
  2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.

3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

**3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 01, Demonstration and Training.
- B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

**END OF SECTION**

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## **SECTION 233113 - AIR DISTRIBUTION SYSTEMS-METAL DUCTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

Section Includes:

1. Sheet metal materials.
2. Rectangular ducts and fittings.
3. Round ducts and fittings.
4. Single wall plenums and connections to louvers.
5. Drain Pans
6. Exhaust stacks
7. Duct liner.
8. Sealant and gaskets.
9. Hangers and supports.
10. Backdraft and pressure relief dampers.
11. Barometric relief dampers.
12. Manual volume dampers.
13. Fire dampers.
14. Smoke dampers, combination fire and smoke dampers, corridor ceiling dampers.
15. Flanged breakaway connectors.
16. Duct silencers.
17. Short radius elbow splitter vanes.
18. Remote damper operators.
19. Duct-mounted access doors.
20. Flexible connectors.
21. Flexible ducts.
22. Duct accessory hardware.

- 23. Diffusers, registers and grilles.
- 24. Duct leakage testing and allowable duct leakage rate calculations

Related Sections:

- 25. Division 08 for fixed and adjustable louvers and wall vents whether or not they are connected to ducts.
- 26. Division 28 for duct-mounted fire and smoke detectors not provided as integral option with smoke and fire-smoke dampers.

### 1.3 PERFORMANCE REQUIREMENTS

Delegated Duct Construction Design: Unless noted otherwise duct construction including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with 2005 SMACNA "HVAC Duct Construction Standards - Metal and Flexible" Third Edition, performance and design criteria indicated in "Duct Schedule" Article.

- 1. In addition to the above basic requirements, the following supplemental requirements apply to this project:
  - a. Minimum sheet metal thickness for welded sections of ductwork shall meet the requirements identified in Part 2 of this Section.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in 2016 ASHRAE Standard 62.1 "Ventilation for Acceptable Indoor Air Quality".

#### Structural Support of Air Distribution Systems

- 2. Install ducts with support systems indicated in Tables 5-1 through 5-3 and Figures 5-1 through 5-10 of SMACNA Duct Construction Manual.
  - a. Select hangers and supports to withstand the effects of gravity loads and stresses within limits and under conditions described in Tables 5-1 through 5-3 and Figures 5-1 through 5-10.
  - b. Horizontal duct shall have a support within 2 feet of each elbow and within 4 feet of each branch connection.
  - c. Upper attachments to structure shall have an allowable gravity load of 25 percent of the failure load (proof test).
- 3. Maximum load from hangers attached to the underside of slabs shall be 250 pounds. If these criteria cannot be met due to field identified space or coordination constraints, submit formal request for interpretation (RFI) to structural design professional of record for review and approval before proceeding with the installation.
- 4. Do not drill or cut notches or holes in any structural member without the express written approval of the structural design professional of record.
- 5. Provide core openings. Submit a formal request for interpretation, identifying location of desired cores to the structural design professional of record for guidance and approval.
- 6. Do not attach or suspend MEP components from metal decking.
- 7. Survey location of concrete reinforcement before drilling for anchors in reinforced concrete walls, beams or slabs. Do not cut reinforcing bars during the drilling of anchors without the express written approval of the structural design professional of record.



8. Provide patching of fireproofing removed or damaged during the attachment of suspended MEP components. Provide documentation that the patching maintains the performance of the fire proofing system.
9. For steel frames, maximum load from hangers attached to steel beams shall be 400 pounds. If clamps or other attachments are made to fireproofed beams, remove ample fireproofing at the point of contact to ensure the attachment device is placed with proper edge distance to develop the required pressure ("bite") on the steel. Patch fireproofing after attachment device is in place. Arrange clamps to equally load each side of flange.
10. Ductwork and Support Wind-Restraint Details:
  - a. Design Analysis: To support selection and arrangement of wind restraints based on duct construction and support spacing. Include calculations of combined tensile and shear loads.
  - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during design wind speed. Indicate association with vibration isolation devices.
  - c. Comply with requirements in other Sections for equipment mounted outdoors.
  - d. Wind-Restraint Loading:
    - 1) Basic Wind Speed: 125 MPH.
    - 2) Building Classification Category: III.
    - 3) Minimum 10 lb/sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.

#### 1.4 ACTION SUBMITTALS

Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Adhesives.
4. Diffusers, registers and grilles.
5. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
6. Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
7. Duct silencers, provide pressure drop, dynamic insertion loss data and breakout noise characteristics.

Samples: for the smallest indicated size of each exposed diffuser, register and grille:

8. Each factory applied color finish.
9. Each texture.

Sustainable Design Submittals:

10. Product data showing compliance with 2016 ASHRAE Standard 62.1 "Ventilation for Acceptable Indoor Air Quality" sections identified below.
  - a. Documentation indicating that duct systems comply with Section 5 - "Systems and Equipment."
  - b. Duct-Cleaning Test Report: Documentation of work performed for compliance with Section 7.2.4 - "Ventilation System Start-up."
11. Product Data: Documentation indicating that duct systems comply with 2016 ASHRAE/IES Standard 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings", Section 6.4.4 - "HVAC System Construction and Insulation."
12. Leakage Test Report: Documentation of work performed for compliance with 2016 ASHRAE/IES Standard 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings", Section 6.4.4.2 - "Duct and Plenum Leakage." Leak test reports shall be submitted as a single comprehensive report for a complete system (e.g. supply, return, exhaust) and not as individual section by section reports.
13. Product Data: For adhesives and sealants, documentation including printed statement of VOC content.

Shop Drawings: For air distribution systems - metal ducts:

14. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
15. Factory- and shop-fabricated ducts and fittings.
16. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
17. Elevation of top of ducts.
18. Dimensions of main duct runs from building grid lines.
19. Fittings.
20. Reinforcement and spacing.
21. Seam and joint construction.
22. Penetrations through fire-rated and other partitions.
23. Equipment installation based on approved equipment submittals.
24. Locations for duct accessories, including dampers, full length splitter vanes, access doors and panels.
25. Hangers and supports, including methods for duct and building attachment and vibration isolation.
26. Detail metal duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
  - a. Special fittings.
  - b. Manual volume damper installations.
  - c. Control-damper installations.

- d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
- e. Wiring Diagrams: For power, signal, and control wiring for smoke and fire-smoke dampers.

Delegated-Design Submittal:

- 27. Sheet metal thicknesses.
- 28. Joint and seam construction and sealing.
- 29. Reinforcement details and spacing.
- 30. Materials, fabrication, assembly, and spacing of hangers and supports.
- 31. Design Calculations:
  - a. For each system provide calculation of duct leakage class and allowable duct leakage required to meet specified system leakage in accordance with ASHRAE recommendations.
  - b. Calculations for selecting hangers and supports.

## 1.5 INFORMATIONAL SUBMITTALS

Air Distribution System Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

- 1. Duct installation, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
- 2. Suspended ceiling components.
- 3. Structural members to which duct will be attached.
- 4. Size and location of initial access modules for acoustical tile.
- 5. Penetrations of smoke barriers and fire-rated construction.
- 6. Items penetrating finished ceiling including the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets (diffusers, registers and grilles).
  - c. Speakers.
  - d. Sprinklers.
  - e. Ceiling and duct access panels.
  - f. Perimeter moldings.
  - g. Ceiling suspension assembly members
  - h. Methods of attaching hangers to building structure
  - i. Size and location of initial access modules for acoustical tile.
  - j. Duct accessories requiring ceiling-mounted access panels and access doors with input from Installers of the items involved.

7. Refer to Division 20 for additional coordination drawing requirements.
8. Duct Cleanliness Verification Report.

Welding certificates.

Duct leakage factors and duct leakage fraction calculations based on installed duct sizes and final routing.

Field quality-control reports.

Source quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

Final duct leakage test reports

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

#### 1.8 QUALITY ASSURANCE

Comply with applicable requirements of the following performance standards and agencies as referenced in this section:

1. 2005 SMACNA "HVAC Duct Construction Standards - Metal and Flexible" Third Edition (SMACNA Duct Construction Manual). Comply with requirements only as the chapters, subchapters, sections, appendices, figures and/or tables of the standard are specifically referenced in Articles in this Section.
  - a. Nothing in this Section shall be interpreted to mean SMACNA Duct Construction Manual is adopted in its entirety.
2. 2012 SMACNA "HVAC Air Duct Leakage Test Manual" (SMACNA Leak Test Manual). Comply with requirements only as the chapters, subchapters, sections, appendices, figures and/or tables of the manual are explicitly referenced in the Articles in this Section.
  - a. Nothing in this Section shall be interpreted to mean SMACNA Leak Test Manual is adopted in its entirety.
3. 2002 SMACNA "Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems – 5<sup>th</sup> Edition".
4. 2008 SMACNA "Accepted Industry Practice for Industrial Duct Construction – 2<sup>nd</sup> Edition".
5. 2015 NFPA 90A "Installation of Air Conditioning and Ventilation Systems" (NFPA 90A).
6. 2016 ASHRAE "HVAC Systems and Equipment Handbook" (ASHRAE Systems Handbook).

7. 2015 ASHRAE "HVAC Applications Handbook" (ASHRAE Applications Handbook).
8. 2016 ASHRAE Standard 62.1 "Ventilation for Acceptable Indoor Air Quality" (ASHRAE 62.1).
  - a. Comply with Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up".
9. 2016 ASHRAE/IES Standard 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings" (ASHRAE/IES 90.1).
  - a. Comply with requirements in Section 6.4.4 - "HVAC System Construction and Insulation."
10. 2006 (RA2011) ASHRAE Standard 70 "Method of Testing the Performance of Air Outlets and Air Inlets" (ASHRAE 70).
11. 2013 ASHRAE Standard 113 "Method of Testing for Room Air Diffusion" (ASHRAE 113).
12. 2002 North American Insulation Manufacturers Association, "Fibrous Glass Duct Liner Standard AH124" Third Edition (NAIMA).
13. 2013 National Air Duct Cleaning Association, "Assessment, Cleaning, Restoration of HVAC Systems" (NADCA).

Welding Qualifications: Qualify procedures and personnel according to the following:

14. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
15. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

AMCA Standard 510-D "Laboratory Methods of Testing Dampers for Rating."

American Society of Testing and Materials (ASTM) standards referenced in other Articles of this Section.

Underwriters Laboratory (UL) standards referenced in other Articles of this Section.

Nationally Recognized Testing Labs (NRTL).

Environmental Protection Agency (EPA).

## **PART 2 - PRODUCTS**

### **2.1 AIR DISTRIBUTION SYSTEM GENERAL REQUIREMENTS**

Comply with NFPA 90A.

Only as referenced in this Section, comply with SMACNA Duct Construction Manual requirements for acceptable materials, material thicknesses, duct sealing methods, and duct construction methods unless otherwise indicated in the Articles of this Section or on the Drawings.

1. All metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

## 2.2 SHEETMETAL MATERIALS

Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A653/A653M.

3. Galvanized Coating Designation: G90.
4. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil thick on opposite surface.
5. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304L or 316L, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be as indicated in the "Duct Schedule" Article.

Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

6. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.3 RECTANGULAR DUCTS AND FITTINGS

General Material Thickness Requirements for Rectangular Duct: Unless otherwise indicated in the Articles of this Section or on the drawings, comply with SMACNA Duct Construction Manual, Tables 2-1 through 2-33 inclusive of the associated details and notes as they relate to acceptable material thicknesses based on duct dimension, static pressure class, reinforcement code and reinforcement spacing.

1. Materials shall be as indicated in the Article "Duct Schedule" in Part 3 of this Section.
2. The thicknesses indicated in Tables 2-1 through 2-33 in the SMACNA Duct Construction Manual shall be acceptable for galvanized steel, carbon steel, stainless steel, and PVC coated galvanized steel.
3. If aluminum duct is specified, the thickness of the material shall be adjusted according to Tables 2-50 through 2-52 of the SMACNA Duct Construction Manual.
4. In addition to the basic requirements of SMACNA Duct Construction Manual, minimum sheet metal thickness for welded section of ductwork shall be 16 gauge and minimum metal thickness for welded elbows shall be 14 gauge. All welded duct construction shall be air and liquid tight. Provide SMACNA thickness where duct pressure class requires heavier gauge.

5. Minimum sheet metal thickness, joint construction and supports for fire-wrap insulated ductwork shall comply with fire-wrap NTRL listing requirements. Coordinate requirements with fire-wrap insulation provided.

General Fabrication Requirements: Except as otherwise noted, comply with Sub-Chapter 2.1 "Introduction to the Rectangular Duct Construction Schedules" of the SMACNA Duct Construction Manual.

6. Coordinate duct wall thickness, seams, joints, joint spacing, support intervals, sealing requirements, reinforcement code, and reinforcement spacing based on the static pressure class, duct material, and duct dimensions indicated in the design documents.
7. Joints and seams shall be formed and assembled with dimensions and proportions for a tight and secure assembly.

Transverse Joints (Non-Welded):

8. For pressure class less than 3 inches of water column, select and fabricate joint types according to Figure 2.1, Tables 2-31 through 2-33 and Sub-Chapter 2.4 (except reference to Chapter 11) of the SMACNA Duct Construction Manual.
9. For pressure classes 3 inches of water column and greater, mechanical joints shall be pre-manufactured joint systems.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
    - 1) Ductmate Industries, Inc.
    - 2) Ward Industries.
    - 3) Dyn Air - Nexus Flange System.
    - 4) Or approved equal.

Longitudinal Seams (Non-Welded):

10. For duct pressure class of 2 inches water column or less, select seam type and fabricate according to Figure 2.2 and Sub-Chapter 2.3 of the SMACNA Duct Construction Manual.
11. For duct pressure classes 3 inches water column or greater provide Type L-1 Pittsburgh Lock seams fabricated according to Figure 2.2 of the SMACNA Duct Construction Manual.

Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Unless otherwise indicated, select types and fabricate according to Figures 4.2 through 4.9 and Chart 4.1 of the SMACNA Duct Construction Manual.

12. Provide only the SMACNA fittings described in Part 3 of this specification, without substitution, as these fittings are the basis of design used to calculate system static pressure losses and motor horsepower requirements. Substitutions from indicated fittings will not be accepted.
13. The following fittings, shown in Figures 4.2 through 4.9 and Chart 4.1 of the SMACNA Duct Construction Manual noted above, shall NOT be used.
  - a. Figure 4-2
    - 1) Type RE-2, RE-4, RE-7, RE-9 and R-10 elbows shall not be used.

- b. Figure 4-3
  - 1) Turning vanes are not acceptable.
- c. Figure 4-4
  - 1) Turning vanes are not acceptable.
- d. Figure 4-5
  - 1) Type 2 is not acceptable.
  - 2) Optional square throat with turning vanes shown for Type 4A and 4B branch connections are not acceptable.
- e. Figure 4-6
  - 1) Straight tap, butt flange or cinch-lick branch connections are not acceptable.
  - 2) Flanged or spin-in round connections without a bell-mouth or conical form are not acceptable.
- f. Figure 4-8
  - 1) Figure D is not acceptable. Figure B is preferable, however, if an offset of this type (I.E. four 90 degree elbows) is needed, use type RE-3 or RE-8 elbows and short radius elbows with full length splitter vanes in accordance with Chart 4-1 and Figure 4-9.

## 2.4 ROUND DUCTS AND FITTINGS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

- 1. Ductmate Industries, Inc.
- 2. Linx Industries (formerly Lindab).
- 3. McGill AirFlow LLC.
- 4. SEMCO LLC.
- 5. Or approved equal.

General Material Thickness Requirements for Round and Flat Oval Duct: Unless otherwise indicated in the Articles of this Section or the drawings, comply with SMACNA Duct Construction Manual, Tables 3-4 through 3-13 for round and table 3-15 for flat oval duct inclusive of the associated details and notes as they relate to acceptable material thickness based on duct dimension, static pressure class, reinforcement class and stiffener spacing.

- 1. Materials shall be as indicated in the Article “Duct Schedule” in Part 3 of this Section.
- 2. The thicknesses indicated in Tables 3-4 through 3-13 for round and Table 3-15 for flat oval duct in the SMACNA Duct Construction Manual shall be acceptable for galvanized steel, carbon steel, stainless steel, and PVC coated galvanized steel.
- 3. If aluminum duct is specified, the thickness of the material shall be adjusted according to Table 3-14 of the SMACNA Duct Construction Manual.

General Fabrication Requirements: Except as otherwise noted in the Articles of this Section or the Drawings, round duct fabrication shall comply with Sub-Chapter 3.1 (excluding sections S3.0, S3.3, S3.4, S3.5, S3.9 and S3.10) and flat oval duct shall comply with Sub-Chapter 3.3



(the reference to Chapter 11 in section S3.17 applies only as referenced and for the purposes of the requirements of section S3.17 in Sub-Chapter 3.3) of the SMACNA Duct Construction Manual.

1. Duct wall thickness, seams, joints, joint spacing, stiffener spacing, support intervals, sealing requirements and reinforcement class shall be coordinated by the Contractor, based on the static pressure class, duct material, and duct dimensions indicated in the design documents, to ensure a proper assembly.
2. Joints and seams shall be formed and assembled with proper dimensions and proportions for a tight and secure assembly.

Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

Transverse Joints: Select and fabricate according to Figure 3.1 of the SMACNA Duct Construction Manual with the exception that draw-band joints and crimp type joints (RT-3 and RT-5 respectively) are not permitted.

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

Longitudinal Seams: Select and fabricate seam types shown Figure 3-2 of the SMACNA Duct Construction Manual.

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

Tees and Laterals: Unless otherwise noted, select types and fabricate according to Figures 3-5 and 3-6 for round duct and Figure 3-7 for flat oval duct of the SMACNA Duct Construction Manual.

1. The following Tees and Laterals shown in Figures 3.5 through 3.7 shall not be used
  - a. Figure 3-5
    - 1) 90 degree tee fitting
    - 2) 90 degree tap
    - 3) 90 degree saddle fitting
    - 4) Rectangular tap straight

## **2.5 SINGLE WALL PLENUMS AND CONNECTIONS TO LOUVERS**

General Fabrication Requirements: Plenums shall be constructed as an insulated single wall casing in accordance with SMACNA Duct Construction Manual, Chapter 9, Equipment and Casings. Insulation shall be applied to the room side of the plenum and shall have a minimum insulation value specified in Division 23 HVAC insulation Section.

Minimum Wall Material: 18 gauge galvanized, solid sheet.

Corner seams and where applicable bottom seams shall be soldered watertight at least 12" up from bottom.

Plenums shall have neoprene gaskets or other corrosion resistant material to make connections to louvers or to base curbs watertight.

For elevated plenum, pitch floor down in direction of louver. Provide 2" half-coupling drain connection at floor of plenum unless noted otherwise. Pipe connection to nearest floor drain.

For plenums 36 inches deep and 80 inches high or larger, provide access 30" wide x 72" high access doors in accordance with SMACNA Duct Construction Manual, Chapter 9, Equipment and Casings. Provide continuous piano hinge. Latches shall be operable from both sides of door. For smaller plenums, provide double wall access door with dimensions 6 inches smaller than the plenum depth and height. Doors shall open against system pressure.

## 2.6 CLOTHES DRYER EXHAUST

Domestic clothes dryer exhaust:

1. Duct shall be constructed in compliance with SMACNA duct construction standard and shall be G90 galvanized steel material, minimum 26 gauge with smooth interior finish.
2. Exhaust duct size shall be in accordance with the manufacturer installation instructions for the specific duct equivalent length, minimum of 4 inches nominal diameter. Do not deform ducts where enclosed in a wall or ceiling cavity.
3. Transition ducts used to connect dryer to exhaust duct system shall be listed and labelled in accordance with UL 2158A. Maximum length of transition duct shall be 8 feet.

## 2.7 DRAIN PANS

General Fabrication Requirements: Drain pans, including their outlets and seals, shall be designed and constructed in accordance with this section and ASHRAE 62.1-2019.

Drain pans shall be aluminum or 304L stainless steel construction. Pans shall be seamless construction or joints soldered or welded liquid tight. Minimum depth shall be 2 inches.

Drain Pan Slope. Pans shall be sloped at least 0.125 in./ft (10 mm/m) from the horizontal toward the drain outlet such that water drains freely from the pan whether the fan is ON or OFF.

Drain Outlet. The drain pan outlet shall be located at the lowest point(s) of the drain pan.

1. Drain pan outlet shall be as follows:

Drain Line Size (inches)	Approximate Equivalent Unit Cooling Coil Airflow (cfm)	Approximate Cooling Capacity for Unit Cooling Coil (tons)
0.75	1,500	15
1	3,850	35
1.25	6,900	65

2. Steam humidifier drain pan outlet shall be 0.75 inches.

Drain Seal. For configurations that result in negative static pressure at the drain pan relative to the drain outlet (such as a draw-through unit), the drain line shall include a P-trap or other sealing device designed to maintain a seal against ingestion of ambient air, while allowing complete drainage of the drain pan under any normally expected operating condition, whether the fan is ON or OFF.

Pan Size. The drain pan shall be located under the water producing device. Drain pan width shall be sized to collect water droplets across the entire width of the water producing device or assembly.

3. For horizontal airflow configurations, cooling coil drain pan length shall begin at the leading face or edge of the water producing device or assembly and extend downstream from the leaving face or edge to a distance of either:
  - a. one half of the installed vertical dimension of the water producing device or assembly or
  - b. as necessary to limit water droplet carryover beyond the drain pan to 0.0044 oz/ft<sup>2</sup> (1.5 mL/m<sup>2</sup>) of face area per hour under peak sensible and peak dew-point design conditions, accounting for both latent load and coil face velocity.
4. Secondary (supplemental) drain pans for terminal units shall extend the full width of unit and shall extend under the cooling coil and 1 foot beyond the main drain pan pipe connection.
5. Duct mounted steam humidifiers shall be installed in an aluminum or 304L stainless steel section of ductwork with the bottom 2 inches of the duct section seamless or welded liquid tight. Humidifier drain pan section shall be 8 feet minimum and shall extend from 2 feet upstream of the humidifier to 3 feet downstream of the provided humidifier dispersion distance.

## 2.8 EXHAUST STACKS

Exhaust stacks shall be all welded minimum 16 gauge 304L stainless steel and shall be air and liquid tight. Stacks shall be factory or shop fabricated and shall be vertically self-supporting. Stacks shall withstand maximum code required design wind speed identified on the structural drawings.

1. Factory Fabricated Exhaust Stacks:
  - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - 1) Van Packer.
    - 2) Warren Environment, Inc.
    - 3) Or approved equal.
  - b. Provide factory fabricated exhaust stacks supported at the base only without use of guy wires.
    - 1) Construct free standing exhaust stacks in accordance with the "Guide for Free Standing Stack Construction – 3rd Edition 2011" manual issued by the Sheetmetal and Air Conditioning Contractors' National Association (SMACNA).

Provide 2 inch stainless steel threaded drain connection at base of each stack. Provide interior sloped drain baffle for positive drainage. Minimum slope shall be 0.125 inch per foot from horizontal in accordance with ASHRAE 62.1 for drain pans.

Provide mounting flanges at the base of each stack to allow attachment to structure or housekeeping pads. Design of stacks shall be based on a free standing stack from the mounting base to the top of stack and shall be based on the code mandated wind velocities indicated on the structural drawings.

All bracing shall be external to stacks (internal bracing will be allowed for shipping and erection as long as it is removed after erection).

Provide stainless steel exhaust stack sections in maximum lengths allowed by structural design to minimize seams. Maximize vertical distance between stiffeners as allowed by structural design. Vertical dimension between stiffeners and at top and bottom of stack shall be equal.

All welds to be ground and polished to match surrounding material.

Prior to shipment remove any inconsistencies, burn marks, slag, or other byproduct of the welding process to ensure a uniform material appearance.

All external stiffeners to be fabricated of material to match exhaust stack material. All stacks, stiffeners, copings, or other visible appurtenances both inside and outside the building shall be No. 3 finish.

## 2.9 DUCT LINER

Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - a. CertainTeed Corporation.
  - b. Johns Manville; a Berkshire Hathaway company.
  - c. Knauf Insulation.
  - d. Owens Corning.
  - e. Or approved equal.
2. Maximum Thermal Conductivity:
  - a. Type I, Flexible: 0.27 Btu x in./h / sf / deg F at 75 deg F mean temperature.
  - b. Type II, Rigid: 0.23 Btu x in./h /sf / deg F at 75 deg F mean temperature.
3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
4. Water-Based Liner Adhesive: Comply with NFPA 90A and with ASTM C 916.
  - a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A.

5. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - a. Aeroflex USA, Inc.
  - b. Armacell LLC.

- c. K-Flex USA.
  - d. Rubatex International, LLC.
  - e. Or approved equal.
- 6. Maximum Thermal Conductivity: 0.25 Btu x in./h x sf x deg F (0.034 W/m x K) at 75 deg F (24 deg C) mean temperature.
  - 7. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
  - 8. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A.
    - a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

Insulation Pins and Washers:

- 9. Cupped-Head: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
- 10. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel, aluminum or stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

Shop Application of Duct Liner: Comply with SMACNA Duct Construction Manual, Figure 7-11, "Flexible Duct Liner Installation".

- 11. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
- 12. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
- 13. Butt transverse joints without gaps, and coat joint with adhesive.
- 14. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
- 15. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
- 16. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
- 17. Secure transversely oriented liner edges facing the airstream with metal nosing that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  - a. Fan discharges.
  - b. Intervals of lined duct preceding unlined duct.
- 18. Terminate inner ducts with build-outs attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build-outs (metal hat sections) or other

build-out means are optional; when used, secure build-outs to duct walls with bolts, screws, rivets, or welds.

## 2.10 SEALANT AND GASKETS

General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

Water-Based Joint and Seam Sealant For Duct Air Temperatures Above 0 deg F:

11. Application Method: Brush on.
12. Solids Content: Minimum 65 percent.
13. Shore A Hardness: Minimum 20.
14. Water resistant.
15. Mold and mildew resistant.
16. VOC: Maximum 75 g/L (less water).
17. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
18. Service: Indoor or outdoor.
19. Service Temperature: 0 to plus 200 deg F.
20. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
21. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

22. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
23. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
24. Service: Indoor or outdoor.
25. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

Solvent-Based Joint and Seam Sealant For Duct Air Temperatures Below 0 deg F (e.g. outside air ductwork in cold climates):

26. Application Method: Brush on.
27. Base: Synthetic rubber resin.
28. Solvent: Toluene and heptane.
29. Solids Content: Minimum 60 percent.
30. Shore A Hardness: Minimum 60.
31. Water resistant.
32. Mold and mildew resistant.
33. Sealant shall have a VOC content of 420 g/L or less.
34. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
35. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
36. Service: Indoor or outdoor.
37. Service Temperature: Minus 20 to plus 200 deg F.
38. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

Flanged Joint Sealant: Comply with ASTM C 920.

39. General: Single-component, acid-curing, silicone, elastomeric.
40. Type: S.
41. Grade: NS.
42. Class: 25.
43. Use: O.
44. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

Round Duct Joint O-Ring Seals:

45. Seal shall provide maximum leakage class of 3 cfm/100 sf at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
46. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
47. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.11 HANGERS AND SUPPORTS

Hanger Rods for Corrosive Environments, including natatorium and natatorium support spaces: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

Hanger Rods for Non-corrosive Environments: Cadmium-plated steel rods and nuts.

Strap and Rod Sizes: Comply with SMACNA Duct Construction Manual, Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

Outdoor Ductwork Supports: Coordinate connections to structure and base supports with project roofing construction. Ductwork supports shall be hot-dipped galvanized, wind load rated, shall prevent uplift and shall comply with one of the following:

4. Provide outdoor ductwork supports in accordance with SMACNA Figure 6-3 "Rooftop Duct installation" and Figure 6-4 "Equipment and Duct Support Flashing" when supported by curbs or posts. Flashed into the roofing system when roof mounted.
5. Provide pre-engineered outdoor duct support system when supported by curbs, posts or weight distributing pads or bases. Flash curbs or posts into the roofing system or provide wind load rated weight distributing pads or bases on top of the roofing system where roof mounted:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
    - 1) Unistrut Service Company - HVAC Duct Supports.
    - 2) Kinetics Noise Control.
    - 3) PHP System Design.
    - 4) Or approved equal.



## 2.12 BACKDRAFT AND PRESSURE RELIEF DAMPERS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

1. American Warming and Ventilating.
2. Greenheck Fan Corporation.
3. Nailor Industries, Inc.
4. Ruskin Company.
5. Vent Products Company, Inc.
6. Or approved equal.

Description: Commercial grade, gravity balanced.

Maximum Air Velocity:

7. For duct systems that do not include air volume control terminals and ductwork between room inlets or outlets and associated air volume terminals, provide backdraft damper with a minimum velocity rating of 1250 fpm.
8. For ductwork between air volume control terminals and equipment (e.g. fan or air handling unit) provide backdraft damper with a minimum velocity rating of 2000 fpm.
9. For fan inlets or outlets provide backdraft damper with a minimum velocity rating of 3000 fpm.

Maximum System Back Pressure:

10. Backdraft Dampers
  - a. For duct systems that do not include air volume control terminals and ductwork between room inlets or outlets and associated air volume terminals, provide backdraft damper with a maximum system backpressure rating of 2 inch water column (0.5 kPa).
  - b. For ductwork between air volume control terminals and equipment (e.g. fan or air handling unit) and for fan inlets or outlets provide backdraft damper with a maximum system backpressure rating of 10 inch water column (2.5 kPa).
11. Pressure Relief Dampers
  - a. For pressure relief dampers with a setpoint of 0.1 to 2 inches water column, dampers shall be rated for a maximum backpressure of 8.5 inches water column.
  - b. For pressure relief dampers with a setpoint of 2.1 to 4 inches water column, dampers shall be rated for a maximum backpressure of 13.5 inches water column.
  - c. For pressure relief dampers with a setpoint of 4.1 to 6 inches water column, dampers shall be rated for a maximum backpressure of 20 inches water column.

Backdraft Damper Maximum Start-Open Pressure:

12. For duct systems that do not include air volume control terminals and ductwork between room inlets or outlets and associated air volume terminals, provide backdraft damper with a maximum start open pressure of 0.05 inch water column when installed vertically and when installed horizontally with upward airflow. Provide damper with 0.075 inch water

column maximum start-open pressure for dampers mounted horizontally with downward airflow.

13. For ductwork between air volume control terminals and equipment (e.g. fan or air handling unit) and for fan inlets or outlets provide backdraft damper with a maximum start open pressure of 0.05 inch water column when installed vertically and when installed horizontally with upward airflow. Provide damper with 0.075 inch water column maximum start-open pressure for dampers mounted horizontally with downward airflow.

Maximum Leakage Rate:

14. Exhaust and relief applications in buildings with fewer than 3 stories only: 20 cfm per square foot at 1 inch water column.
15. Outside air applications in ASHRAE 90.1 Climate Zones 1, 2 and 3 only: 20 cfm per square foot at 1 inch water column.
16. Provide motorized control dampers in all other applications.

Frame: Manufacturer standard shape, minimum 0.05-inch- thick (18 gauge), galvanized sheet steel, minimum 0.063-inch- thick extruded aluminum (14 gauge) or minimum 0.05-inch- thick stainless steel (18 gauge), with welded corners or mechanically attached and mounting flange. Material to match associated duct material.

Blades: Multiple single-piece blades, center pivoted or end pivoted, maximum 6-inch width, minimum 0.03-inch- thick, roll-formed aluminum with sealed edges. Orientation of blades for backdraft dampers located on fan discharge shall be selected to minimize system effect pressure drop.

Blade Action: Parallel.

Blade Seals: Extruded vinyl, mechanically locked or neoprene, mechanically locked.

Blade Axles:

17. Material: Nonferrous metal, galvanized steel, plated steel, stainless steel or aluminum and shall be compatible with blade material and frame material.
18. Diameter: Minimum 0.20 inch.

Tie Bars and Brackets: Aluminum or galvanized steel and shall be compatible with blade and frame material.

Return Spring: Adjustable tension.

Bearings: Steel ball or synthetic pivot bushings.

Accessories:

19. Provide adjustment device to permit setting of varying differential static pressure.
20. Provide counterweights or spring-assist to assist in opening damper blades.
21. 90-degree stops.

## **2.13 BAROMETRIC RELIEF DAMPERS**

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

1. American Warming and Ventilating.

2. Greenheck Fan Corporation.
3. Nailor Industries, Inc.
4. Ruskin Company.
5. Vent Products Company, Inc.
6. Or approved equal.

Suitable for horizontal or vertical mounting.

Maximum Air Velocity: Provide barometric relief damper with velocity rating of 2000 fpm.

Maximum System Back-Pressure: Provide barometric relief damper with a maximum back pressure of 2 inch water column (0.5 kPa).

Maximum Start-Open Pressure: Provide barometric relief damper with a maximum start-open pressure of 0.05 inch water column (0.01 kPa) adjustable to 0.10 inch water column (0.02 kPa).

Maximum Leakage Rate:

7. Exhaust and relief applications in buildings with fewer than 3 stories only: 20 cfm per square foot at 1 inch water column.
8. Outside air applications in ASHRAE 90.1 Climate Zones 1, 2 and 3 only: 20 cfm per square foot at 1 inch water column.
9. Provide motorized control dampers in all other applications.

Frame: Manufacturer standard shape, minimum 0.05-inch- thick (18 gauge), galvanized sheet steel, minimum 0.063-inch- thick extruded aluminum or minimum 0.03-inch- thick stainless steel as recommended by the manufacturer for the specific application, with welded corners or mechanically attached and mounting flange. Material to match associated duct material.

Blades:

10. Multiple, minimum 0.050-inch- thick aluminum sheet.
11. Maximum Width: 6 inches.
12. Action: Parallel.
13. Balance: Gravity.
14. End pivoted.

Blade Seals: Vinyl or Neoprene.

Jamb Seals: EPDM.

Blade Axles: Galvanized steel, non-ferrous metal, plated steel or stainless steel compatible with blade material.

Tie Bars and Brackets:

15. Material: Aluminum or galvanized steel and shall be compatible with blade material
16. Rattle free with 90-degree stop.

Bearings: Stainless steel.

Counterbalance: Blade mounted with adjustable weights.

2.14 MANUAL VOLUME DAMPERS

Standard, Steel, Manual Volume Dampers: Dampers shall be shop or factory fabricated.

1. Shop Fabricated Volume Dampers:
  - a. Dampers shall meet the requirements of SMACNA Duct Construction Manual Section 7.1.
2. Factory Fabricated Volume Dampers:
  - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - 1) American Warming and Ventilating; a Mestek Architectural Group company.
    - 2) Flexmaster U.S.A., Inc.
    - 3) Greenheck Fan Corporation.
    - 4) McGill AirFlow LLC.
    - 5) Nailor Industries Inc.
    - 6) Ruskin Company.
    - 7) Trox USA Inc.
    - 8) Vent Products Co., Inc.
    - 9) Or approved equal.
3. Provide dampers that meet the following requirements:
  - a. Standard leakage rating, with linkage outside airstream.
  - b. Minimum differential pressure rating: 1 inch water column.
  - c. Minimum velocity rating: 2000 fpm.
  - d. Suitable for horizontal or vertical applications.
  - e. Frames:
    - 1) Frame: Manufacturer standard shape, minimum 0.0396-inch thick, galvanized sheet steel or stainless steel. Material shall match connecting duct materials.
    - 2) Corners shall be mitered, welded or shall be provided with gusset reinforcements.
    - 3) Flanges for attaching to walls or flanged ductwork. For other application provide flangeless frames for installing in ducts.
  - f. Blades:
    - 1) Multiple or single blade.
    - 2) Opposed-blade design for multiple blade dampers.
    - 3) Stiffen damper blades for stability.

- 4) Galvanized or stainless-steel, minimum 0.0635-inch thick. Material shall match connecting duct materials
- g. Blade Axles: Galvanized steel, plated steel or stainless steel.
- h. Bearings:
  - 1) Oil-impregnated bronze or oil-impregnated stainless-steel sleeve.
- i. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axle length that matches full length of damper blades and bearings at both ends of operating shaft.
- j. Tie Bars and Brackets: Galvanized steel.
- k. Provide with locking quadrant arm and standoff bracket. For ductwork requiring Seal Class A, provide sealed end bearing and regulator arms assembly to prevent leakage through the shaft core.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a) Ventfabrics - Ventlok HIVEL.
    - b) DuroDyne.
    - c) Or approved equal.
  - 2) Air tight regulator arm.
    - a) For solid core shafts, where the damper shaft penetration of duct is not air tight, provide a shaft seal assembly similar to a Ventlok Model 617 air seal.

Standard, Aluminum, Manual Volume Dampers:

- 4. Dampers shall meet the requirements of SMACNA Duct Construction Manual Section 7.1 and shall meet the following requirements.
  - a. Standard leakage rating, with linkage outside airstream.
  - b. Minimum differential pressure rating: 1 inch water column.
  - c. Minimum velocity rating: 2000 fpm.
  - d. Suitable for horizontal or vertical applications.
  - e. Frames: Hat-shaped, minimum 0.10-inch thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
  - f. Blades:
    - 1) Multiple or single blade.
    - 2) Parallel- or opposed-blade design.
    - 3) Stiffen damper blades for stability.
    - 4) Roll-formed aluminum blades: minimum 0.10-inch thick sheet or extruded-aluminum blades: minimum 0.050-inch thick sheet.
  - g. Blade Axles: Galvanized steel or stainless steel.

- h. Bearings: Oil-impregnated bronze or stainless-steel sleeve.
- i. Dampers in ducts with pressure classes of 3-inch wg or less shall have axle length that matches full length of damper blades and bearings at both ends of operating shaft.
- j. Tie Bars and Brackets: Aluminum.
- k. Provide with locking quadrant arm and standoff bracket. For ductwork requiring Seal Class A, provide sealed end bearing and regulator arm assembly to prevent leakage through the shaft core.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
    - a) Ventfabrics - Ventlok HIVEL.
    - b) DuroDyne.
    - c) Or approved equal.
  - 2) Air tight regulator arm.
    - a) For solid core shafts, where the damper shaft penetration of duct is not air tight, provide a shaft seal assembly similar to a Ventlok Model 617 air seal.

## **2.15 AIRFLOW REGULATING DEVICE - SELF-CONTAINED**

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

- 1. Aldes - Constant Airflow Regulator.
- 2. Greenheck - Automatic Balancing Damper.
- 3. Ruskin - Automatic Balancing Damper.
- 4. Young Regulator Company - Constant Volume Regulator.
- 5. Or approved equal.

Provide airflow regulating device that meet the following requirements:

- 6. Self-contained regulator shall maintain constant supply, return and exhaust airflow within plus/minus 10 percent of design document airflow rate without external power or sensors.
  - a. Airflow setpoint shall be manually field adjustable.
- 7. Operating Pressure Range: 0.2 to 0.8 inches water column.
- 8. Temperature Rating: 25 to 140 degrees F.
- 9. Regulating device shall be UL listed for flame and smoke spread.
- 10. Material: Thermoplastic resin or ABS plastic. Include gasket seal at joints.

## **2.16 FIRE DAMPERS**

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

1. American Warming and Ventilating; a Mestek Architectural Group company.
2. Arrow United Industries.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Pottorff.
6. Prefco.
7. Ruskin Company.
8. Vent Products Co., Inc.
9. Or approved equal.

Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

Closing rating in ducts up to 4-inch wg static pressure class (differential pressure) and minimum 2000-fpm velocity.

Fire Rating: 1-1/2 hour rated damper for walls rated for less than 3 hours and 3 hour rated damper for walls with higher fire rating. Refer to architectural drawings for wall fire ratings.

Frame: For duct mounted dampers provide curtain type with blades outside air stream or multiple opposed blade type with blades in air stream. For dampers located behind grilles curtain type dampers, blades inside airstream are acceptable. Fabricate with hat channel of galvanized steel or stainless steel to match duct material with thickness (gage) required by the damper U.L. listing.

10. Curtain type fire dampers shall be Case 2 or 3 with blades out of airstream Type "B or C" as defined in SMACNA "Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems – 5<sup>th</sup> Edition" pages 5.8, 5.11, and 7.2.
11. Where duct dimensions require multiple damper sections, provide curtain type identified above with dampers arranged out of airstream (limited to two stacked dampers with blades on perimeter) or provide multiple opposed blade type dampers.

Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

12. Minimum Thickness: Thickness (gage) required by the damper U.L. listing.
13. Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame shall comply with sleeve requirements.

Provide breakaway connections at all fire dampers. Seal all breakaway connections with manufacturer UL approved sealant to prevent air leakage.

Mounting Orientation: Vertical and horizontal - refer to plans for orientation. Confirm orientation based on approved coordination drawings.

Blades: Roll-formed, galvanized or stainless steel sheet steel to match duct construction in thickness required by damper U.L. listing. Blades shall be one of the following:

14. Interlocking blade, or
15. Constructed with full-length blade connectors matching blade material.

Horizontal Dampers: Include blade lock and stainless-steel closure spring where required by manufacturer UL listing.

Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

**2.17 SMOKE DAMPERS, COMBINATION FIRE-SMOKE DAMPERS, CORRIDOR (CEILING) DAMPERS**

Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

1. American Warming and Ventilating; a Mestek Architectural Group company.
2. Cesco Products; a division of MESTEK, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Pottorff.
6. Ruskin Company.
7. Or approved equal.

General Requirements:

1. Combination Fire-Smoke Damper Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
2. Smoke Damper: rated and labeled according to UL 555S by an NRTL.

Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

Fire-Smoke Damper Fire Rating: 1-1/2 hour rated damper for walls rated for less than 3 hours and 3 hour rated damper for walls with higher fire rating. Refer to architectural drawings for wall fire ratings.

Heat-Responsive Device: Resettable, 165 deg F rated, fire-closure device or electric fuse link.

1. Smoke Detector: provided by Division 28.
  - a. Smoke detector shall be no-flow rated.

Frame: Fabricate with hat channel of galvanized steel or stainless steel to match duct material with thickness (gage) required by the damper U.L. listing. Frame shall have welded, interlocking gusseted or reinforced mechanically attached corners and mounting flange.

Mounting Sleeve: Factory-installed, galvanized sheet steel in thickness required by the damper U.L. listing; length to suit wall or floor application with factory-furnished silicone calking.

Blades: Roll-formed galvanized sheet steel or extruded aluminum in thickness (gage) required by the damper U.L. listing.

Leakage: Class I.

Mounting Sleeve: Factory-installed, galvanized sheet steel in thickness required by the damper U.L. listing; length to suit wall or floor application with factory-furnished silicone calking.

Master control panel for use in dynamic smoke-management systems.

Damper Actuators: Provide two-position action unless modulating type action is indicated otherwise on the drawings.



1. Actuators shall be provided by and factory mounted by the damper manufacturer in accordance with the damper U.L Listing.
2. Actuators shall be electric unless noted otherwise.
3. Electrical Connection: 115 V, single phase, 60 Hz.

Accessories:

4. Auxiliary switches for position indication. Provide additional switches for signaling and fan control where indicated on drawings.
5. Test and reset switches with red (closed) and green (open) LED indicator lights, remote mounted.

## **2.18 FLANGED BREAKAWAY CONNECTORS**

Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

1. Ductmate Industries, Inc.
2. Hardcast, Inc.
3. Nexus PDQ.
4. Ward Industries; a brand of Hart & Cooley, Inc.
5. Or approved equal.

Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

Material: Galvanized steel.

Gage and Shape: Match connecting ductwork.

Seal all breakaway connections with manufacturer UL approved sealant to prevent air leakage.

## **2.19 SOUND ATTENUATORS (SILENCERS) FOR AIR DISTRIBUTION SYSTEMS**

Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

1. Price Industries.
2. Vibro-Acoustics.
3. VAW Systems, LTD.
4. Or approved equal.

General:

1. Factory fabricated.
2. Media-filled silencers

- a. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E84.
- b. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1 Section 5.4 "Airstream Surfaces."

Shapes indicated on the drawings (e.g. linear, elbow, round).

Outer Casing Material Shall Match Attached Ductwork:

3. ASTM A653/A653M, G90, galvanized sheet steel,

Inner Casing and Baffle Material Shall Match Outer Casing Material:

4. ASTM A653/A653M, G90 galvanized sheet metal, thickness and perforations as determined by the manufacturer to meet the specified performance.

Special Construction:

5. Suitable for outdoor use where indicated on drawings.

Connection Sizes: Match connecting ductwork or fans unless otherwise indicated.

6. For axial fans, silencers shall be tubular with center cone consisting of a shell with fill material.

Principal Sound-Absorbing Mechanism:

7. Media-filled Silencers
  - a. Film-lined type with fill material.
    - 1) Fill Material: Inert and vermin-proof fibrous material.
    - 2) Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
    - 3) Lining: Mylar, Tedlar or Foil Lined meeting flame and smoke spread fire performance requirements.

Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

8. Joints: Lock formed and sealed, continuously welded or flanged connections to match connected ductwork.
9. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
10. Reinforcement: Cross or trapeze angles for rigid suspension.

Accessories:

11. Factory-installed end caps to prevent contamination during shipping.

Source Quality Control: Performance shall be verified according to ASTM E477-13 verified in an NVLAP accredited laboratory.

12. Selections shall be made based on published acoustic ratings, including dynamic insertion loss and self-generated-noise power levels with minimum airflow face velocity matching schedule. Performance data shall be provided with airflow in same direction as attenuation for supply ducts and in opposite direction of airflow for return or exhaust

systems. Attenuation shall not be less than the scheduled performance in each octave band.

13. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

## 2.20 SHORT RADIUS ELBOW SPLITTER VANES (FULL LENGTH SPLITTER VANES)

Provide short radius (full length splitter) vanes for elbows with a centerline radius less than 1.5 times the duct width in the plane of the elbow.

1. Comply with SMACNA Duct Construction Manual; Chart 4-1 and Figure 4-2 (Type RE-3) elbows for spacing of vanes and figure 4-9 for construction of short radius full length splitter vanes. Refer to detail on drawings for quantity of full length splitter vanes required based on ratio of centerline to duct width dimensions.

## 2.21 REMOTE DAMPER OPERATORS

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

1. Pottorff.
2. Ventfabrics, Inc.
3. Young Regulator Company.
4. Or approved equal.

Description: Cable system designed for remote manual damper adjustment.

Cable: Sheathed stainless steel.

Rack and Pinion Controller:

1. Controller with embedded sheetrock ceiling or wall cup.
  - a. Cup Mounting: Recessed unless noted otherwise.
  - b. Cup Cover-Plate Material: Stainless steel.

## 2.22 DUCT-MOUNTED ACCESS DOORS

Duct Mounted Sandwich (Clamp) Type Access Doors – Ductwork and Plena Greater Than 2 inch Pressure Class.

1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - a. Aire Technologies.
  - b. Ductmate Industries, Inc.
  - c. Nailor Industries Inc.
  - d. Ward Industries; a brand of Hart & Cooley, Inc.
  - e. Or approved equal.

2. Duct-Mounted Access Doors: Factory fabricated, leak free insulated sandwich (clamp) type access door with minimum pressure rating equal to or greater than the attached ductwork. Material shall match connecting ductwork.
3. Provide with manufacturer standard gasket, bolts and springs between inner and outer door.
4. Provide wing nuts or molded knobs for low temperature applications and wing nuts for high temperature applications.

SMACNA Access Doors – Ductwork and Plena 2” and Lower Pressure Class.

5. Fabricate access panels according to SMACNA Duct Construction Manual, Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
  - a. Door:
    - 1) Double wall, rectangular.
    - 2) Galvanized sheet metal with insulation fill and thickness for duct pressure class.
    - 3) Vision panel.
    - 4) Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    - 5) Fabricate doors airtight and suitable for duct pressure class.
  - b. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
  - c. Number of Hinges and Locks:
    - 1) Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    - 2) Access Doors up to 18 Inches Square: Continuous hinge and two sash locks.
    - 3) Access Doors up to 24 by 48 Inches: Continuous hinge and two compression latches with outside and inside handles.
    - 4) Access Doors Larger than 24 by 48 Inches: Continuous hinge and two compression latches with outside and inside handles.

Pressure Relief Access Door:

6. Door and Frame Material: Galvanized sheet steel.
7. Door: Single wall for non-insulated ductwork and double wall with insulation fill for insulated ductwork with metal thickness applicable for duct pressure class.
8. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
9. Factory set at 3.0- to 8.0-inch wg.
10. Doors close when pressures are within set-point range.
11. Hinge: Continuous piano.
12. Latches: Cam.
13. Seal: Neoprene or foam rubber.
14. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

## 2.23 FLEXIBLE CONNECTORS

Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

1. Laboratory exhaust fan discharge and biological safety cabinet discharge collar connections:
  - a. Proco Style 501.
  - b. Mercer.
  - c. Pathway.
  - d. Dynex.
  - e. Or approved equal.
2. For other non-grease exhaust systems and applications:
  - a. CL WARD & Family Inc.
  - b. Ductmate Industries, Inc.
  - c. Duro Dyne Inc.
  - d. Elgen Manufacturing.
  - e. Hardcast, Inc.
  - f. JP Lamborn Co.
  - g. Ventfabrics, Inc.
  - h. Ward Industries; a brand of Hart & Cooley, Inc.
  - i. Or approved equal.

Materials: Flame-retardant or noncombustible fabrics.

Coatings and Adhesives: Comply with UL 181, Class 1.

Metal-Edged Connectors: Factory fabricated with a fabric strip with the following minimum dimensions: 3-1/2 inches wide attached to two strips of 2-3/4 inch wide, 0.028 inch thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

Indoor System, Flexible Connector Fabric:

3. Unless noted otherwise fan discharge connections shall be glass fabric double coated with neoprene.
  - a. Minimum Weight: 26 oz./sq. yd..
  - b. Minimum Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  - c. Service Temperature: Minus 40 to plus 200 degrees F.

Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

4. Minimum Weight: 24 oz./sq. yd..
5. Minimum Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.

6. Service Temperature: Minus 50 to plus 250 deg F.

Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

7. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
8. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
9. Minimum Additional Travel: 50 percent of the required deflection at rated load.
10. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
11. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
12. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
13. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

## 2.24 FLEXIBLE DUCTS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

1. Buckley Associates, Inc.
2. Flexmaster U.S.A., Inc.
3. JP Lamborn Co.
4. McGill AirFlow LLC.
5. Thermaflex; a Flex-Tek Group company.
6. Ward Industries; a brand of Hart & Cooley, Inc.
7. Or approved equal.

### Non-Insulated Flexible Duct

8. Performance:
  - a. UL 181, Class 1.
  - b. Pressure Rating: Minimum 4-inch wg positive and 0.5-inch wg negative.
  - c. Maximum Air Velocity: 4000 fpm.
  - d. Temperature Range: Minus 20 to plus 175 deg F.

### Insulated Flexible Ducts

9. Performance:
  - a. UL 181, Class 1, fibrous-glass insulation, vapor-barrier film.
  - b. Pressure Rating: Minimum 4-inch wg positive and 0.5-inch wg negative.
  - c. Maximum Air Velocity: 4000 fpm.

- d. Temperature Range: Minus 20 to plus 175 deg F.
- e. Insulation R-Value: Comply with ASHRAE/IES 90.1.

Flexible Duct Connectors:

- 10. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

## 2.25 DUCT ACCESSORY HARDWARE

Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot-tube and other testing instruments and of length to suit duct-insulation thickness.

Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## 2.26 DIFFUSERS, REGISTERS & GRILLES

Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

- 1. Anemostat Products; a Mestek Company.
- 2. Carnes Company.
- 3. Hart & Cooley Inc.
- 4. Kreuger.
- 5. Metalaire, Inc.
- 6. Nailor Industries Inc.
- 7. Price Industries.
- 8. Titus.
- 9. Tuttle & Bailey.
- 10. Or approved equal.

Provide diffusers, registers, and grilles for supply, return and exhaust outlets of size, type and, material of construction matching the basis of design devices scheduled on the drawings.

Equipment shall be tested and rated according to ASHRAE Standard 70-2006 (RA 2011), "Method of Testing for Rating the Performance of Air Outlets and Inlets".

Room air velocities shall be determined in accordance with ASHRAE Standard 113-2013.

Equipment shall handle air quantities at operating velocities:

- 1. With maximum diffusion within space supplied or exhausted.
- 2. Without objectionable air movement as determined by Architect.
- 3. With rated sound level not to exceed NC30.

Supply, return and exhaust outlets shall have opposed blade volume dampers operable from front.

Supply registers shall have two sets of directional control blades.

Diffusers within same room or area shall be of same type and style to provide uniformity of appearance.

Surface mount diffusers, registers and grilles shall be furnished with gaskets and installed with faces set level and plumb, tightly against mounting surface.

Coordinate diffusers, registers and grilles with ceiling and wall construction. Refer to Architectural Drawings for exact lengths and for framing and mitering arrangements that may differ from those shown on Division 23 Drawings.

#### General Construction and Performance Requirements

1. Supply diffusers shall be specifically designed for variable-air-volume flows.
2. Material: Steel, aluminum or stainless steel consistent with basis of design scheduled diffuser, register or grille.
3. Finish: Steel and aluminum diffusers, registers and grilles shall have a baked enamel finish with color selected by Architect. Stainless steel diffusers and grilles shall have a brushed finish.
4. Mounting: Coordinate selections with ceiling grid indicated on the architectural drawings.
5. Pattern: Provide fully adjustable or fixed pattern consistent with scheduled basis of design diffuser, register or grille.
6. Dampers: Opposed blade or butterfly.
7. Accessories:
  - a. Equalizing grid where length of straight duct in the section of duct connected to the device is less than 18 inches long.
  - b. Plaster ring for devices mounted in dry wall construction.
  - c. Safety chain for devices with a face area equal to or larger than 3 square feet.

#### Supplemental Requirements for Continuous Linear Diffusers

1. Provide materials and accessories for a complete installation of linear and modular slot air diffusers. Installation shall include appurtenances to meet performance indicated. Provide plenums, hoods, blank-offs and sheet metal components including duct connections to the plenums.
2. For ceiling mounted continuous linear slot and modular slot diffusers, diffusers shall integrate into the ceiling system. Where curved linear slot diffusers are indicated, they shall be stretch formed to the exact radii required. Rolled or segmented linear slot diffusers will not be accepted.
3. Linear slot diffusers shall have the number of slots scheduled and shall be capable of being used for supply air, return air, exhaust air or any combination.
4. Provide hanger wire support clips that are integral with the linear slot diffusers in lay in ceilings to allow diffusers to be supported from the building structure. For hard ceilings, provide clips integral with the linear slot diffusers to allow diffusers to be secured directly to the ceiling framing without need for hanger supports. Provide spline clips to secure joints and ceiling tees to the diffusers.



5. Provide ends and corners. Ends shall be butt type, field installed, or mitered picture frame type factory installed. Corners shall be mitered one piece unit.
  6. Pattern controllers shall be one piece positioned between spring loaded spacers. Pattern controllers shall allow the airstream to be directed flat against the ceiling in either direction or downward as well as allowing throw reduction every two feet along the entire length of the linear slot diffusers. Airstream shall be maintained at the ceiling plane and shall not dump when volume is reduced.
  7. Material shall match the basis of design product specified. Spring steel retainers shall be used under the spacers to hold the slot diffusers assembly tightly together and allow the slot diffusers to be disassembled easily for field trimming.
  8. Flanges exposed to view shall be painted factory standard white. All other surfaces shall be painted flat black. Provide paint samples for approval prior to shipment.
  9. Slot diffusers shall be manufactured by the same manufacturer of the plenums and hoods.
  10. Plenums shall be minimum 24-gauge galvanized steel and lined inside with black matte fiberglass insulation with antimicrobial spray coating.
  11. Provide a friction type volume damper located in the entry collar of the supply air plenum, accessible for adjustment through the slot diffuser.
  12. Position pattern controllers in their normal operation positions before performing air testing and balancing.
  13. Slot diffusers shall be performance tested with air plenums as a composite assembly.
- Specialized Diffusers, Registers and Grilles.

## **PART 3 - EXECUTION**

### **3.1 DUCT INSTALLATION**

Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

Install ducts and specified fittings in accordance with procedures outlined in SMACNA Duct Construction Manual unless otherwise indicated.

Examine areas and ductwork to receive wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

Install ducts in maximum practical lengths to minimize quantity of joints in the system.

Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

Install drain pans.

Install ducts with a clearance of 1 inch plus allowance for insulation thickness.

Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

Where supply, return, makeup air and non-hazardous exhaust ducts pass through fire-rated assemblies identified on the architectural drawings including but not limited to interior partitions, floors and exterior walls, install fire dampers. Where supply, return, makeup air and non-hazardous exhaust pass through a fire rated shaft enclosure provide fire and smoke dampers or combination fire-smoke dampers except where a code acceptable alternate 22-inch sub-duct assembly is indicated on the drawings (e.g. hazardous exhaust duct risers or some toilet exhaust risers in hospitality occupancies).

Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

#### Duct Sleeves and Prepared Openings

1. Provide galvanized-steel sheet duct sleeves for round ducts 15 inches and smaller. Provide prepared, framed openings for round ducts larger than 15 inches and for square, rectangular and flat oval ducts, except as specified otherwise. Sleeves shall meet SMACNA requirements.
2. Provide galvanized-steel sheet duct sleeves for ducts through 1-, 2- or 3-hour fire-rated construction and smoke partitions, regardless of size and shape of ducts. Sleeves shall maintain fire rating of construction penetrated. Sleeve and seal materials, construction and clearances shall meet requirements of SMACNA Fire Damper and Heat Stop Guide for Air Handling Systems.
3. Prepared openings shall be framed to provide 1-inch clearance between framing and duct or duct insulation.
4. Provide 4 inches wide 20-gauge galvanized sheet metal collars at sleeves and prepared openings, sized to cover entire duct penetration including sleeve and seal, and to accommodate duct and insulation as necessary. Edges shall have milled lips ground smooth. Paint to match finish of duct or as directed by Architect.
5. All duct penetrations through concrete floors in mechanical rooms shall be provided with 2 inches high water stopped curbs surrounding the openings. This applies to mechanical rooms located above the lowest floor level.

Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view in finished spaces, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 for materials.

Verify final equipment locations for roughing-in.

### 3.2 DRYER EXHAUST DUCT INSTALLATION

#### Domestic Dryer Exhaust Ducts

1. Provide protective shields where nails or screws from finish or other work may penetrate the dryer exhaust duct in accordance with the applicable mechanical code.
2. Ducts shall be supported and secured in place on at 4-foot intervals.
3. Ducts shall be joined by extending each section into the adjoining section or fitting in direction of airflow.
4. Screws and fasteners shall not protrude into the ducts more than 0.125 inches.
5. Duct design is based on a maximum 35 feet code equivalent duct length.. Where equivalent duct length exceeds 35 feet, provide a permanent label or tag identifying the installed equivalent duct length and mount within 6 feet of the dryer connection.
6. Offsets in risers are prohibited. Dampers and screens are prohibited in system except at the discharge.
7. Provide a backdraft damper at the system discharge.

### 3.3 INSTALLATION OF EXPOSED DUCTWORK

Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 2B, 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.4 HANGER AND SUPPORT INSTALLATION

Provide hangers and supports in compliance with SMACNA Duct Construction Manual, Chapter 5, "Hangers and Supports" And Chapter 6, Section 6.2 "Rooftop Equipment Installation."

Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

Hanger Spacing: Comply with SMACNA Duct Construction Manual, Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

Hangers Exposed to View: Threaded rod and angle or channel supports.

Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.

Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

Install outdoor duct supports. Comply with support manufacturer installation instructions.

### 3.5 INSTALLATION OF METAL DUCT ACCESSORIES

Install duct accessories according to applicable details in SMACNA Duct Construction Manual for metal ducts.

Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ductwork, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

Install backdraft and control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated. Refer drawings for applicable damper types.

Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

Set dampers to fully open position before testing, adjusting, and balancing.

Install test holes at fan inlets and outlets and elsewhere as indicated.

Install fire and smoke dampers according to UL listing.

Installation of sound attenuators (silencers):

1. Rigidly connect ducts to sound attenuators.
2. Sound attenuator manufacturer basic installation instructions shall not be compromised to ensure pressure drops and self-generated sound power levels do exceed scheduled values. Install sound attenuators with baffles oriented in plane of turn when distance to nearest change in direction is less than attenuator manufacturer optimal distance.
3. Duct sound attenuator supplier or qualified representative shall provide supervision to ensure correct installation of duct sound attenuators.
4. Resiliently isolate sound attenuators from building construction at points of penetration of building structure with 0.75 inch minimum of 3 pound per cubic foot density fibrous glass. Seal penetration ends airtight with non-hardening caulk.
5. Multiple attenuators grouped together in parallel within duct system shall be sealed airtight with the same sealant used on the attached ductwork.

Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct mounted filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.

5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream from splitter vanes.
9. Upstream or downstream from sound attenuators (silencers).
10. Control devices requiring inspection.
11. Elsewhere as indicated.
12. Install access doors with swing against duct static pressure.
13. Minimum Access Door Sizes:
  - a. One-Hand or Inspection Access: 8 inches by 5 inches.
  - b. Two-Hand Access: 12 inches by 6 inches.
  - c. Head and Hand Access: 18 inches by 10 inches.
  - d. Head and Shoulders Access: 21 inches by 14 inches.
  - e. Body Access: 25 inches by 14 inches.
  - f. Body Plus Ladder Access: 25 inches by 17 inches.
  - g. Access doors for fire dampers shall be located so that the spring catch and fusible links are accessible when the damper is closed. Fire damper access doors shall be no smaller than 12 inches by 12 inches. Where duct size does not permit the minimum size access door, provide a minimum 12-inch long removable duct section to allow access for reset of fusible link. As duct size increases beyond 16 inches in any one direction, access door shall be no less than 2 inches smaller than the larger duct dimension by a minimum of 12" long. As the shorter dimension increases above 16 inches the length of the damper shall be no less than 2 inches smaller than the duct in each dimension but shall not exceed 18 inches x 16 inches. For dampers that are too large for an ordinary person's arms to reach from outside the duct to reset the damper and replace the fusible link, the minimum size for the access door shall be increased to 24 inches x 16 inches to allow the entrance of an individual.

Label access doors according to Division 23 to indicate the purpose of access door.

Install flexible connectors to connect ducts to equipment.

For fans developing static pressures of 5 inches water column and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

Connect terminal units with fans to supply and return ducts with flexible connectors. Do not use flexible connectors to change directions.

Connect diffusers or light troffer boots to ducts directly or with maximum 6 foot lengths of flexible duct clamped or strapped in place.

Connect flexible ducts to metal ducts with ty-wrap tool or reusable stainless steel draw bands.

Install duct test holes where required for testing and balancing purposes.

Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

### 3.6 INSTALLATION OF DIFFUSERS, REGISTERS AND GRILLES

Prior to installation, examine areas where diffusers, registers and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

Install diffusers, registers and grilles level and plumb.

Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

Install diffusers, registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

### 3.7 CONNECTIONS TO EQUIPMENT

Comply with SMACNA Duct Construction Manual for branch, outlet and inlet, and terminal unit connections.

Make connection to motorized equipment with flexible connectors.

### 3.8 PAINTING

Paint interior of metal ducts that are visible through diffusers, registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09.

### 3.9 AIR DISTRIBUTION SYSTEM CLEANLINESS

Maintain new ductwork in accordance with SMACNA "Duct Cleanliness for New Construction Guidelines." Maintain "Advanced Cleanliness Level" as defined in the guideline.

Air Distribution System Cleanliness Verification and Testing:

1. Visually inspect duct system per NADCA ACR 2013 to ensure that no visible contaminants are present. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to cleanliness testing identified in "Additional Verification" paragraph below.
2. Additional Verification (only where visible contaminants are evident):

- a. Perform NADCA Surface Comparison Testing. Ductwork is considered clean if there is no significant visible difference in the surface characteristics. If Surface Comparison Testing test is inconclusive, perform NADCA Vacuum Test. To be considered clean according to the NADCA Vacuum Test, the net weight of the debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.
3. Air distribution system will be considered defective if it does not pass tests and inspections.

Unless noted otherwise (e.g. existing ductwork), clean duct systems and components that do not pass visual inspection or random testing as follows:

1. Use service openings for entry and inspection.
  - a. Create new openings and install access panels or doors appropriate for static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer.
  - b. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
  - c. Remove and reinstall ceiling to gain access during the cleaning process.
2. Particulate Collection and Odor Control:
  - a. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
  - b. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
3. Clean the following components by removing surface contaminants and deposits:
  - a. Air outlets and inlets (registers, grilles, and diffusers).
  - b. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
  - c. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
  - d. Coils and related components.
    - 1) Measure static-pressure differential across each coil.
    - 2) Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent of the differential measured when the coil was first installed and if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.
  - e. Return-air ducts, dampers, actuators, and splitter vanes except in ceiling plenums and mechanical equipment rooms.
  - f. Supply-air ducts, dampers, actuators, and splitter vanes.
  - g. Dedicated exhaust, ventilation and makeup air system components.

- h. Plenums.
- 4. Mechanical Cleaning Methodology:
  - a. Clean metal duct air distribution systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
  - b. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
  - c. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
  - d. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
  - e. Clean coils and coil drain pans according to NADCA ACR 2013. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
  - f. Provide drainage and cleanup for wash-down procedures.
  - g. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

Prepare a written cleanliness verification report. At a minimum, include the following:

- 1. Written documentation of the success of the cleaning.
- 2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
- 3. Surface comparison and vacuum test results where required.
- 4. System areas found to be damaged.

Photographic Documentation: Comply with requirements in Division 01, Photographic Documentation.

### 3.10 START UP AND ADJUSTING

Air Balance: Comply with requirements in other Sections of Division 23.

After installation, adjust diffusers, registers and grilles to air patterns indicated or as directed, before the start of air balancing.

### 3.11 DUCT SEALING

Duct Sealant and Leakage Fraction: Seal ducts to the following seal and leak classes. For purposes of this specification seal class identified shall be used only to define specific seams and joints to be sealed and applies to all duct pressure classes. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage. Pressure-sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory, and the tape is used in accordance with that certification. All connections shall be sealed, including but not limited to spin-ins, taps, other



branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.

1. Seal Class A as defined by ASHRAE 90.1: A ductwork sealing category that requires sealing all transverse joints, longitudinal seams, and duct wall penetrations. Duct wall penetrations are openings made by pipes, holes, conduit, tie rods, or wires. Longitudinal seams are joints oriented in the direction of airflow. Transverse joints are connections of two duct sections oriented perpendicular to airflow.
2. Leakage factors specified are as recommended in the ASHRAE Systems and Equipment Handbook.

Duct Construction Class	Pressure	SMACNA Seal Class	Maximum Allowable Leakage Fraction***
10 inches water column (2500 Pa)	Pos. or Neg.	A	2 percent * 5 percent**
6 inches water column (1500 Pa)	Pos. or Neg.	A	2 percent * 5 percent**
4 inches water column (1000 Pa)	Pos. or Neg.	A	2 percent * 5 percent**
3 inches water column (750 Pa)	Pos. or Neg.	A	2 percent * 5 percent**
2 inches water column (500 Pa)	Pos. or Neg.	A	2 percent * 5 percent**
*2 percent of system air flow rate for return and supply ducts outdoors and exhaust ducts indoors. **5 percent of system air flow rate for all other duct. ***See "FIELD QUALITY CONTROL" Article, Sub-Articles "Duct System Leakage Tests" and "Leakage Factor/Leakage Fraction" in this Section.			

### 3.12 DUCT SCHEDULE

Duct Construction: Fabricate ducts with galvanized sheet steel except as otherwise indicated.  
Duct pressure classification criteria: Duct system pressure classification shall be determined based on the following criteria:

General Duct Service	Duct Construction Minimum Pressure Classification Criteria Fan Discharge = Positive Return Inlet = Negative Exhaust Inlet = Negative	Duct Material of Construction
VAV air handling unit supply ductwork from AHU to terminal box inlet	125 percent of unit external static pressure shown in the equipment schedules – minimum 4 inches water column	G90 galvanized
Constant volume air handling unit supply ductwork (systems with no terminal boxes)	125 percent of supply fan external static pressure shown in equipment schedules – minimum 2 inches water column	G90 galvanized

General Duct Service	Duct Construction Minimum Pressure Classification Criteria Fan Discharge = Positive Return Inlet = Negative Exhaust Inlet = Negative	Duct Material of Construction
Constant volume return ductwork (systems with no terminal boxes) and all ductwork on return fan discharge	125 percent of return fan external static pressure shown in equipment schedules and when system has no separate return fan – minimum 2 inches water column	G90 galvanized
Non-laboratory constant volume exhaust ductwork (systems with no terminal boxes) and all ductwork on exhaust fan discharge	125 percent of exhaust fan external static pressure shown in equipment schedules – minimum 2 inches water column.	G90 galvanized
Ductwork downstream of supply air terminal boxes	2 inches water column	G90 galvanized (except where noted otherwise)
All ducts connected to local terminal units including fan coil units, furnaces, and heat pumps.	2 inches water column	G90 galvanized
Ductwork containing unconditioned air from outside intake location to equipment being served	100 percent of air handling unit or fan external static pressure, minimum 2 inches water column	G90 galvanized
Supply, return and exhaust ducts connected to equipment not listed or otherwise identified in this Section	4 inches water column	G90 galvanized
Toilet room and shower (wet exhaust) – slope 1 percent back to room	125 percent of fan external static pressure or 2 inches water column whichever is greater, air and watertight.	304L stainless steel or aluminum for first 20 feet from the space then G90 galvanized for remainder of the system
Supply ducts within wet corrosive spaces exposed to high concentrations of chlorine (natatoriums and chlorine storage spaces)	125 percent of fan external static pressure or 2 inches water column, whichever is greater.	PVC-coated galvanized steel or Aluminum
Return and Exhaust ducts within wet corrosive spaces exposed to high concentrations of chlorine (natatoriums and chlorine storage spaces)	125 percent of fan external static pressure or 2 inches water column whichever is greater, air and watertight.	PVC-coated galvanized steel or Aluminum
Ducts immediately before and after duct mounted humidifiers – slope 1 percent back to drain	Match duct pressure class, air and watertight.	304L stainless steel or aluminum
All outdoor non-insulated ductwork.	125 percent of fan or unit external static pressure shown in the equipment schedules – minimum of 4 inches water column, air and watertight.	Welded 304L stainless steel with No. 3 Finish
**Construct at the next higher SMACNA pressure class when calculation results in a fractional condition. (e.g. where fan external static is 4 inches water column and test pressure is defined as 110 percent of the		

General Duct Service	Duct Construction Minimum Pressure Classification Criteria Fan Discharge = Positive Return Inlet = Negative Exhaust Inlet = Negative	Duct Material of Construction
fans external static pressure, $1.1 \times 4 = 4.4$ ; duct shall be constructed at 6 inches water column pressure class).		
All ductwork exposed in occupied spaces shall be considered finished material and shall be cleaned of all contractor markings. Provide Number 4 finish for all exposed stainless-steel ductwork. Concealed stainless steel ductwork shall be 2B finish.		

Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Stainless-Steel Ducts:
  - a. Exposed to Airstream: Match duct material.
  - b. Not Exposed to Airstream: Galvanized.
3. Aluminum Ducts: Aluminum.

Liner:

4. Provide the following liner material:
  - a. Supply Air Ducts: Fibrous glass, Type I or Flexible elastomeric.
  - b. Return Air Ducts: Fibrous glass, Type I or Flexible elastomeric.
  - c. Exhaust Air Ducts: Fibrous glass, Type I or Flexible elastomeric.
  - d. Supply Fan Plenums: Fibrous glass, Type II or Flexible elastomeric.
  - e. Return- and Exhaust-Fan Plenums: Fibrous glass, Type II or Flexible elastomeric.
  - f. Transfer Ducts: Fibrous glass, Type I or Natural fiber.
5. Thickness of liner shall meet the following requirements:
  - a. For acoustical duct lining provide the following thicknesses:
    - 1) Supply Air Ducts: 1 inch thick.
    - 2) Return Air Ducts: 1 inch thick.
    - 3) Exhaust Air Ducts: 1 inch thick.
    - 4) Supply Fan Plenums: 2 inches thick.
    - 5) Return- and Exhaust-Fan Plenums: 2 inches thick.
    - 6) Transfer Ducts: 1 inch thick.

Ductwork Fittings:

6. Use only the following fittings, shown in Figures 4.2 through 4.9 and Chart 4.1 of the SMACNA Duct Construction Manual.
  - a. Rectangular Elbows - Figure 4.2
    - 1) Type RE-1

- 2) Type RE-3. See also Chart 4-1 and Figure 4-9
- 3) Type RE-5
- 4) Type RE-6
- 5) Type RE-8
- b. Round Elbows – Figure 3-4
  - 1) Round Mitered Elbows Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA Duct Construction Manual, Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
    - a) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
    - b) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
    - c) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
  - 2) Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
  - 3) Round Elbows, 14 Inches and Larger in Diameter: Standing seam for non-welded ductwork. Provide welded elbows where welded ductwork is provided.
- c. Divided Flow Branches - Figure 4-5
  - 1) Type 1
  - 2) Type 3
  - 3) Type 4A (optional mitered elbow not acceptable)
  - 4) Type 4B (optional mitered elbow not acceptable)
- d. Branch Connections from Rectangular Duct - Figure 4-6
  - 1) 45 Degree Entry
  - 2) 45 Degree Lead In
  - 3) Conical
  - 4) Bellmouth
- e. Branch Connections From Round Duct - Figure 3-5 and 3-6
  - 1) Velocity 1000 fpm or Lower: 90-degree tap.
  - 2) Velocity 1000 to 1500 fpm : Conical tap.
  - 3) Velocity 1500 fpm or Higher: 45-degree lateral.
- f. Offsets & Transitions - Figure 4-7
  - 1) Any type shown.
- g. Obstructions – Figure 4-8
  - 1) Figure A, B, C and E.

- 2) Figure D only if mitered elbows with vanes are replaced with short radius elbows with full length splitter vanes.

### 3.13 FIELD QUALITY CONTROL

Perform tests and inspections.

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect splitter vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

Duct System Leakage Tests:

6. The following chapters, articles and appendices of 2012 SMACNA Leakage Test Manual are not applicable to this construction of this project.
  - a. Chapter 1
  - b. Chapter 2.
  - c. Chapter 3, Article 3.1
  - d. Chapter 3, Article 3.2.1.j.
  - e. Chapter 5
  - f. Appendix A
  - g. Appendix B
  - h. Appendix C
  - i. Appendix D
  - j. Appendix E
  - k. Appendix F
  - l. Appendix G
7. The following appendices of 2012 SMACNA Leakage Test Manual are informational and may be of some assistance to the contractor, though they are not a requirement of the Project Specifications
  - a. Appendix H
  - b. Appendix I
  - c. Appendix J
  - d. Appendix K
  - e. Appendix L
  - f. Appendix M

- g. Appendix N
  - h. Appendix O
8. Unless otherwise noted in this specification section, the leakage test procedures shall comply with chapter 4 of the 2012 SMACNA Leak Test Manual except as follows:
- a. Article 4.1.3 be replaced with the text: “Calculate the allowable leakage in accord with the Project Specifications Section 233113, Field Quality Control article, Duct System Leakage Test sub-article and the example in the ASHRAE Systems Handbook Compliant Leakage Allowance Calculation article.”
  - b. Article 4.1.7 shall be replaced with the text: “Read the flow meter and compare the leakage in CFM to the allowable leakage calculated in 4.1.3 above. If it meets allowable leakage, proceed to step 4.1.8. If it does not meet the allowable limit, proceed to steps 4.1.7.a through 4.1.7.c”.
  - c. Article 4.1.7.a shall be replaced with the text: “Inspect pressurized duct (and all connections between the flow meter and the duct) for sensible leaks. If necessary, apply a soap solution to locate small leaks. If deemed appropriate by the contractor, submit a request to the Architect to utilize a smoke bomb to identify leaks. Under no circumstances shall a smoke bomb be used without the written approval of the architect.”
  - d. The reference to Appendix G shall be deleted in article 4.1.7.b.
  - e. Article 4.1.10.d shall be replaced with the text: “Isolate equipment (fans, air handling units, air valves, VAV terminals, fan coil units, heat pumps, etc.) from the tested ductwork. Contractor shall obtain leakage of this equipment from the manufacturers of the equipment and use it directly as described in the Project Specifications Section 233113 article addressing ‘Fixed Leakages’ in the sub-article ‘Total System Leakage’”.
  - f. Delete article 4.1.10.e.
9. Leakage test apparatus shall comply with Chapter 6 of the SMACNA Leak Test Manual. Flow measuring equipment shall have a calibrated accuracy of plus or minus 3 percent of the maximum allowable air flow leakage rate (calculated in accordance with the project specifications in the articles below) of the duct section being tested. Calibration certificates, showing acceptable instrument accuracy and dated within 90 days of leakage tests, of all instrumentation (flow, temperature, pressure) shall be submitted with test reports
10. Unless otherwise noted, allowable system leakage shall be expressed as a fraction (percentage) of the total system flow as recommended in Chapter 19 of the ASHRAE Systems Handbook, article “Leakage Testing” beginning on page 19.3.
- a. All outdoor supply and return ductwork shall have a leakage fraction less than or equal to 2 percent of the system air flow.
  - b. All indoor exhaust ductwork shall have a leakage fraction less than or equal to 2 percent of the system air flow.
  - c. All other ductwork shall have a leakage fraction less than or equal to 5 percent of the system air flow.
11. Leakage tests shall be conducted at the pressure classification of the ductwork being tested. Do not exceed the installed duct pressure class rating.

12. Submit a test report for the entire system with each test represented and totaled showing the total duct leakage measured during the tests plus the fixed leakage is less than or equal to the allowable leakage of the system.
  - a. Reports shall be based on the requirements of 2012 SMACNA Leak Test Manual, Chapter 7 as modified by the Project Specifications.
    - 1) Article 7.1 delete the fourth bullet referencing Section 5.1.
    - 2) Article 7.2 delete the reference to table 5-1 in the second bullet.
    - 3) Article 7.2 delete the parenthetical content (10 percent, 20 percent, 50 percent, all) and replace with the phrase “as specified in the Project Specifications.
    - 4) Article 7.3 delete the term “leakage class” at the end of the first sentence and replace with the phrase “allowable leakage, calculated in accord with the Project specifications”.
    - 5) Article 7.4 shall be deleted in its entirety and replaced with the following:
      - a) The test results form shall be similar to and contain all the information noted in the “Test Results Form” in the project specifications.
      - b) The heading of the form shall include the project name, contractor’s project number, air system to which the tested sections are attached, testing company information and logo, air system design air flow rate, connected equipment total allowable leakage.
      - c) The test results form shall include the results of the duct section calculations including the duct section calculation number (cross referenced to the sheet metal shop drawings), the design air flow in the calculated section, the surface area of the calculated section, maximum leakage class of the calculated section, allowable leakage rate (CFM) in the calculated section and pressure class of the calculated section.
      - d) The proposed duct test sections (cross referenced to the sheet metal shop drawings) identifying which duct calculation sections are included in the test section, the resultant total air leakage in the test section (i.e. the sum of the calculation sections in the test section) if calculated sections are combined into one test section
      - e) The test result form shall include field test data including the test date, the name of the technician performing the test, the name of the witness of the test, the test equipment identification (manufacturer, model number, serial number), the pressure in the duct during the test, test equipment raw data (i.e. pressure differential across the orifice) and resultant measured air flow based orifice differential pressure.
      - f) The test results form shall also identify resultant allowable leakage if the test static pressure is not equal to the design duct pressure classification.
      - g) Test reports are to be submitted to the architect for review.

13. See Article “Leakage Factor/Leakage Fraction”, “ASHRAE Systems Handbook Compliant Duct Leakage Calculation”, and “Total System Leakage” articles in this specification section for calculation methodology
14. As recommended in the ASHRAE Systems Handbook, duct leakage testing shall be performed with takeoffs, dampers (fire, smoke, control, combination fire/smoke manual volume control, etc.) duct mounted coils, and access doors installed.
15. Duct leakage tests shall not include the leakage of air handlers or terminal equipment (e.g., VAV air valves, fan coil units, heat pumps). Provide necessary arrangements so these devices are isolated from the duct sections under test.
16. Duct leakage tests shall not include the leakage of air handlers or terminal equipment (e.g., VAV boxes).
  - a. Air handlers and terminal equipment shall be tested separately by the manufacturers. The associated leakage shall be obtained by the contractor from the selected manufacturers on the project. Their leakage shall be included in the overall system leakage. The total system (e.g. Duct, ahu, dampers, access doors, duct coils) leakage shall not exceed 5 percent of the total airflow of the system generated at the fan (e.g. Ahu).
17. Refer to Division 23 for testing, adjusting, and balancing for HVAC for additional requirements.
18. Leak test the following systems:
  - a. 100 percent of exterior ductwork regardless of pressure class.
  - b. 100 percent of interior ductwork with a pressure class 3 inches water column or higher.
  - c. All other ductwork: Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area.
19. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
20. Test for leaks before applying external insulation.
21. Give seven-day advance notice for testing to the Architect.
  - a. Notification regarding testing of Smoke Management systems shall be directed to the Owner, Architect and Special Inspector for Smoke Control systems.

**Leakage Factor/Leakage Fraction**

22. Conduct tests at static pressures equal to maximum design pressure class of the system or section being tested. Do not pressurize systems above maximum design pressure class.
23. For each fan system (fan system includes air handling unit fans) with ductwork required to be leak tested, the contractor shall determine the normalized air flow rate per square foot of duct surface area (Q<sub>fn</sub>) based on the ductwork shop drawings and the approved fan (AHU, etc) shop drawings.
24. Contractor shall determine the duct surface area for each main, branch main branch and subbranch of duct connected to each fan system with ductwork required to be leak tested for each change in designed air flow carried in the duct.



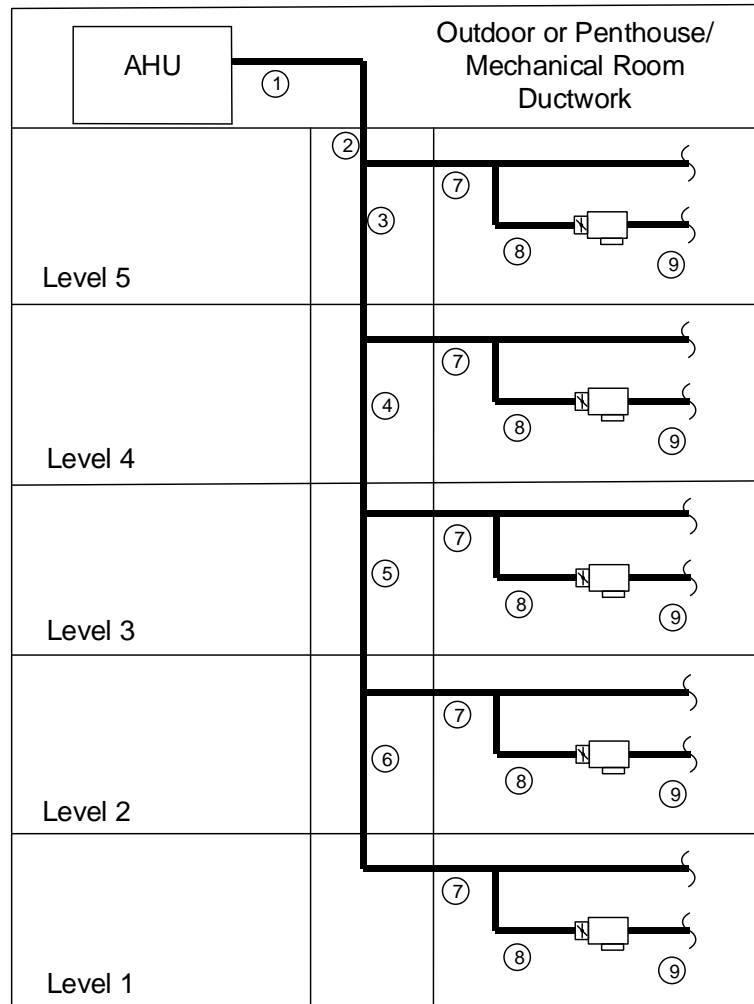
25. Leakage class (Cl) can be determined in accordance with ASHRAE/IES 90.1 by using the leakage fraction (Qlf), translated into a decimal, specified duct pressure class (Cp) and system air flow rate normalized per square foot of system duct surface area (Qfn) as follows:
  - a.  $Cl = (Qlf * Qfn) / (Cp ^ 0.65)$
  - b. To comply with ASHRAE/IES 90.1 Article 6.4.4.2.2, leakage class (Cl) shall be no greater than 4. When calculating leakage class, contractor shall reduce the leakage fraction, Qlf, as necessary to ensure leakage class does not exceed 4. See calculation example in the Article below.
26. For those systems wherein leakage testing will be conducted in sub-sections of the overall duct system, comply with the recommended procedures for calculating the allowable leakage fraction in a test sub-section described in Chapter 19 of the ASHRAE Systems Handbook Article “Calculating Test Section Allowable Leakage” beginning on page 19.4
27. Should testing reveal greater than the allowable leakage, inspect, re-seal and re-test as necessary and as described in the 2012 SMACNA Leak Test Manual as modified by the Project Specification to attain a measured air flow leakage from the test section equal to or less than the allowable air flow leakage from the test section.
28. For an example of the preceding paragraphs, refer to the Article “Leakage Test Example Calculations” in this Section.
29. Duct sections used for calculations shall be of constant air flow, constant cross section, constant design pressure class.
30. Duct sections for testing may combine the duct sections used for calculations so long as the combined section does not exceed the capacity of the test apparatus, the combined section is of the same design pressure class and the combined section is contiguous.
  - a. Note in the example in the article “ASHRAE Systems Handbook Compliant Leakage Allowance Calculation” below, the six duct sections associated with the leakage calculation for the 6” pressure class duct could be combined into one test section with an allowable leakage rate equal to the sum of the individual calculated sections as long as the combined section does not exceed the capacity of the test apparatus.

### 3.14 ASHRAE SYSTEMS HANDBOOK COMPLIANT DUCT LEAKAGE ALLOWANCE SAMPLE CALCULATION

#### Example System Description and Diagram

1. The supply side of a penthouse air handling unit designed to produce 100,000 CFM with an external static pressure of 4.5 inches water column is connected to a 6 inches water column pressure class duct riser system, serving five stories of office space. Each story will be supplied 20,000 CFM through a 4 inches water column pressure class branch main duct routed on the office floor and connected to 25 VAV terminal units. Downstream of the VAV terminal will be 2 inches water column pressure class duct routed to ceiling diffusers. The penetrations through the shaft on each floor will be protected by a combination smoke/fire damper with associated access doors, the branch connections will have manual volume dampers for balancing; VAV boxes will have duct mounted reheat coils.

- a. Section 1: The surface area of the supply duct work in the penthouse is measured to be 750 square feet between the AHU discharge and the riser shaft and carries 100,000 CFM
- b. Section 2 The surface area of the supply riser between the shaft entrance and the first take-off connection is 270 square feet and carries 100,000 CFM.
- c. Section 3 – 6: The surface area between each subsequent take-off on the next four floors is 360 square feet between levels 5 and 4 (80,000 CFM); 325 square feet between level 4 and 3 (60,000 CFM); 265 square feet between levels 3 and 2 (40,000 CFM) and 200 square feet between levels 2 and 1 (20,000 CFM).
- d. Section 7 – 8: The surface area of the branch main duct, including access doors, fire/smoke dampers and manual volume dampers, on each floor is 3,500 square feet, each VAV terminal has a 40 square foot surface area inlet connection (800 CFM).
- e. Section 9: Downstream of each VAV box there is 150 square feet of surface area, including manual volume dampers, access doors and reheat coils, of distribution duct to 4 diffusers.



f. Duct Leakage Test Example Diagram

Calculations for 6 inches water column pressure class in the example. Contractor to perform calculations for all pressure classes and duct sections to be tested.

2. The total surface area of the duct is:
  - a.  $750$  (duct in penthouse) +  $270$  (duct between penthouse and level 5) +  $360$  (duct between L5 and L4) +  $325$  (duct between L4 and L3) +  $265$  (duct between L3 and L2) +  $200$  (duct between L2 and L1) +  $3500 * 5$  (total branch main duct on all floors) +  $25 * 5 * 40$  (total VAV inlet branch connections) +  $25 * 5 * 150$  (total duct downstream of VAV) =  $43,420$  square feet.
3. Determine the normalized air flow of each section of duct (example continues for the 6 inches water column pressure class duct only, contractor to continue for all duct and pressures classes required to be leakage tested).
  - a. Penthouse duct;  $Q_{fn} = 100,000 / 750 = 133.33$  CFM/SF
  - b. Riser between PH and Level 5:  $Q_{fn} = 100,000 / 270 = 370.37$  CFM/SF
  - c. Riser between L5 and L4:  $Q_{fn} = 80,000 / 360 = 222.22$  CFM/SF
  - d. Riser between L4 and L3:  $Q_{fn} = 60,000 / 325 = 184.61$  CFM/SF
  - e. Riser between L3 and L2:  $Q_{fn} = 40,000 / 265 = 150.94$  CFM/SF
  - f. Riser between L2 and L1:  $Q_{fn} = 20,000 / 200 = 100$  CFM/SF
4. Determine the leakage class each section of duct (example continues for the 6 inches water column pressure class duct only, contractor to continue for all duct and pressure classes required to be leakage tested).  $Cl = Q_{fl} * Q_{fn} / (C_p ^{0.65})$ .  $Q_{fl}$  shall be set to allowable leakage fraction (0.02 for outdoor/mechanical room ductwork. 0.02 for all exhaust ductwork and 0.05 for all other ductwork). If calculations result in a leakage class greater than 4, reduce the allowable leakage fraction  $Q_{fl}$  for that section to attain  $Cl = 4$  or less. The adjusted value of  $Q_{fl}$  for that section shall be used in subsequent calculations to determine allowable leakage from the affected duct section.
  - a. Penthouse duct:  $Cl = .02 * 133.33 / (6 ^{0.65}) = .83$
  - b. Riser between PH and Level 5:  $Cl = .05 * 370.37 / (6 ^{0.65}) = 5.77$
  - c. Riser between L5 and L4:  $Cl = .05 * 222.22 / (6 ^{0.65}) = 3.46$
  - d. Riser between L4 and L3:  $Cl = .05 * 184.61 / (6 ^{0.65}) = 2.88$
  - e. Riser between L3 and L2:  $Cl = .05 * 150.94 / (6 ^{0.65}) = 2.35$
  - f. Riser between L2 and L1:  $Cl = .05 * 100 / (6 ^{0.65}) = 1.56$
5. Determine the duct section area to total duct area ratio for each section of duct (example continues for the 6 inches water column pressure class duct only, contractor to continue for all duct and pressure classes required to be leakage tested).
  - a. Penthouse duct: Section Area / Total Area =  $750 / 43,420 = 0.017$
  - b. Riser between PH and Level 5:  $270 / 43,420 = 0.006$
  - c. Riser between L5 and L4:  $360 / 43,420 = 0.0083$
  - d. Riser between L4 and L3:  $325 / 43,420 = 0.0075$
  - e. Riser between L3 and L2:  $265 / 43,420 = 0.0061$
  - f. Riser between L2 and L1:  $200 / 43,420 = 0.0046$

6. Determine the allowable leakage per section of duct (example continues for the 6 inches water column pressure class duct only, contractor to continue for all duct and pressure classes required to be leakage tested). Allowable leakage = (Section to total area ratio) \* (Section air flow rate) \* (Section Leakage Fraction, Qlf, adjusted if necessary as described above)
  - a. Penthouse duct: Allowable leakage =  $0.017 * 100,000 * .02 = 34 \text{ CFM}$
  - b. Riser between PH and Level 5:  $0.006 * 100,000 * .05 = 30 \text{ CFM}$
  - c. Riser between L5 and L4:  $0.0083 * 80,000 * .05 = 33.2 \text{ CFM}$
  - d. Riser between L4 and L3:  $0.0075 * 60,000 * .05 = 22.5 \text{ CFM}$
  - e. Riser between L3 and L2:  $0.0061 * 40,000 * .05 = 12.2 \text{ CFM}$
  - f. Riser between L2 and L1:  $0.0046 * 20,000 * .05 = 4.6 \text{ CFM}$
7. The allowable leakage in the duct system, is the sum of the allowable leakage from each section of duct. For this example, the allowable leakage in the 6 inches water column pressure class duct sections is 136.5 CFM. Contractor shall continue these calculations for all pressure-classes to be tested to get a resulting total leakage allowed from the duct system.

#### Total System Leakage

8. The calculations above are for duct and accessories testing only and do not include leakage from air handlers or terminal equipment (see the Article “Duct System Leakage Tests” in the “Field Quality Control” Article) which are tested separately, or leakage is published by the manufacturer and are considered “fixed” leakages.
9. The total system leakage, including “fixed” leakage, shall not exceed 5 percent of the total air flow for the fan (AHU, etc.) system being tested. If calculations of allowable duct leakage indicate a total system leakage, including “fixed” leakage values, exceeds 5 percent of the total fan (AHU, etc.) system flow; the leakage fraction (Qlf) of some or all of ductwork shall be reduced and the calculations repeated until total calculated leakage is less than or equal to 5 percent of the fan (AHU, etc.) system, total flow rate.
10. “Fixed” leakages may be determined by the manufacturer (published data and/or factory tests) or field tested by the contractor with the assistance and in the presence of the manufacturer at the design pressure class. If the manufacturers’ data are to be utilized, the leakage rate published by the manufacturers shall be adjusted to the design pressure class and calculated leakage class of the ductwork in which the item is installed.
  - a. For example, the AHU described above has been determined by the manufacturer to leak 1 percent of the total air flow at 4 inches water column. As the AHU is installed in 6 inches water column pressure class duct, the “fixed” leakage rate for the AHU shall be calculated as follows:
    - 1) AHU “fixed” leakage = Manufacturers stated leakage rate \* AHU design flow rate \* (design pressure class / manufacturer’s test pressure class) <sup>.65</sup> =  $0.01 * 100,000 * (6/4) ^{.65} = 1301.55 \text{ CFM}$
    - 2) In this example, 1.3 percent of the total system allowable leakage is allotted to the AHU; meaning either the duct construction (plus other “fixed” leakages) must result in no more than 3.7 percent of the total system flow rate in leaks or the manufacturer must be consulted to reduce the AHU leakage.

END OF SECTION

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SAMPLE

AIR LEAKAGE TEST RESULTS FORM

Project Name:						Project Number:										
Air System Designation:						Page:                      of			TESTING COMPANY INFORMATION AND LOGO							
System Design Airflow Rate (cfm) =				Total Equipment Leakage AHU, Valves, VAV, etc. (cfm) =												
Calculation Data (from contractor submitted and approved pre-construction calculations)						Field Test Section Data			Field Test Data							
Duct Calculation Section ID (cross referenced to shop drawings)	Air Flow in Section (CFM)	Section Surface Area (Sq. Ft.)	Section Leakage Class	Allowable DUCT Leakage in Section (CFM)	Section Pressure Class (in w.g.)	Test section number (cross referenced to shop drawings)	Calculation sections that are combined into this test section	Combined allowable leakage in test section	Test Date	Performed by	Witnessed by:	Test Equipment Info	Static Pressure in Duct During Test (in. w.g.)	Test Equipment Differential Pressure Reading (in. w.g.)	Adjusted Allowable Leakage Based on Static Pressure in Duct During Test vs. Duct Pressure class (CFM). See Note 1.	Measured Leakage (CFM)
Totals																
<p>Note 1. Adjusted Allowable Leakage Based on Static Pressure in Duct During Test vs. Duct Pressure Class is determined as follows: (Allowable Leakage) * (Pressure in Duct During Test/Pressure Class of Duct) ^ 0.65.</p>									Leakage from AHU, VAV, Valves, etc. connected to this system			Connected Equipment Leakage (CFM)				
									100 * (Total measured leakage during tests + Connected equipment leakage)/Total design air flow			Leakage Percent of Total Air Flow				
									Pass if 5 percent or less			SYSTEM STATUS AT END OF TEST		Pass/Fail		

## SECTION 233400 - HVAC FANS AND VENTILATORS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Centrifugal Fans
    - a. Square in-line centrifugal fans.
  - 2. HVAC Power Ventilators
    - a. Centrifugal ventilators - roof up blast and sidewall.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
  - 2. Rated capacities, operating characteristics, and furnished specialties and accessories.
  - 3. Certified fan performance curves with system operating conditions indicated.
  - 4. Certified fan sound-power ratings.
  - 5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  - 6. Material thickness and finishes, including color charts.
  - 7. Dampers, including housings, linkages, and operators.
  - 8. Prefabricated roof curbs.
  - 9. Fan speed controllers.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.

4. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated Design Submittal: For vibration isolation, hangers and supports, indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  1. Design Calculations: Calculate requirements for selecting vibration isolators, supports,.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Fan room layout and relationships between components and adjacent structural and mechanical elements, drawn to scale, and coordinated with each other, using input from installers of the items involved.
- B. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Startup service reports.
- D. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fans to include:
  1. Operation in normal and emergency modes.
  2. Operation, and maintenance manuals with replacement parts listing.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified nationally recognized testing laboratory (NRTL), and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Startup."



- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, supports, including comprehensive engineering analysis by a qualified professional engineer, using performance and design criteria indicated.
- F. Wind Performance: Fans shall withstand the effects of wind determined in accordance with ASCE/SEI 7. See Division 23 for vibration and seismic requirements where applicable.
- G. Capacities and Characteristics: Refer to schedules on drawings.

## 2.2 GENERAL

- A. Source Limitations: Obtain each individual fan type from single manufacturer.
- B. Refer to Division 23 for duct silencer requirements.
- C. Motors
  - 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23.
  - 2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  - 3. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.
- D. Bearings:
  - 1. Heavy-duty regreasable ball or roller type in a cast iron self-aligning pillow block housing.
  - 2. Ball-Bearing Rating Life: ABMA 9, L(50) of 200,000 hours.
  - 3. Roller-Bearing Rating Life: ABMA 11, L(50) of 200,000 hours.
  - 4. Extend grease fitting to accessible location outside of unit.
  - 5. Where fans are required to be spark resistant, bearing shall be located outside the airstream.
- E. Source Quality Control
  - 1. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.
  - 2. AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.
  - 3. AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.
  - 4. Operating Limits: Classify fans in accordance with AMCA 99, Section 14.
  - 5. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

## 2.3 SQUARE IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
  - 1. Acme Engineering & Manufacturing Corp.
  - 2. Aerovent; a division of Twin City Fan Companies, Ltd.
  - 3. Carnes Company.
  - 4. Greenheck Fan Corporation.
  - 5. Hartzell Fan Incorporated.
  - 6. Loren Cook Company.
  - 7. Penn Barry.
  - 8. Or approved equal.
- B. Description: Square in-line centrifugal fans.
- C. Housing:
  - 1. Housing Material: Reinforced steel.
  - 2. Housing Coating: None.
  - 3. Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- D. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- E. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.
- F. Motor Enclosure: Open, dripproof.
- G. Accessories:
  - 1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
  - 2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  - 3. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
  - 4. Companion Flanges: For inlet and outlet duct connections.
  - 5. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
  - 6. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
  - 7. Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

## 2.4 CENTRIFUGAL VENTILATORS - ROOF UPBLAST OR SIDEWALL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

1. Aerovent; a division of Twin City Fan Companies, Ltd.
  2. Carnes Company.
  3. Greenheck Fan Corporation.
  4. Jenco Fan.
  5. Loren Cook Company.
  6. New York Blower Company (The).
  7. Penn Barry.
  8. Or approved equal.
- B. Configuration: Centrifugal roof upblast ventilator.
- C. Housing: Removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
- F. Accessories:
1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
  3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
  4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
  5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
  6. Spark-resistant, all-aluminum wheel construction.
  7. Mounting Pedestal: Galvanized steel with removable access panel.
  8. Wall Mount Adapter: Attach wall-mounted fan to wall.
  9. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust.
- G. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Built-in raised cant and mounting flange.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Install fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:
  - 1. Support duct-mounted and other hanging fans directly from the building structure, using suitable hanging systems as specified in Division 23.
  - 2. Comply with requirements for vibration isolation and seismic-control devices specified in Division 23.
  - 3. Comply with requirements for vibration isolation devices specified in Division 23.
- E. Curb Support, Prefabricated: Rail-type wood support provided by fan manufacturer.
- F. Unit Support: Install fans level on structural curbs. Coordinate with duct connections. Secure units to structural support with anchor bolts.
- G. Install units with clearances for service and maintenance.
- H. Label fans according to requirements specified in Division 23.

### 3.2 DUCTWORK AND PIPING CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23.
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

### 3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Division 26.
- B. Ground equipment according to Division 26.
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Division 26.
  - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

### 3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect wiring in accordance with Division 26.
- C. Connect control wiring according to Division 26.

### 3.5 STARTUP SERVICE:

- A. Perform startup service.
  - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
  - 2. Verify that shipping, blocking, and bracing are removed.
  - 3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 4. Verify that cleaning and adjusting are complete.
  - 5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
  - 6. Adjust damper linkages for proper damper operation.
  - 7. Verify lubrication for bearings and other moving parts.
  - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  - 9. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  - 10. Shut unit down and reconnect automatic temperature-control operators.
  - 11. Remove and replace malfunctioning units and retest as specified above.

### 3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.
- D. Comply with requirements in Division 23.

### 3.7 CLEANING

- A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust

### 3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
  - C. Perform tests and inspections.
    - 1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - 3. Fans and components will be considered defective if they do not pass tests and inspections.
  - D. Prepare test and inspection reports.
- 3.9 DEMONSTRATION
- A. Train Owner's maintenance personnel to adjust, operate, and maintain fans.

END OF SECTION

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## SECTION 233600 - AIR TERMINAL UNITS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Shutoff, single-duct air terminal units.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
  - 1. Air terminal units.
  - 2. Liners and adhesives.
  - 3. Sealants and gaskets.
- B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
  - 3. Hangers and supports, including methods for duct and building attachment and vibration isolation.
- C. Delegated-Design Submittal:
  - 1. Materials, fabrication, assembly, and spacing of hangers and supports.
  - 2. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, Operation and Maintenance Data, include the following:
1. Instructions for resetting minimum and maximum air volumes.
  2. Instructions for adjusting software set points.

#### 1.6 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.

#### 2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

#### 2.3 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
1. Anemostat Products; a Mestek Company.
  2. Environmental Technologies, Inc.
  3. Krueger.
  4. Nailor Industries Inc.
  5. Price Industries.
  6. Titus.
  7. Tuttle & Bailey.
  8. Or approved equal.



- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 0.034-inch steel, double wall.
  - 1. Casing Lining: Adhesive attached, 1/2-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
    - a. Cover liner with nonporous foil.
    - b. Cover liner with nonporous foil and perforated metal.
  - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
  - 3. Air Outlet: S-slip and drive connections, size matching inlet size.
  - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
  - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
  - 1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
  - 2. Damper Position: Normally open.
- E. Attenuator Section: 0.034-inch steel sheet.
  - 1. Lining: Adhesive attached, 1/2-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
    - a. Cover liner with nonporous foil.
    - b. Cover liner with nonporous foil and perforated metal.
  - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- G. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 and shall have the following features:
  - 1. Damper Actuator: 24 V, powered closed, spring return open.
  - 2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
    - a. Occupied and unoccupied operating mode.
    - b. Remote reset of airflow or temperature set points.

- c. Adjusting and monitoring with portable terminal.
  - d. Communication with temperature-control system specified in Division 23 for instrumentation and control.
- 3. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.
- H. Control Sequence:
  - 1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
  - 2. System-powered, wall-mounted thermostat.

## 2.4 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Steel Cables: Galvanized steel complying with ASTM A 603.
- D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

## 2.5 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
  - 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
  - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.3 CONNECTIONS

- A. Install piping adjacent to air terminal unit to allow service and maintenance.
- B. Hot-Water Piping: In addition to requirements in Division 23 for hydronic piping, connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Connect ducts to air terminal units according to Division 23 for metal ducts.
- D. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 for air duct accessories.

### 3.4 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 for identification for HVAC piping for equipment labels and warning signs and labels.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
  - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
  - 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Air terminal unit will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

### 3.6 STARTUP SERVICE

- A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
  2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
  3. Verify that controls and control enclosure are accessible.
  4. Verify that control connections are complete.
  5. Verify that nameplate and identification tag are visible.
  6. Verify that controls respond to inputs as specified.

### 3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION

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## SECTION 235216 - CONDENSING BOILERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
    - a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
    - b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
  - 2. Include diagrams for power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23. Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

- b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Warranty: Special warranty specified in this Section.
- E. Other Informational Submittals:
  - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

#### 1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

#### 1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Fire-Tube Condensing Boilers:
    - a. Leakage and Materials: 10 years from date of Substantial Completion.
    - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FIRE-TUBE CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:
  - 1. AERCO International.
  - 2. Bosch Thermotechnology Corp.
  - 3. Heat Transfer Products, Inc.
  - 4. Or approved equal.
- B. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.
- C. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.
- D. Pressure Vessel: Carbon steel with welded heads and tube connections.
- E. Burner: Natural gas, forced draft.
- F. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
  - 1. Motors: Comply with requirements specified in Division 23 for common motor requirements.
    - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- H. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- I. Casing:
  - 1. Jacket: Sheet metal, with snap-in or interlocking closures.

2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Baked-enamel protective finish.
4. Insulation: Minimum 2-inch- thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.
6. Mounting base to secure boiler.

## 2.2 TRIM

- A. Include devices sized to comply with ANSI B31.1, "Power Piping."
- B. Aquastat Controllers: Operating, firing rate, and high limit.
- C. Safety Relief Valve: ASME rated.
- D. Pressure and Temperature gauge: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gauge. gauges shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- E. Boiler Air Vent: Automatic.
- F. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- G. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

## 2.3 CONTROLS

- A. Refer to Division 23 for instrumentation and control.
- B. Boiler operating controls shall include the following devices and features:
  1. Control transformer.
  2. Set-Point Adjust: Set points shall be adjustable.
  3. Operating Pressure Control: Factory wired and mounted to cycle burner.
  4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
  5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
  6. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature at 200 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.



7. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
  - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
- C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
  1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design pressure.
  2. Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
  3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
  4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- D. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
  1. Hardwired Points:
    - a. Monitoring: On/off status, common trouble alarm low water level alarm.
    - b. Control: On/off operation, hot water supply temperature set-point adjustment.
  2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

## 2.4 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
  1. House in NEMA 250, Type 1 enclosure.
  2. Wiring shall be numbered and color-coded to match wiring diagram.
  3. Install factory wiring outside of an enclosure in a metal raceway.
  4. Field power interface shall be to wire lugs.

5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
6. Provide each motor with overcurrent protection.

## 2.5 VENTING KITS

- A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
- B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

## 2.6 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
  1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 BOILER INSTALLATION

- A. Equipment Mounting: Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases specified in Division 03 for cast in place concrete.
  1. Coordinate sizes and locations of concrete bases with actual equipment provided.
  2. Construct bases to withstand, without damage to equipment, seismic force required by code.
  3. Construct concrete bases 4 inches high and extend base not less than 6 inches in all directions beyond the maximum dimensions of boiler unless otherwise indicated or unless required for seismic anchor support.

4. Minimum Compressive Strength: 5000 psi at 28 days.
  5. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  6. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
  7. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  8. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Equipment Mounting: Install boilers using elastomeric pads. Comply with requirements for vibration isolation devices specified in Division 23.
1. Minimum Deflection: 1/4 inch.
- C. Install gas-fired boilers according to NFPA 54.
- D. Assemble and install boiler trim.
- E. Install electrical devices furnished with boiler but not specified to be factory mounted.
- F. Install control wiring to field-mounted electrical devices.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 for hydronic piping.
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tapings with shutoff valve and union or flange at each connection.
- G. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tapings with shutoff valve and union or flange at each connection.
- H. Install piping from safety relief valves to nearest floor drain.
- I. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- J. Boiler Venting:
1. Install flue venting kit and combustion-air intake.
  2. Connect full size to boiler connections.

- K. Ground equipment according to Division 26.
- L. Connect wiring according to Division 26.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
  - 1. Perform installation and startup checks according to manufacturer's written instructions.
  - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.
- F. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- G. Performance Tests:
  - 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
  - 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
  - 3. Perform field performance tests to determine capacity and efficiency of boilers.
    - a. Test for full capacity.
    - b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
  - 4. Repeat tests until results comply with requirements indicated.
  - 5. Provide analysis equipment required to determine performance.

6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

**3.5 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 01, Demonstration and Training.

**END OF SECTION**

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## SECTION 237413 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
  - 1. Direct-expansion cooling.
  - 2. Hot-gas reheat.
  - 3. Gas furnace.
  - 4. Economizer outdoor- and return-air damper section.
  - 5. Integral, space temperature controls.
  - 6. Roof curbs.

#### 1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating

operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

- H. VVT: Variable-air volume and temperature.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design RTU supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Wind-Restraint Performance:
1. Basic Wind Speed: 125 MPH.
  2. Building Classification Category: III.
  3. Minimum 10 lb/sq. ft multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
  4. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

#### 1.5 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Wiring Diagrams: Power, signal, and control wiring.
- C. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
  2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
  3. Wind-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Structural members to which RTUs will be attached.
  2. Roof openings
  3. Roof curbs and flashing.

- B. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Division 23, Vibration and Seismic Controls for HVAC Piping and Equipment.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control test reports.
- D. Warranty: Special warranty specified in this Section.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: One set of filters for each unit.

#### 1.9 QUALITY ASSURANCE

- A. ARI Compliance:
  - 1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
  - 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
  - 1. Comply with ASHRAE 15 for refrigeration system safety.
  - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
  - 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995 (except when compliant with ASHRAE 15 and NFPA 90A and 90B).
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.



## 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  - 2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
  - 3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
  - 4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - 1. AAON, Inc.
  - 2. Addison Products Company.
  - 3. Carrier Corporation (Basis of Design).
  - 4. Annexair (Basis of Design).
  - 5. Engineered Air.
  - 6. Lennox Industries Inc.
  - 7. McQuay International.
  - 8. Trane; American Standard Companies, Inc.
  - 9. YORK International Corporation.
  - 10. Or approved equal.

### 2.2 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
  - 1. Exterior Casing Thickness: 0.052 inch thick.
- C. Inner Casing Fabrication Requirements:
  - 1. Inside Casing: Galvanized steel, 0.028 inch thick.
- D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
  2. Thickness: 2 inch (50 mm).
  3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
  4. Liner Adhesive: Comply with ASTM C 916, Type I.
- E. Condensate Drain Pans: Formed sections of galvanized-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.
1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
  2. Drain Connections: Threaded nipple both sides of drain pan.
  3. Pan-Top Surface Coating: Corrosion-resistant compound.
- F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

## 2.3 FANS

- A. Direct-Driven Supply-Air Fans: Plenum fan array; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- C. Relief-Air Fan: Plenum fan array, shaft mounted on permanently lubricated motor.
- D. Fan Motor: Comply with requirements in Division 23 for common motor requirements, in addition to the following:
1. Comply with NEMA MG 1 unless otherwise indicated.
  2. Comply with IEEE 841 for severe-duty motors.
  3. Motors under 1/2 HP shall be designed for 120V, 60 Hz, single phase, unless otherwise specified.
  4. Motors 1/2 HP and over shall be voltages as indicated in schedules on drawings.
  5. Efficiency: All motors shall be premium efficiency type as defined in NEMA MG 1 and shall have their efficiencies determined in accordance with IEEE Standard 112 Method B. The NEMA nominal efficiency shall be listed on the motor nameplate.
  6. Motor windings shall be spike resistant to withstand 1,600 peak volts. Motors shall have shaft grounding system to protect bearings from induced voltage. Shaft grounding system shall have very low drag, less than 1/2 percent of motor HP, and shall operate for a minimum of three (3) years without periodic adjustments. All consumables of the shaft grounding system shall be replaceable without a shutdown of the motor or VFD. System shall be as manufactured by SGS (Albany, Oregon) or approved equal.
- E. Each fan in a fan array shall be provided with an isolation backdraft damper.
- F. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15 percent of scheduled values.
- G. Each direct drive fan shall be in AMCA arrangement 4 according to drawings.

- H. Fans are to be equipped with lifting points.
- I. Fan array shall be equipped with piezometer rings to measure airflow. One piezometer ring shall be supplied on each fan in the fan array.

## 2.4 COILS

- A. Supply-Air Refrigerant Coil:
  - 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
  - 2. Coil Split: Interlaced.
  - 3. Baked phenolic coating.
  - 4. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating formed with pitch and drain connections complying with ASHRAE 62.1.
- B. Outdoor-Air Refrigerant Coil:
  - 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
  - 2. Baked phenolic coating.
- C. Hot-Gas Reheat Refrigerant Coil:
  - 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
  - 2. Baked phenolic coating.

## 2.5 REFRIGERANT CIRCUIT COMPONENTS

- A. Number of Refrigerant Circuits: Two.
- B. Compressor: Hermetic, reciprocating or Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.
- C. Refrigeration Specialties:
  - 1. Refrigerant: R-454B.
  - 2. Expansion valve with replaceable thermostatic element.
  - 3. Refrigerant filter/dryer.
  - 4. Manual-reset high-pressure safety switch.
  - 5. Automatic-reset low-pressure safety switch.
  - 6. Minimum off-time relay.
  - 7. Automatic-reset compressor motor thermal overload.
  - 8. Brass service valves installed in compressor suction and liquid lines.
  - 9. Low-ambient kit high-pressure sensor.
  - 10. Hot-gas reheat solenoid valve with a replaceable magnetic coil.
  - 11. Hot-gas bypass solenoid valve with a replaceable magnetic coil.

12. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

## 2.6 AIR FILTRATION

- A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  1. Pleated: Minimum 90 percent arrestance, and MERV 8 and 13.

## 2.7 GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
  1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel.
  1. Fuel: Natural gas.
  2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Venting: Gravity vented with vertical extension.
- E. Safety Controls:
  1. Gas Control Valve: Modulating.
  2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

## 2.8 DAMPERS

- A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
  1. Damper Motor: Modulating with adjustable minimum position.
  2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

## 2.9 UV RADIATION (AHU-1 ONLY)

- A. Provide UV light in supply airstream that emits UV-C radiation to kill airborne pathogens.

## 2.10 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

## 2.11 CONTROLS

- A. Control equipment and sequence of operation are specified in Division 23, Instrumentation and Control for HVAC.
- B. Basic Unit Controls:
  - 1. Control-voltage transformer.
  - 2. Wall-mounted thermostat or sensor for single-zone units with the following features:
    - a. Heat-cool-off switch.
    - b. Fan on-auto switch.
    - c. Fan-speed switch.
    - d. Automatic changeover.
    - e. Adjustable deadband.
    - f. Exposed set point.
    - g. Exposed indication.
    - h. Degree F indication.
    - i. Unoccupied-period-override push button.
    - j. Data entry and access port to input temperature and humidity set points, occupied and unoccupied periods, and output room temperature and humidity, supply-air temperature, operating mode, and status.
  - 3. Wall-mounted humidistat or sensor with the following features:
    - a. Exposed set point.
    - b. Exposed indication.
  - 4. Unit-Mounted Annunciator Panel for Each Unit:
    - a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
    - b. DDC controller or programmable timer and interface with HVAC instrumentation and control system.
    - c. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.
- C. DDC Controller:
  - 1. Controller shall have volatile-memory backup.
  - 2. Safety Control Operation:
    - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
    - b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F enters unit. Provide additional contacts for alarm interface to fire alarm control panel.

- c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Division 28, Digital, Addressable Fire-Alarm System and Division 28, Zoned (DC Loop) Fire-Alarm System.
  - d. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F.
- 3. Scheduled Operation: Occupied and unoccupied periods on 365-day clock with a minimum of four programmable periods per day.
- 4. Unoccupied Period:
  - a. Heating Setback: 10 deg F.
  - b. Cooling Setback: System off.
  - c. Override Operation: Two hours.
- 5. Supply Fan Operation:
  - a. Occupied Periods: Run fan continuously.
  - b. Unoccupied Periods: Cycle fan to maintain setback temperature.
- 6. Refrigerant Circuit Operation:
  - a. Occupied Periods: Cycle or stage compressors, and operate hot-gas bypass to match compressor output to cooling load to maintain discharge temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
  - b. Unoccupied Periods: Cycle compressors and condenser fans for heating to maintain setback temperature.
- 7. Hot-Gas Reheat-Coil Operation:
  - a. Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
  - b. Unoccupied Periods: Reheat not required.
- 8. Gas Furnace Operation:
  - a. Occupied Periods: Modulate burner to maintain discharge temperature.
  - b. Unoccupied Periods: Cycle burner to maintain setback temperature.
- 9. Economizer Outdoor-Air Damper Operation:
  - a. Occupied Periods: Open to fixed minimum intake percentage as defined by schedules, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F. Use mixed-air temperature and select between outdoor-air and return-air enthalpy to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper. During economizer cycle operation, lock out cooling.
  - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
  - c. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature, and output shall range from 2- to 10-V dc.

10. Carbon Dioxide Sensor Operation:
  - a. Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 1000-ppm concentration.
  - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
11. VVT Relays:
  - a. Provide heating- and cooling-mode changeover relays compatible with VVT terminal control system required in Division 23, Air Terminal Units and Division 23, Instrumentation and Control for HVAC.
- D. Interface Requirements for HVAC Instrumentation and Control System:
  1. Interface relay for scheduled operation.
  2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
  3. Provide BACnet compatible interface for central HVAC control workstation for the following:
    - a. Adjusting set points.
    - b. Monitoring supply fan start, stop, and operation.
    - c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
    - d. Monitoring occupied and unoccupied operations.
    - e. Monitoring constant and variable motor loads.
    - f. Monitoring variable-frequency drive operation.
    - g. Monitoring cooling load.
    - h. Monitoring economizer cycles.
    - i. Monitoring air-distribution static pressure and ventilation air volume.

## 2.12 ACCESSORIES

- A. Electric heater with integral thermostat maintains minimum 50 deg F temperature in gas burner compartment.
- B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
- C. Low-ambient kit using variable-speed condenser fans for operation down to 35 deg F.
- D. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- E. Coil guards of painted, galvanized-steel wire.
- F. Hail guards of galvanized steel, painted to match casing.
- G. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

## 2.13 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 23, Vibration and Seismic Controls for HVAC Piping and Equipment.
- B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
  - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
    - a. Materials: ASTM C 1071, Type I or II.
    - b. Thickness: 1-1/2 inches.
  - 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
    - a. Liner Adhesive: Comply with ASTM C 916, Type I.
    - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
    - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
    - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- C. Curb Height: 24 inches.
- D. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Division 23, Vibration and Seismic Controls for HVAC Piping and Equipment for wind-load requirements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Roof Curb: Install on roof structure or concrete base, level and secure, according to ARI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07, Roof Accessories. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.



- B. Install wind restraints according to manufacturer's written instructions. Wind restrained vibration isolation roof-curb rails are specified in Division 23, Vibration Controls for HVAC Piping and Equipment.

### 3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Install piping adjacent to RTUs to allow service and maintenance.
  - 1. Gas Piping: Comply with applicable requirements in Division 22, Plumbing Natural-Gas Piping. Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  - 1. Install ducts to termination at top of roof curb.
  - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
  - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23, Air Duct Accessories.
  - 4. Install return-air duct continuously through roof structure.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Tests and Inspections:
  - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
  - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

### 3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
  - 1. Inspect for visible damage to unit casing.
  - 2. Inspect for visible damage to furnace combustion chamber.

3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Verify lubrication on fan and motor bearings.
14. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
15. Adjust fan belts to proper alignment and tension.
16. Start unit according to manufacturer's written instructions.
  - a. Start refrigeration system.
  - b. Do not operate below recommended low-ambient temperature.
  - c. Complete startup sheets and attach copy with Contractor's startup report.
17. Inspect and record performance of interlocks and protective devices; verify sequences.
18. Operate unit for an initial period as recommended or required by manufacturer.
19. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
  - a. Measure gas pressure on manifold.
  - b. Inspect operation of power vents.
  - c. Measure combustion-air temperature at inlet to combustion chamber.
  - d. Measure flue-gas temperature at furnace discharge.
  - e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
  - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
20. Calibrate thermostats.
21. Adjust and inspect high-temperature limits.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
  - a. Coil leaving-air, dry- and wet-bulb temperatures.

- b. Coil entering-air, dry- and wet-bulb temperatures.
  - c. Outdoor-air, dry-bulb temperature.
  - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
- 24. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
- 25. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
  - a. Supply-air volume.
  - b. Return-air volume.
  - c. Relief-air volume.
  - d. Outdoor-air intake volume.
- 26. Simulate maximum cooling demand and inspect the following:
  - a. Compressor refrigerant suction and hot-gas pressures.
  - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
- 27. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
  - a. High-temperature limit on gas-fired heat exchanger.
  - b. Low-temperature safety operation.
  - c. Filter high-pressure differential alarm.
  - d. Economizer to minimum outdoor-air changeover.
  - e. Relief-air fan operation.
  - f. Smoke and firestat alarms.
- 28. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

### 3.6 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 01, Demonstration and Training.

END OF SECTION

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AIR-HANDLING UNITS.DOC

## SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: One set(s) for each air-handling unit.

2. Gaskets: One set(s) for each access door.
3. Fan Belts: One set(s) for each air-handling unit fan.

#### 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
  1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
  2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

#### 1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03, Cast-in-Place Concrete.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

#### 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
  1. Warranty Period:
    - a. For Compressor: Five year(s) from date of Substantial Completion.
    - b. For Parts: One year(s) from date of Substantial Completion.
    - c. For Labor: One year(s) from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
  1. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
  2. Friedrich Air Conditioning Company.
  3. Koldwave, Inc.; a Mestek company.
  4. Lennox International Inc.

5. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
6. Mitsubishi Electric Sales Canada Inc.
7. Mitsubishi Heavy Industries America, Inc.
8. SANYO North America Corporation; SANYO Fisher Company.
9. Trane; a business of American Standard companies.
10. YORK; a Johnson Controls company.
11. Or approved equal.

## 2.2 INDOOR UNITS (5 TONS OR LESS)

### A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 for common motor requirements.
  - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
  - c. Enclosure Type: Totally enclosed, fan cooled.
  - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
  - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
  - f. Mount unit-mounted disconnect switches on exterior of unit.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Condensate Drain Pans:
  - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
    - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
    - 2) Depth: A minimum of 1 inch deep.
  - b. Double-wall, galvanized-steel sheet with space between walls filled with foam insulation and moisture-tight seal.

- c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
    - 1) Minimum Connection Size: NPS 1 <Insert size>.
  - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
7. Air Filtration Section:
- a. General Requirements for Air Filtration Section:
    - 1) Comply with NFPA 90A.
    - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
    - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
  - b. Disposable Panel Filters:
    - 1) Factory-fabricated, viscous-coated, flat-panel type.
    - 2) Thickness: 1 inch.
    - 3) Merv according to ASHRAE 52.2: 5.
    - 4) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

## 2.3 OUTDOOR UNITS (5 TONS OR LESS)

### A. Air-Cooled, Compressor-Condenser Components:

- 1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gauge ports on exterior of casing.
- 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - a. Compressor Type: Scroll.
  - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
  - c. Refrigerant Charge: R-410A.
  - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
- 3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
- 4. Fan: Aluminum-propeller type, directly connected to motor.
- 5. Motor: Permanently lubricated, with integral thermal-overload protection.



6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

## 2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Division 23, Instrumentation and Control for HVAC and Division 23, Sequence and Operations for HVAC Controls.
- B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
  1. Compressor time delay.
  2. 24-hour time control of system stop and start.
  3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
  4. Fan-speed selection including auto setting.
- D. Automatic-reset timer to prevent rapid cycling of compressor.
- E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- F. Drain Hose: For condensate.
- G. Additional Monitoring:
  1. Monitor constant and variable motor loads.
  2. Monitor variable-frequency-drive operation.
  3. Monitor economizer cycle.
  4. Monitor cooling load.
  5. Monitor air distribution static pressure and ventilation air volumes.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07, Roof Accessories. Anchor units to supports with removable, cadmium-plated fasteners.
- D. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. See Division 23, Vibration Controls for HVAC Piping and Equipment.
- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

### 3.4 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

### 3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

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## **SECTION 238216 - AIR COILS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following types of air coils that are not an integral part of air-handling units:
  - 1. Electric.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil.
- B. Shop Drawings: Diagram power, signal, and control wiring.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.
- B. Field quality-control test reports.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

#### **1.6 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance:
  - 1. Comply with ASHRAE 15 for refrigeration system safety.
  - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

## PART 2 - PRODUCTS

### 2.1 ELECTRIC COILS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  1. Brasch Manufacturing Co., Inc.
  2. Chromalox, Inc., Wiegand Industrial Division; Emerson Electric Company.
  3. Dunham-Bush, Inc.
  4. INDEECO.
  5. Trane.
  6. Or approved equal.
- B. Coil Assembly: Comply with UL 1995.
- C. Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, and fastened to supporting brackets.
- D. High-Temperature Coil Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.
  1. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
- E. Frames: Galvanized-steel channel frame, minimum 0.052 inch thick for flanged mounting.
- F. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
  1. Magnetic contactor.
  2. Mercury contactor.
  3. Toggle switches; one per step.
  4. Step controller.
  5. Time-delay relay.
  6. Pilot lights; one per step.
  7. Airflow proving switch.
- G. Refer to Division 23, Instrumentation and Control for HVAC for thermostat.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

### **3.3 CONNECTIONS**

- A. Ground equipment according to Division 26, Grounding and Bonding for Electrical Systems.
- B. Connect wiring according to Division 26, "Low-Voltage Electrical Power Conductors and Cables."

### **3.4 FIELD QUALITY CONTROL**

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

**END OF SECTION**

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## SECTION 238239.13 - CABINET UNIT HEATERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes cabinet unit heaters with centrifugal fans and hot-water coils.

#### 1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. CWP: Cold working pressure.
- C. PTFE: Polytetrafluoroethylene plastic.
- D. TFE: Tetrafluoroethylene plastic.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include location and size of each field connection.
  - 4. Include details of anchorages and attachments to structure and to supported equipment.
  - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
  - 6. Indicate location and arrangement of piping valves and specialties.
  - 7. Indicate location and arrangement of integral controls.

8. Wiring Diagrams: Power, signal, and control wiring.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Suspended ceiling components.
  2. Structural members to which cabinet unit heaters will be attached.
  3. Method of attaching hangers to building structure.
  4. Size and location of initial access modules for acoustical tile.
  5. Items penetrating finished ceiling, including the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
  6. Perimeter moldings for exposed or partially exposed cabinets.
- B. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Cabinet Unit-Heater Filters: Furnish one spare filter(s) for each filter installed.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:

1. Airtherm; a Mestek company.
2. Berko; Marley Engineered Products.
3. Carrier Corporation; a UTC company.
4. Chromalox, Inc.
5. Dunham-Bush, Inc.
6. Engineered Air.
7. Indeeco.
8. International Environmental Corporation.
9. Markel Products Company; TPI Corporation.
10. Marley Engineered Products.
11. McQuay International.
12. Ouellet Canada Inc.
13. QMark; Marley Engineered Products.
14. Rosemex Products.
15. Trane Inc.
16. USA Coil & Air.
17. Or approved equal.

## 2.2 DESCRIPTION

- A. Factory-assembled and -tested unit complying with AHRI 440.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.3 PERFORMANCE REQUIREMENTS

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

## 2.4 COIL SECTION INSULATION

- A. Insulation Materials: ASTM C 1071; surfaces exposed to airstream shall have erosion-resistant coating to prevent erosion of glass fibers.



1. Thickness: 1 inch.
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

## 2.5 CABINETS

- A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
  1. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch- thick galvanized sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
  2. Recessed Flanges: Steel, finished to match cabinet.
  3. Control Access Door: Key operated.
  4. Base: Minimum 0.0528-inch- thick steel, finished to match cabinet, 4 inches high with leveling bolts.
  5. Extended Piping Compartment for concealed piping connections.
  6. False Back: Minimum 0.0428-inch- thick steel, finished to match cabinet.

## 2.6 FILTERS

- A. Minimum Arrestance: According to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  1. Pleated: 90 percent arrestance and MERV 7.

## 2.7 COILS

- A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

## 2.8 CONTROLS

- A. Fan and Motor Board: Removable.
  1. Fan: Forward curved, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.

2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 for common motor requirements.
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- B. Factory, Hot-Water Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
  1. Two-way, modulating control valve.
  2. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
    - a. Length: 24 inches.
    - b. Minimum Diameter: Equal to cabinet unit-heater connection size.
  3. Two-Piece, Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
  4. Calibrated-Orifice Balancing Valves: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venture, connection for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
  5. Automatic Flow-Control Valve: Brass or ferrous-metal body, 300-psig working pressure at 250 deg F, with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow within plus or minus 10 percent of differential pressure range of 2 to 80 psig.
  6. Y-Pattern, Hot-Water Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig minimum working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 threaded pipe and full-port ball valve in strainer drain connection.
  7. Wrought-Copper Unions: ASME B16.22.
- C. Control devices and operational sequences are specified in Division 23, Instrumentation and Control for HVAC and Division 23, Sequence of Operations for HVAC Controls.
- D. Basic Unit Controls:
  1. Control voltage transformer.
  2. Unit-mounted thermostat with the following features:
    - a. Heat-off switch.
    - b. Fan on-auto switch.
    - c. Manual fan-speed switch.
    - d. Adjustable deadband.

- e. Concealed set point.
  - f. Concealed indication.
  - g. Deg F indication.
- 3. Unit-mounted temperature sensor.
- 4. Unoccupied period override push button.
- 5. Data entry and access port.
  - a. Input data includes room temperature and occupied and unoccupied periods.
  - b. Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.
- E. DDC Terminal Controller:
  - 1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
  - 2. Unoccupied Period Override: Two hours.
  - 3. Unit Supply-Air Fan Operations:
    - a. Occupied Periods: Fan runs continuously.
    - b. Unoccupied Periods: Fan cycles to maintain setback room temperature.
  - 4. Heating-Coil Operations:
    - a. Occupied Periods: Modulate control valve to provide heating if room temperature falls below thermostat set point.
    - b. Unoccupied Periods: Start fan and modulate control valve if room temperature falls below setback temperature.
  - 5. Controller shall have volatile-memory backup.
- F. BAS Interface Requirements:
  - 1. Interface relay for scheduled operation.
  - 2. Interface relay to provide indication of fault at central workstation.
  - 3. Interface shall be BAC-net compatible for central BAS workstation and include the following functions:
    - a. Adjust set points.
    - b. Cabinet unit-heater start, stop, and operating status.

- c. Data inquiry, including supply-air and room-air temperature.
- d. Occupied and unoccupied schedules.
- G. Electrical Connection: Factory-wired motors and controls for a single field connection.

## 2.9 CAPACITIES AND CHARACTERISTICS

- A. Cabinet:
  - 1. Vertical, Surface Mounted: Upflow.
    - a. Top: Flat.
    - b. Air Inlet: Open bottom.
    - c. Air Outlet: Top, punched louver.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07, Joint Sealants.
- B. Install cabinet unit heaters to comply with NFPA 90A.
- C. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Section 23, Vibration and Seismic Controls for HVAC Piping and Equipment.
- D. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in Division 23, Hydronic Piping and Division 23, Steam and Condensate Heating Piping. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- D. Comply with safety requirements in UL 1995.

- E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of cabinet unit heater. Hydronic specialties are specified in Division 23, Hydronic Piping.
- F. Ground equipment according to Division 26, Grounding and Bonding for Electrical Systems.
- G. Connect wiring according to Division 26, Low-Voltage Electrical Power Conductors and Cables.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.5 ADJUSTING

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

END OF SECTION

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## SECTION 238239.19 - WALL AND CEILING UNIT HEATERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include details of anchorages and attachments to structure and to supported equipment.
  - 4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
  - 5. Wiring Diagrams: Power, signal, and control wiring.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
1. Modine.
  2. Berko; Marley Engineered Products.
  3. Chromalox, Inc.
  4. Indeeco.
  5. Markel Products Company; TPI Corporation.
  6. Marley Engineered Products.
  7. Ouellet Canada Inc.
  8. QMark; Marley Engineered Products.
  9. Trane Inc.
  10. Or approved equal.

### 2.2 DESCRIPTION

- A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### 2.3 CABINET

- A. Front Panel: Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
- B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

### 2.4 COIL

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant

metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection.

## 2.5 FAN AND MOTOR

- A. Fan: Aluminum propeller directly connected to motor.
- B. Motor: Permanently lubricated. Comply with requirements in Division 23 for common motor requirements for HVAC equipment.

## 2.6 CONTROLS

- A. Controls: Unit-mounted thermostat.
- B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

## 2.7 CAPACITIES AND CHARACTERISTICS

- A. Refer to schedules.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

- A. Install wall and ceiling unit heaters to comply with NFPA 90A.
- B. Install wall and ceiling unit heaters level and plumb.
- C. Ground equipment according to Division 26, Grounding and Bonding for Electrical Systems.
- D. Connect wiring according to Division 26, Low-Voltage Electrical Power Conductors and Cables.

END OF SECTION

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## SECTION 238323 - RADIANT-HEATING ELECTRIC PANELS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes prefabricated radiant-heating electric panels.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For electric heating panels.
  - 1. Include plans, sections, details, and attachments to other work.
  - 2. Include diagrams for power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Method of attaching hangers to building structure.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric heating panels to include in operation and maintenance manuals.

#### 1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace electric heating panels that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Three years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL REQUIREMENTS FOR RADIANT-HEATING ELECTRIC PANELS**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### **2.2 PREFABRICATED RADIANT-HEATING ELECTRIC PANELS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following, or approved equal:
  - 1. Brasch (basis-of-design).
  - 2. Berko; c/o Marley Engineered Products.
  - 3. QMark; c/o Marley Engineered Products.
  - 4. SSHC, Inc.
  - 5. Or approved equal.
- B. Description: Sheet-metal-enclosed panel with heating element suitable for wall surface mounting. Comply with UL 2021.
  - 1. Panel: Minimum 0.0276-inch- thick, galvanized sheet steel back panel riveted to minimum 0.0396-inch- thick, galvanized sheet steel front panel with fused-on crystalline surface.
  - 2. Heating Element: Powdered graphite sandwiched between sheets of electric insulation.
  - 3. Electrical Connections: Nonheating, high-temperature, insulated-copper leads, factory connected to heating element.
  - 4. Exposed-Side Panel Finish: Baked-enamel finish in manufacturer's standard paint color as selected by Architect.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine surfaces and substrates to receive electric heating panels for compliance with requirements for installation tolerances and other conditions affecting performance.
  - 1. Ensure surfaces in contact with electric heating panels are free of burrs and sharp protrusions.
  - 2. Ensure surfaces and substrates are level and plumb.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install radiant-heating panels level and plumb.

### 3.3 CONNECTIONS

- A. Ground equipment according to Division 26, Grounding and Bonding for Electrical Systems.
- B. Connect wiring according to Division 26, Low-Voltage Electrical Power Conductors and Cables.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
  - 1. Operate electric-heating elements through each stage to verify proper operation and electrical connections.
  - 2. Test and adjust controls and safeties.
- C. Radiant-heating electric panels will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.5 PROTECTION

- A. Protect installed radiant-heating electric panels from damage during construction.
- B. Remove and replace damaged radiant-heating electric panels.

END OF SECTION

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## SECTION 238416 - MECHANICAL DEHUMIDIFICATION UNITS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes packaged, factory-assembled and -tested, refrigerant-type, mechanical dehumidification units designed for outdoor installation.

#### 1.3 PERFORMANCE REQUIREMENTS

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each dehumidification unit indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
  - 1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
  - 2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5, "Systems and Equipment."
- C. Shop Drawings: For each dehumidification unit indicated. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
- D. Delegated-Design Submittal: For dehumidification units indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
  - 2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.
- B. Field quality-control reports.
- C. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For dehumidification units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: One set(s) of each type of filter specified.
  - 2. Fan Belts: One set(s) for each belt-drive fan.

1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
  - 1. Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment" and Section 7, "Construction and Startup."
  - 2. Applicable requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of dehumidification units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  - 2. Warranty Period for Refrigerant Coils: Manufacturer's standard, but not less than five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
  - 1. Comitale National Inc.
  - 2. Dectron Internationale.
  - 3. Dehumidifier Corporation of America.
  - 4. Desert Aire.
  - 5. DryAire Systems.
  - 6. Nautica Dehumidifiers, Inc.
  - 7. PoolPak Technologies Corporation.
  - 8. Thermoplus Air Inc.
  - 9. Or approved equal.

### 2.2 CASINGS

- A. Casing: Double-wall construction with corrosion-protective coating and exterior baked-enamel or powder-coated finish, stainless-steel fasteners, knockouts for electrical and piping connections, condensate drain connection, and lifting lugs.
  - 1. Access: Hinged access doors with neoprene gaskets.
  - 2. Insulation: Minimum 2-inch- thick, glass-fiber-insulation fill with no metal structure through the insulation.
  - 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- B. Drain Pan and Connection: baked powder paint coated aluminum with fully welded corners; insulated and complying with ASHRAE 62.1.

### 2.3 FANS

- A. Supply Fans: Airfoil plenum; galvanized steel with baked-enamel powder-coated finish; belt driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings with extended grease fittings easily accessible inside the casing of dehumidification unit.
- B. Exhaust Fans: Airfoil plenum; galvanized steel with baked-enamel powder-coated finish; belt driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings with extended grease fittings easily accessible inside the casing of dehumidification unit.
- C. Fan Motor: Comply with requirements in Division 23.
  - 1. Enclosure Type: Totally enclosed, fan cooled.

## 2.4 FILTERS

- A. Pleated: Minimum 90 percent arrestance according to ASHRAE 52.1, and MERV 8 and MERV 13 according to ASHRAE 52.2.

## 2.5 REFRIGERATION SYSTEM

- A. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1.
- B. Refrigerant Coils: Copper tubes with mechanically bonded aluminum fins; factory fabricated and tested to comply with ASHRAE 33 and ARI 410; with multiple refrigerant circuits, seamless-copper headers with brazed connections, and galvanized-steel frame. Coil and fins shall have a polyester coating. Coils shall have a minimum 300-psig working-pressure rating and be factory tested to 450 psig and to 300 psig while underwater.
- C. Compressors: Hermetic, scroll compressors with integral vibration isolators and crankcase heaters that de-energize during compressor operation; with thermal-expansion valves, filter-dryers, sight glasses, compressor service valves, and liquid- and suction-line service valves.
  - 1. Number of Refrigerant Circuits: Two for compressor capacities more than 7-1/2 tons.
  - 2. Refrigerant: R-454b.
  - 3. Capacity Control:
    - a. Hot-gas bypass valve and piping on one compressor.
  - 4. Low-Pressure Cutout: Manual reset after three automatic-reset failures.
  - 5. High-Pressure Cutout: Manual reset.
  - 6. Compressor Motor Overload Protection: Manual reset.
  - 7. Antirecycling Timing Device: Prevent compressor restart for five minutes after shutdown.
- D. Energy Recovery Heat Exchanger (Pool Heater): Cupronickel, coaxial, vented, double-wall construction for potable-water service.

## 2.6 PACKAGED, AIR-COOLED CONDENSER UNIT

- A. Casing: Steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gauge ports on exterior of casing.
- B. Refrigerant Coil: ARI 210/240, copper tube with mechanically bonded aluminum fins; with liquid subcooler.
- C. Fan: Aluminum-propeller type, directly connected to permanently lubricated motor with integral thermal-overload protection.
- D. Adjustable, Low Ambient Head-Pressure Control: Designed to operate at temperatures as low as 0 deg F by cycling condenser fans and controlling speed of last fan of each circuit.

## 2.7 REHEATING COILS

- A. Hot-Water Coil: Continuous circuit coil fabricated according to ARI 410.
  - 1. Tubes: Copper.

2. Fins: Aluminum.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Cast iron with drain and air vent tappings.
5. Frames: Galvanized-steel channel, 0.052 inch.
6. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
  - a. Working-Pressure Ratings: 200 psig, 325 deg F.
7. Source Quality Control: Test to 300 psig.

## 2.8 DAMPERS

- A. Outdoor and Exhaust-Air Dampers: Opposed-blade, extruded-aluminum dampers with steel operating rod rotating in sintered bronze or nylon bearings. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod. Size for 0 to 25 percent outdoor air, with motorized operator and filter.
- B. Damper Operator: Close coupled, with gear train sealed in oil and with spring return.

## 2.9 CONTROLS

- A. Control Panel: Integral service compartment containing fan-motor thermal and overload cutouts, compressor thermal and overload cutouts, 115-V control transformer if required, magnetic contactors for fan and compressor motors, and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.
- B. Building Automation System Interface: Factory-installed hardware and software to enable the building automation system to monitor, control, and display status and alarms.
- C. Operating Controls: Factory-installed microprocessor controller, capable of being remotely mounted.
  1. Display the following on the face of controller:
    - a. System on.
    - b. System dehumidifying mode.
    - c. System air-conditioning mode.
    - d. System outdoor-air (economizer) mode.
    - e. System heating pool water.
    - f. Auxiliary space heat is operating.
    - g. Unit requires service.
    - h. Return-air (space) temperature.
    - i. Return-air (space) humidity.
    - j. Outdoor-air temperature.
  2. Indicate the following sensor failures on panel:
    - a. Airflow: Dirty air filter, blocked airflow, and fan failure.
    - b. Refrigerant high and low pressure.



- c. High water temperature.
  - d. High and low evaporator temperature.
  - e. Low water flow.
  - f. Communication fault.
  - g. System off.
  - h. Antishort cycle delay.
  - i. Power failure.
3. Provide access to the following set points on panel:
- a. Space temperature.
  - b. Space relative humidity.
  - c. Outdoor ventilation/air-conditioning changeover temperature.
  - d. Airflow alarm.
4. Provide the following displays on panel:
- a. Space temperature.
  - b. Space relative humidity.
  - c. Outdoor-air temperature.
  - d. Supply-air temperature.
  - e. Return-air temperature.
  - f. Airflow rating.
  - g. Air-off evaporator temperature.
  - h. Return-air relative humidity.
  - i. Service codes.
5. Provide the following controls on panel:
- a. System on-off, fan continues to run.
  - b. Fan on-off.
  - c. Service code access.
  - d. System dehumidifying mode.
  - e. System air-conditioning mode.
  - f. System outdoor-air (economizer) mode.
  - g. Auxiliary space heat is operating.
  - h. Outdoor-air-temperature, conditioned-space-temperature, and control set-point-temperature digital display.
  - i. Outdoor enthalpy digital display.
  - j. Filter pressure drop digital display.
  - k. Status: Airflow, fans, system, unit operation, and operating mode.

1. Alarm digital display.
- D. Operating Controls: Factory-installed microprocessor controller.
  1. Factory-installed operator panel with backlit display, capable of being remotely mounted, allows menu-driven display for navigation and control of unit.
  2. Integral clock.
  3. Personal computer interface.
  4. Integral local area network for direct connection to BACnet.
  5. Factory programmed.
  6. Unit-Mounted Sensors:
    - a. Airflow switch.
    - b. Compressor-discharge temperature.
    - c. Evaporator-air temperature.
    - d. Pool-water-out temperature.
    - e. Pool-water-in temperature.
    - f. Relative humidity.
    - g. Return-air temperature.
    - h. Supply-air temperature.
  7. Integral diagnostics.
  8. Nonvolatile memory.
  9. IP or SI display.
  10. Provide the following status and alarm functions:
    - a. System: On-off.
    - b. Power failure.
    - c. Fan: Off, overload.
    - d. Compressor: On, turned off, overload, high pressure, low pressure, overheat, oil failure, and pumpdown.
    - e. Evaporator damper closed.
    - f. Pool: Low water flow, heating on.
    - g. Dehumidification: Call for, on.
    - h. Air Conditioning: Call for, on.
    - i. System outdoor-air (economizer) mode.
    - j. Auxiliary space heat on.
    - k. Alarms: Firestat, freezestat, and filters.
  11. Provide the following controls via operator panel:
    - a. Compressor auto-off.

- b. Fan auto-off.
  - c. Set-Point Adjustments: Relative humidity, temperatures, deadbands, and differentials.
  - d. Sensor calibration.
- 12. Monitor constant and variable motor loads.
  - 13. Monitor cooling load.
  - 14. Monitor economizer cycles.
  - 15. Monitor ventilation air volumes.

## 2.10 ACCESSORIES

- A. Smoke Detectors: Photoelectric detector located in return-air plenum, to de-energize unit.
  - 1. Operating Voltage: 24-V dc, nominal.
  - 2. Self-Restoring: Detectors do not require resetting or readjusting after actuation to restore them to normal operation.
  - 3. Plug-in Arrangement: Detector and associated electronic components mounted in module with tamper-resistant connection to fixed base with twist-locking plug. Terminals in fixed base accept building wiring.
  - 4. Integral Visual-Indicating Light: Digital-display type indicating detector operation.
  - 5. Sensitivity: Can be tested and adjusted in-place after installation.
  - 6. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the fire-alarm control panel.
  - 7. Sensor: Digital display or infrared light source with matching silicon-cell receiver.
  - 8. Detector Sensitivity: Between 2.5 and 3.5 percent/foot of smoke obscuration when tested according to UL 268A.
  - 9. Integral Thermal Detector: Fixed-temperature type with 135 deg F setting.
- B. Electrical Convenience Outlet: 115-V ac fused, duplex, straight-blade receptacles, separately fused and located inside casing of dehumidification unit or in roof-curb perimeter.

## 2.11 ROOF CURBS

- A. Roof curbs with vibration isolators and wind restraints are specified in Division 23.
- B. Curb Height: 24 inches.
- C. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match dehumidification unit; used to anchor unit to the curb and designed for loads at Project site. Comply with requirements in Division 23 for wind-load requirements.

## 2.12 SOURCE QUALITY CONTROL

- A. Verification of Performance: Factory test and rate dehumidification units according to ARI 910.

- B. Sound-Power-Level Ratings: Factory test and rate dehumidification units according to ARI 575.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for water piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where dehumidification units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Unit Support: Install dehumidification units level on structural curbs. Coordinate wall penetrations and flashing with wall construction.

#### **3.3 CONNECTIONS**

- A. Where piping is installed adjacent to dehumidification units, allow space for service and maintenance of dehumidification units.
- B. Connect condensate drain pans using minimum NPS 1-1/4 copper tubing. Construct deep trap at connection to drain pan, and install cleanout at changes in direction.
- C. Refrigerant Piping (for remote condensers only): Comply with requirements in Division 23. Connect to supply and return coil tapplings with shutoff valve and union or flange at each connection.
- D. Hot-Water Piping: Comply with requirements in Division 23. Connect to supply coil tapplings with shutoff valve, return coil tapplings with balancing valve, and union or flange at each connection.
- E. Duct installation requirements are specified in Division 23. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  - 1. Install ducts to termination in roof-mounted frames. Where indicated, terminate return-air duct through roof structure and insulate the space between roof and bottom of dehumidification unit.

#### **3.4 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
  - 1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks. Repair leaks and retest until no leaks exist.

2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Dehumidification unit will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
- B. Perform the following final checks before startup:
1. Verify that shipping, blocking, and bracing are removed.
  2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  3. Perform cleaning and adjusting specified in this Section.
  4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
  5. Check lubrication of bearings, pulleys, belts, and other moving parts.
  6. Set outside- and return-air mixing dampers to minimum outside-air setting.
  7. Install clean filters.
  8. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- C. Starting procedures for dehumidification units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace malfunctioning motors, bearings, and fan wheels.
  2. Measure and record motor's electrical values for voltage and amperage.
  3. Manually operate dampers from fully closed to fully open position and record fan performance.
- D. Comply with requirements in Division 23 for testing, adjusting, and balancing of dehumidification unit.
- E. Startup Report: Report findings during startup. Identify startup steps, corrective measures taken, and final results.

### 3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust initial temperature and humidity set points.

**3.7 CLEANING**

- A. Clean dehumidification units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils' entering-air face.
- B. After completing system installation, testing, and startup service of dehumidification units, clean filter housings and install new filters.

**3.8 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain dehumidification units.

**END OF SECTION**

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**DEHUMIDIFICATION**

## SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
  - 1. For example, prior to requesting an occupancy permit, the MEP documentation listed in Part 3 of Division 20 (in paragraph "MEP and Fire Protection Completion Requirements", subparagraph "Occupancy Permit" must be submitted and approved so the Engineer can certify that the MEP systems and life safety provisions are completed.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Electrical equipment coordination and installation.
  - 2. Sleeves for raceways and cables.
  - 3. Sleeve seals.
  - 4. Grout.
  - 5. Common electrical installation requirements.

#### 1.3 DEFINITIONS

- A. Emergency Systems: Loads defined by NFPA 70, Article 700 "Emergency Systems". Those systems intended to supply egress lighting.
- B. Legally Required Standby Systems: Loads defined by NFPA 70, Article 701 "Legally Required Standby Systems". Those systems classified as legally required intended to supply loads such as smoke exhaust systems.
- C. Optional Standby Systems: Loads defined by NFPA 70, Article 702 "Optional Standby Systems". Those systems intended to supply loads such as laboratory equipment.
- D. Feeder: All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent. Feeders may be identified in the "Legend of Feeder Sizes" identified on the drawings. All feeders are required to be in conduit. MC cable is not permitted unless specifically approved by the Engineer via an RFI or substitution request form. Submittal reviews of product does not permit use of MC cable for feeders.
- E. Branch Circuit: The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s) device. Branch circuits may be identified in the "Branch Circuit Schedule" on the drawings.

- F. EPDM: Ethylene-propylene-diene terpolymer rubber.

#### 1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

#### 1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
  - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  - 3. To allow right of way for piping and conduit installed at required slope.
  - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.

#### 1.6 MATERIALS AND WORKMANSHIP

- A. Work shall be neat and rectilinear. Install material and equipment in accordance with manufacturers written instructions. Installation shall operate safely and without noise, vibration or corrosion. Work shall be properly and effectively protected, and raceway openings shall be temporarily closed to prevent obstruction and damage before completion.
- B. Except as specified otherwise, material and equipment shall be new, factory tested and delivered ready for field installation. Provide supplies, accessories and connections necessary for complete and operational installation. Provide components required or recommended by OSHA and applicable NFPA documents. Equipment damaged during installation shall be repaired to new condition or replaced with new material. The contractor shall be responsible for all costs associated with testing, replacing to repair, including but not limited to, all replacement or repair costs, preparations prior to testing, all testing costs, extended warranties, re-commissioning of the equipment, etc. with no additional cost to the contract.
- C. The contractor shall take steps necessary to ensure that all materials and equipment can be delivered and installed in sections sufficiently small to fit within openings in the building and that the weight and size of all equipment pieces so not exceed the capacity of the hoisting and/or elevator system.
- D. Owner will not be responsible for material and equipment before testing, commissioning, and acceptance.



## 1.7 EQUIPMENT LOCATION

- A. Location of all wall outlets shall be verified with the Architect prior to roughing in. Refer to details and elevations on the architectural drawings. Mounting heights indicated on the architectural drawings shall take precedence over information indicated on the electrical drawings.
- B. If discrepancies regarding the locations of outlet boxes exist between the electrical drawings and any other drawings associated with the project, notify the Architect. Any reasonable change in location of outlets shall not involve additional expense to Owner. The term “reasonable” shall be interpreted as moving outlet 10’-0” in any direction from the location indicated on the Electrical drawings. Refer to specifications 230000 for additional information.

## 1.8 EMERGENCY SYSTEMS

- A. To comply with the Building Code, “Emergency Systems” shall be separated from other loads in a dedicated room within a 2-hour fire rated enclosure. Generally emergency power will be distributed from the emergency system transfer switch to distribution equipment located in 2-hour fire rated emergency electrical rooms/closets located at strategic points in the building.
- B. The electrical contractor shall identify the 2-hour fire rated rooms/closets with the General Contractor for coordination purposes. All equipment, conduit, piping, ductwork etc, alien to the emergency system shall not be located within these rooms, closets or shafts.
- C. All feeders located outside the 2 hour fire rated rooms/closets shall be installed in a 2-hour fire rated enclosure or the feeder shall be 2-hour mineral insulated (MI) cable.

## 1.9 CABLE TERMINATION TEMPERATURE RATINGS

- A. All equipment terminations connecting to wire and cable, rated 600V or less shall be rated for 75 deg. C for conductors 1 AWG and smaller and/or where conductor ampacities are 100 A or less.

## PART 2 - PRODUCTS

### 2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel.
  - 1. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
    - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

### 2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Advance Products & Systems, Inc.
  - b. Calpico, Inc.
  - c. Metraflex Co.
  - d. Pipeline Seal and Insulator, Inc.
  - e. or approved equal.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Plastic. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

### 2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

### 2.4 CORDS AND CAPS

- A. Attachment Plug Configuration: Match receptacle configuration at outlet with plug provided for equipment.
- B. Cord Construction: Oil-resistant thermoset insulated Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for extra hard usage in damp locations.
- C. Cord Size: Suitable for connected load of equipment and rating of branch circuit overcurrent protection.

### 2.5 ACCESS AND ACCESS PANELS

- A. This Section supplements requirements of Division 08.
- B. Description: Interior construction access panels,
- C. Available Manufacturers:
  1. Milcor.
  2. Knapp.
  3. Nystorm.
  4. Inland Steel.
  5. Or approved equal.
- D. Coordinate selection with other Sections supplying similar access panels.
- E. Access panels shall have same fire rating classification as surface penetrated.

## PART 3 - EXECUTION

### 3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to satisfaction of Architect and in accordance with code requirements. Installation shall permit clearance for access to equipment for repair, servicing and replacement.
- C. Install equipment so as to properly distribute equipment loads on building structural members provided for equipment support under other Sections. Roof-mounted equipment shall be installed and supported on structural steel provided under other Sections.
- D. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall or ceiling mounting of equipment as required.
- E. Provide steel supports and hardware for proper installation of hangers, anchors, guides, etc.
- F. Provide cuts, weights, and other pertinent data required for proper coordination of equipment support provisions and installation.
- G. Structural steel and hardware shall conform to Standard Specifications of ASTM; use of steel and hardware shall conform to requirements of Section Five of Code of Standard Practice for Steel Buildings and Bridges.
- H. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly which may void warrantee. Report in writing to Architect, prior to purchase or shipment of equipment involved, on conditions which may prevent proper installation.
- I. The Electrical Contractor shall not allow any equipment, ductwork, or piping foreign to the electrical installation to be installed or pass through any room in which electrical systems or equipment is located, such as electrical room, electric closets telephone or data closets. The Electrical Contractor shall notify the Construction Manager of such violations and request removal of such equipment, ductwork, or piping.
- J. Coordinate location of motor control centers, panelboards, and transformers installed in mechanical rooms with the HVAC, Plumbing and Fire Protection subcontractors. No piping, ductwork or other mechanical equipment shall be allowed to pass through the area of the electrical equipment equal to the width and depth of the electrical equipment extending from floor to structural ceiling above. A hung or gypsum board ceiling is not considered structure.
- K. Give right of way to piping systems installed at a required slope and/or specific mounting height or elevation.
- L. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- M. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- N. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

- O. Right of Way: Give to piping systems installed at a required slope.

### 3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
  - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07.
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07.
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

### 3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07.

3.5 HVAC, PLUMBING AND FIRE PROTECTION CONNECTIONS

A. General

- 1. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source through starters and disconnects to motors or to packaged control panels. Packaged control panels may include disconnects and starters and overcurrent protection. Provide all wiring between packaged control panels and motors.
- 2. HVAC, Plumbing and Fire Protection equipment is defined as products provided under other divisions that require power 120 volts and higher.
- 3. Unless otherwise specified, all electrical control devices such as aquastats, float and pressure switches, electro pneumatic switches, solenoid valves and damper motors requiring mechanical connections shall be furnished and installed and wired by the Contractor supplying the devices.
- 4. Provide conduit and power wiring for connection to alarm panels, remote alarms, etc. Refer to HVAC, Plumbing and Fire Protection drawings for location and quantity of panels/alarms to be connected. Provide connections from local 120-volt panel via 20 ampere circuit breaker.
- 5. All control wiring shall be provided by others, unless noted otherwise in the specification or drawings.

B. Coordination

- 1. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

C. Examination

- 1. Examine the areas and conditions under which the equipment is to be installed.
- 2. Verify that equipment is ready for electrical connection, wiring, and energization.

D. Installation

- 1. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.
- 2. Make conduit connections to vibrating equipment using flexible conduit. Use liquid tight flexible conduit in damp or wet locations.
- 3. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
- 4. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes for vibrating equipment.

5. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
6. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated. Connect with conduit and wiring as indicated.
7. Each motor terminal box shall be connected with a minimum 12 inches, maximum 24 inches piece of flexible conduit to a fixed junction box. A green wire run through the flexible conduit shall interconnect the motor frame and the branch circuit ground wire. Use liquid tight flexible metal conduit for connection. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
8. Check for proper rotation of each motor.

E. Building Management Panels

1. Provide conduit and power wiring (120 volt) to all Building Management System Panels, Direct Digital Control panels, Utility Monitoring System (UMS) panels, etc. Provide connection from local 120 volt panel via 20 ampere circuit breaker. Provide one branch circuit for every panel, unless directed otherwise.

3.6 ACCESS PANELS

- A. Provide access panels in accordance with this Section and requirements of Division 08.
- B. Access panels are generally not shown on the drawings, but shall be provided to allow access to system components.
- C. Provide proper access to materials and equipment that require inspection, replacement, repair or service, and coordinate their delivery with the installing Trade. If proper access cannot be provided, confer with Architect as to best method of approach for minimizing effect of reduced access which may result.
- D. Coordinate and prepare a location, size, and function schedule of access panels required to fully service equipment and deliver to a representative of the installing Trade. Furnish and install distinctively colored buttons (color as selected by Architect) in finished ceiling to identify all access panels.
- E. Provide access panels to all items requiring maintenance including at fire dampers, volume dampers, controls, shut-off valves, control valves, check valves, or other items that require access and are concealed in floor, wall, furred space or above ceiling.
- F. Ceilings consisting of lay-in or removable splined tiles do not require access panels and dampers, splitters, or test hole openings above ceiling shall have location marked with thumb tack on finished ceiling panel. Location shall be noted on record drawings.
- G. Access panels shall have same fire rating classification as surface penetrated.
- H. Panels within 8" of the surface being penetrated shall be the sized for the greater of 12"x12" or size required to allow removal of the component being maintained; panels further than 8" from the surface being penetrated and access at all equipment requiring service (including disconnects) shall be a minimum of 24"x24". Access doors to fire dampers shall be a minimum of 18"x16" if fire damper is within ordinary person's arms reach of the access panel or 24"x24" if beyond arms reach as required by NFPA 90A-2002.

### 3.7 CONNECTIONS TO OWNER AND ARCHITECT EQUIPMENT

#### A. General

1. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source to owner and architectural equipment for complete and operational equipment.
2. Owner and Architectural equipment is defined as products provided under other divisions that operate at voltages 110 and above. Equipment may include but not be limited to the following:
  - a. Coffee machines
  - b. Vending machines
  - c. Microwaves
  - d. Refrigerators
  - e. Dishwashers
  - f. Copy machines
  - g. Projector screens
  - h. Motorized doors
  - i. Electric hand dryers
  - j. Scoreboards
3. All control wiring shall be provided by others, unless noted otherwise in the specification or drawings.

#### B. Coordination

1. Coordinate location of equipment with Architect and Owner.
2. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.
3. Obtain wiring diagrams and installation methods from equipment manufacturers.

#### C. Examination

1. Examine the areas and conditions under which the equipment is to be installed.
2. Verify that equipment is ready for electrical connection, wiring, and energization.

#### D. Installation

1. Make conduit connections to vibrating equipment using flexible conduit. Use liquid tight flexible conduit in damp or wet locations.
2. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
3. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes for vibrating equipment or for cord drops from ceilings.

4. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
5. Each motor terminal box shall be connected with a minimum 12", maximum 24" piece of flexible conduit to a fixed junction box. A green wire run through the flexible conduit shall interconnect the motor frame and the branch circuit ground wire. Use liquid tight flexible metal conduit for connection. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
6. Check for proper rotation of each motor.

### 3.8 ELECTRICAL INSTALLATION FOR ELEVATORS

#### A. General

1. Electrical Contractor shall provide electrical power and auxiliary services to elevators generally as described and as amended by the elevator contract shop drawings and specifications. Prior to installation, Electrical Contractor shall coordinate work with Elevator Contractor.
2. All traveling cables, control stations, control station wiring and final control connections at the controller shall be furnished and installed under Division 11 Elevator Work.

#### B. Coordination

1. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.
2. Coordinate entire installation with Division 11 Contractor prior to rough-in.

#### C. Examination

1. Verify that equipment is ready for electrical connection, wiring, and energization.

#### D. Installation

1. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
2. Provide all power wiring from source through disconnect to elevator controller to motor.

#### E. Provide the following auxiliary services to the elevator pit for each elevator. Locate and identify all services as directed by elevator shop drawings or Elevator Contractor.

1. Elevator pit shall be provided with vapor-tight lighting fixture with polycarbonate lens switched from the entrance of elevator pit served by a dedicated branch circuit. Do not wire light fixture on GFI circuit.
2. Provide 120 volt, 20 ampere dedicated GFI receptacle in the elevator pit served by a dedicated branch circuit.
3. Where provided, connect to sump pump in elevator pit with dedicated branch circuit.

#### F. Provide the following auxiliary services for each elevator. Locate and identify all services as directed by elevator shop drawings or Elevator Contractor.



1. Cab lighting: Provide manual switch labeled "cab lights" adjacent to power disconnect. Extend 120 volt circuit from source through lockable switch to controller. Provide one lockable switch and 120-volt circuit per unit.
2. Cab telephone: Junction box with 1" conduit to local telephone backboard.
3. Cab security: Junction box with 1" conduit to local security backboard.
4. Controller: Provide separate 120 volt, single phase, 20 ampere circuit to lockable thermal overload switch.
5. Intercom System: Provide 120 volt, 20-ampere branch circuit.

### 3.9 CLEANING

- A. Cleaning shall be performed on a day-to-day basis and a final cleaning prior to commissioning.
- B. Equipment
  1. All electrical equipment shall be cleaned inside and out prior to initial energizing.
  2. Cleaning shall consist of vacuuming busses, windings, enclosures (inside and out), etc. After vacuuming is complete, the equipment shall be wiped down.
  3. If equipment is wet or contains moisture, it shall be thoroughly dried out and inspected by the manufacturer's representative before energizing.
- C. Raceways
  1. All raceways shall be blown out and dried prior to installation of conductors.
  2. Raceways installed in or below the slab shall have a mandrel pulled through to clear any dirt and debris.
- D. Pull, Junction, Work and Floor Boxes
  1. All boxes shall be cleaned of debris such as plaster and concrete residue prior to installation of conductors.
  2. Vacuum all dirt and debris from floor boxes prior to installing inserts.
- E. Electrical Rooms
  1. Upon completion of cleaning equipment, raceways and boxes, but before energizing equipment, the entire room shall be swept clean with all garbage removed from the area.
  2. When the room is clean and equipment energized, the area shall remain clean and the doors to the room shall remain closed until completion of project.
  3. If the room or equipment is subjected to dust or moisture after energizing the equipment shall be de-energized and re-cleaned as outlined above.
- F. Final Cleaning
  1. All light fixtures, devices, device plates, etc., shall be cleaned and left in new condition to the satisfaction of the Architect, prior to final occupancy.
  2. All rubbish, discarded materials and unused materials shall be removed from site.

END OF SECTION

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## SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Conductors
  - 2. Multi-conductor cable
  - 3. Connectors and splices
  - 4. Cable supports

#### 1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. Feeder: All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent device.
- C. Branch Circuit: The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s).

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

#### 1.6 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. American Insulated Wire Corp.; a Leviton Company.
  - 2. General Cable Corporation.
  - 3. Senator Wire & Cable Company.
  - 4. Southwire Company.
  - 5. or Approved Equal
- B. Copper Conductors: Comply with NEMA WC 70 and ASTM B-496. Copper conductors shall be soft drawn annealed copper, having a conductivity of not less than 98 percent of that of pure copper.
  - 1. Conductor Insulation:
    - a. Comply with NEMA WC 70 for Types THHN-THWN
    - b. All copper conductor insulation shall be Type “THHN” or “THHN/THWN”, except as specified hereinafter in subparagraph c, below.
    - c. All conductors within lighting fixtures shall be temperature rated as required by National Electrical Code, latest edition. Branch circuit conductors within 3 inches of fluorescent ballast shall be Type “THHW” or “XHHW”.

### 2.2 MULTI-CONDUCTOR CABLE

- A. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC.
- B. Multiconductor cables run in parallel shall include full size grounding conductor in accordance with NFPA 70 Article 250.122
- C. MC Cable
  - 1. Available Manufacturers: The design is based on AFC Cable Systems, Inc. to establish standards of quality for materials and performance. The naming of a specific manufacturer or catalog number does not waive any requirements or performance of individual components described in the specifications.
  - 2. Acceptable alternate manufacturers are
    - a. Southwire Company
    - b. Allflex
    - c. Alliance
    - d. or approved equal.
  - 3. General
    - a. Cable shall be multi-conductor Metal Clad (UL-Type MC) Power cable that meets or exceeds the requirements of UL Standard 83, UL Standard 1063, UL Standard

1569 for Type MC, Federal Specification A-A59544, IEEE 1202 (70,000 Btu/hr) Vertical Cable Tray Flame Test, and the National Electrical Code.

- b. Cable assemblies shall be prefabricated at the factory and shipped to the job site on cable reels.

4. Material

- a. Conductors shall be minimum No. 12 AWG, soft drawn copper with 90°C, THHN, 600 V rated insulation. Where the length of MC cable exceeds 65 feet for 120 volt circuits and 145 feet for 277 volt circuits provide No. 10 AWG conductor with same properties as listed above. For branch circuits longer than 100 feet for 120 volt and 230 feet for 277 volt refer to the Branch Circuit Schedule on the drawings for the conductor size.
- b. Each length of MC cable shall have a dedicated neutral conductor for each phase conductor. Each length shall include a full size equipment grounding conductor. Where isolated ground receptacles are indicated on plans provide an isolated ground conductor (green with yellow strip) with each length of cable.
- c. Cable shall be UL Classified 1, 2, and 3 hour Through Penetration Firestop Systems: W-J-3037, W-L-3110, W-L-3113, W-L-3117, W-L-3120, W-L-3121, W-L-3160, C-AJ-3115, C-AJ-3140, C-AJ-3142, C-AJ-3145, C-AJ-3173, C-AJ-3202, C-AJ-4065, C-AJ-4066, F-C-3038.
- d. Sheath shall be continuous welded, corrugated aluminum sheath.

D. Mineral Insulated (MI) Cable

1. Available Manufacturers:

- a. The design is based on Tyco Thermal Controls/Pyrotenax to establish standards of quality for materials and performance. The naming of a specific manufacturer or catalog number does not waive any requirements or performance of individual components described in the specification.
- b. Alternate Manufacturers:
  - 1) Nvent
  - 2) MI Cable Co.
  - 3) or approved equal.

2. Materials

- a. MI cables and components shall not contribute to flame or smoke spread and shall not generate toxic, hazardous or flammable products when subjected to the UL 2196 fire test. Cables shall maintain complete circuit integrity when subjected to a 100 psi, 2-1/2 inch hose stream at the end of the UL 2196 fire test without the loss of any phase, neutral, equipment grounding conductor while under full load.
- b. Manufacturer's MI cable compressive strength testing shall yield 80,000 psi minimum to 120,000 psi before circuit failure while under full load.
- c. MI Cable and components shall be as follows:
  - 1) Conductors: Copper
  - 2) Insulation Voltage Rating: 600 volts

- 3) Cable Temperature Rating: 75 deg C application, 90 deg C maximum
- 4) Termination Temp. Rating: 75 deg C application, 105 deg C maximum
- 5) Insulation Material: Inorganic magnesium oxide refractory mineral.
- 6) Metal-sheath Material: Seamless soft-drawn copper.
- 7) Fire Rating: 2-hour fire rating, completed cable assembly
- 8) Overjacket: None, except PVC where directly buried.
- 9) Cable Sheath Marking: Conductor size, voltage, and UL fire resistive classification number.
- 10) Cable Termination:
  - a) Conductors No. 10 AWG and smaller – Tyco Thermal Controls / Pyrotenax Model Pyro-Pak Installation Sheet 545.
  - b) Conductors No. 8 AWG and larger – Tyco Thermal Controls / Pyrotenax Model Quick-Term Installation Sheet 638.
- 11) Cable Splice: Tyco Thermal Controls / Pyrotenax Model Installation Sheet 550
- 12) Supporting Hardware: As approved by MI cable manufacturer.

## 2.3 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. AFC Cable Systems, Inc.
  2. Hubbell Power Systems, Inc.
  3. O-Z/Gedney; EGS Electrical Group LLC.
  4. 3M; Electrical Products Division.
  5. Tyco Electronics Corp.
  6. Or approved equal.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- C. Copper: All No. 6 AWG and larger copper conductors shall be connected with bolt-on compression connectors by Thomas & Betts (or approved equal) sized as required by codes and specifically intended to connect copper wire and cable to panelboards, substations, disconnect switches, and other equipment. Install with hydraulic crimping tool as required by manufacturer's recommendations, to ensure permanent high conductivity connection.
  1. Terminations: Thomas & Betts Series 54200 (or approved equal) two hole connectors shall be used. Exceptions are as follows:
    - a. Where equipment or device cannot be provided by the manufacturer to accept two hole connectors, T&B Series 54100 (or approved equal) single hole connectors with anti-rotation lug or restraint shall be used.

- b. Where equipment or devices cannot be provided by the manufacturer to accept either two-hole or single hole compression connectors, set screw type connectors may be submitted. For a set screw connector to be considered by the Engineer, the manufacturer shall provide deviation with his/her equipment submittals that his/her equipment will not accommodate the required compression connectors. See Division 20 for deviation requirements.
- 2. Copper to Copper Splices, if allowed, shall be with T&B Series 54500 (or approved equal) compression connectors.
- 3. Tapping of Copper Conductors shall be with T&B Series 54700 (or approved equal) compression taps.
- 4. All No. 8 AWG and smaller solid conductors shall be spliced with pre-insulated spring connectors. Connectors shall be Skotch-lok, Buchanan B-Cap or approved equal.
- 5. For NEC Class 1, 2 or 3 wiring, No. 10 AWG and smaller stranded conductors and terminated with AMP, Inc. "PIDG", UL listed premium grade insulated compression fork connectors or approved equal and shall be spliced in a junction box with AMP, Inc. "Plastic-Grip" UL listed, standard grade insulated butt splices or approved equal. All motor branch circuit conductors terminating at the motor termination box shall be spliced with compression type connectors.

## 2.4 CABLE SUPPORTS

- A. Available Manufacturers:
  - 1. The design is based on O.Z./Gedney to establish standards of quality for materials and performance. The naming of a specific manufacturer or catalog number does not waive any requirements or performance of individual components described in the specification.
  - 2. Acceptable alternate manufacturers are Cross Hinds, Kellem or the Engineer's approved equal.
- B. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- C. Provide split wedge cable supports with clamps for cable without metallic sheath. Provide basket weave or approved equal cable supports approved by cable manufacturer for cable with metallic sheath.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Stranded Copper.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. VFD to motor Wiring
  - 1. Ampacity of input wiring to VFDs shall be at least 125 percent of the VFD input rating.

2. Wiring from variable frequency drive output to the motor terminals, shall be in grounded metallic conduit.

### 3.2 CONDUCTOR INSULATION AND MULTI-CONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway or Metal-clad cable, Type MC.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway
- H. Emergency feeders when installed outside of electrical rooms: MI Cable
- I. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- J. Class 2 Control Circuits: Type THHN-THWN, in raceway.

### 3.3 INSTALLATION OF CONDUCTORS

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26.
- F. Identify and color-code conductors and cables according to Division 26.
- G. Provide cable supports and boxes for vertical feeders as required by NEC.
- H. Wire from point of service connection to receptacles, lighting fixtures, devices, equipment, outlets for future extension, and other electrical apparatus as shown on Drawings. Provide slack wire for connections. Tape ends of wires and provide blank covers for outlet boxes designated for future use. Mark future conductors as such with panel and circuit designation.
- I. Conductors No. 10 and smaller in branch circuit panelboards, signal cabinets, signal control boards, switchboards and motor control centers shall be bundled. Conductors larger than No. 10 in switchboards, motor control centers and pull boxes shall be cabled in individual circuits.



- J. Two or more conduits installed instead of single conduit shall contain duplicate conductors, including neutrals and ground conductors where required; total capacity of duplicate conductors shall be at least equal to capacity of conductors replaced.
- K. Follow homerun circuit numbers shown on Drawings to connect circuits to panelboards. Where homerun circuit numbers are not shown on Drawings, divide similar types of connected loads among phase buses so that currents are approximately equal in normal usage. Connect each branch circuit homerun with two or more circuits to circuit breaker or switch in three-wire or four-wire branch circuit panelboard so that no two circuits are fed from same bus. Where panelboard cabinets are recessed, provide conduits with sufficient capacity for future conductors for spare branch circuit protective devices and spaces in panelboard; stub up concealed to junction box. Provide extensions above ceiling.
- L. Where conductors have been oversized for voltage drop provide reducers on feeders and branch circuits to accommodate wire size at terminations.
- M. Conductors entering panels, junction boxes, equipment cabinets, etc. shall be neatly formed, laced and supported around the equipment or devices. Adhesive glues or tapes shall not be used to support conductors.

### 3.4 MULTI-CONDUCTOR CABLE APPLICATIONS AND WIRING METHODS:

- A. Uses Permitted: administration areas of building only.
  - 1. Branch circuit conductors in EMT shall be provided to first devices. MC cable shall be permitted from first device to subsequent devices in the circuit where run concealed within a wall or partition
  - 2. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Metal-clad cable, Type MC.
- B. Uses not permitted
  - 1. Pool and gymnasium areas
  - 2. Branch circuit from panelboard to first device.
  - 3. Feeders.
  - 4. In open spaces such as finished areas.
  - 5. Underground or embedded within concrete.
  - 6. Where subject to physical damage.
  - 7. Theater dimmer circuits.
  - 8. Life safety and critical systems in healthcare facilities.
  - 9. Where exposed at “floating” or hung ceilings.
- C. MC Cable Management:
  - 1. Other than Electric Rooms and Electric Closets:
    - a. At a minimum provide independent Unistrut support for MC cables
      - 1) Supports shall be installed such that MC cable length is free of sags.
    - b. Where more than eight MC cables are bundled together, provide cable tray for MC cable management.

- c. Contractor shall develop cable management plans for review with Owner, Architect, and Engineer indicating:
  - 1) Locations of rigid raceway
  - 2) Locations of MC cable including:
    - a) Locations of cable tray for MC cable management
    - b) Indicate locations where field conditions cannot accommodate cable tray.
    - c) Where cable tray is not required or cannot be installed due to field conditions, indicate method of support such as Unistrut, hanger support etc.
- d. Metal clad cable shall be secured using mechanical fasteners. Tie wraps shall not be used to secure cables unless installed in cable tray.

### 3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- D. No modifications to any connector or fitting shall be permitted.
- E. The approved connector manufacturer's recommended installation tool and procedures shall be used.
- F. Water chilling unit motor terminations shall be made with compression connectors, which accommodate the conductor size indicated on the Drawings and have a hole size to fit the water chilling unit motor connection stud. Subcontractor shall coordinate the compression connector with the water chilling unit manufacturer's termination requirements. Field modification to the compression lug or the motor stud will not be permitted.
- G. All bolt and screw connections shall be torqued in accordance with the manufacturer's recommendations. Subcontractor shall include a copy of the manufacturer's recommendations with all applicable submittals.
- H. Where conductors are oversized for voltage drop, provide cable reducing adapters for cable terminations. Cable reducers shall be manufactured by Greaves or equal.
- I. All exterior wiring connections, and those made at or below grade shall be waterproof with UL listed waterproof connectors.

### 3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
  - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
  - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- C. Test Reports: Prepare a written report to record the following:
  1. Test procedures used.
  2. Test results that comply with requirements.
  3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

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## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:
  - 1. Conductors
  - 2. Connectors
  - 3. Grounding electrodes
- B. Equipment grounding system shall be designed so metallic structures, enclosures, raceways, cable tray, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with electrical circuits operate continuously and ground potential and provide low impedance path for possible ground fault currents.

#### 1.3 REFERENCES

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form part of this specification to the extent referenced. Publications are referenced in the text by the basic designations only.
  - 1. NFPA 70      National Electrical Code
  - 2. NFPA 780     Standard for the Installation of Lightning Protection Systems
  - 3. UL 96        UL Standard for Safety for Lightning Protection Systems
  - 4. UL 467       Grounding and Bonding Equipment
  - 5. UL 486A      Wire Connectors and Soldering Lugs for Use with Copper Conductors
  - 6. IEEE/ANSI 142 Latest Edition Recommended Practice for Grounding of Industrial and Commercial Power Systems
  - 7. ASTM B3      Solid Conductors
  - 8. ASTM B8      Assembly of Stranded Conductors
  - 9. ASTM B33     Tinned Conductors
  - 10. NEMA GR1    Ground Rods and Ground Rod Couplings

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
  - 1. Ground rods.
  - 2. Ground rings.
  - 3. Concrete encased electrodes.
  - 4. Grounding arrangements and connections for separately derived systems.
- C. Field quality-control test reports that include the following.
  - 1. Test procedures used.
  - 2. Test results that comply with the requirements.
  - 3. If applicable, results of failed tests and corrective action taken to achieve test results that comply with the requirements.
- D. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
  - 1. Instructions for periodic testing and inspection of grounding features at ground rings and grounding connections for separately derived systems based on NETA MTS.
    - a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
    - b. Include recommended testing intervals.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

### PART 2 - PRODUCTS

#### 2.1 CONDUCTORS

- A. Insulated Feeder and Branch Circuit Equipment Ground Conductors: Copper stranded conforming to ASTM B8 and B33 wire or cable insulated for 600 V sized as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Insulation class other than 600V shall only be provided where otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Grounding Electrode Conductors: Bare, stranded cable of size shown on drawings, specifications or as required by NFPA 70, whichever is larger.
  - 1. Stranded Conductors: ASTM B 8.

2. Solid Conductors: ASTM B 3.
- C. Grounding Bus: Provide ground bus where specified and required.
  1. Grounding Bus Material: Rectangular bars of bare copper, (1/4 by 2 inches in cross section, minimum 24 inch length unless otherwise indicated; with insulated standoffs and stainless steel fasteners.
  2. Ground Bus shall be UL 467 listed.
  3. Field modification or cut bus shall not be acceptable.

## 2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Mechanical Connectors: Provide mechanical connectors of the two bolt type, listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
  1. Pipe Connectors: Clamp type, sized for pipe.
  2. Materials: The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolted pressure type. Split bolt connector types shall NOT be accepted.
  3. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.
- C. Compression Connectors: Provide compression connectors that meet or exceed the performance requirements of IEEE 837, latest revision. Compression connectors shall be listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
  1. Materials: The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.
    - a. The installation of the connectors shall be made with a compression tool and die system as recommended by the manufacturer of the connectors.
    - b. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compressions tool settings.
    - c. Each connector shall be factory filled with an oxide-inhibiting compound.
- D. Welded Connectors: Provide exothermic connections for copper to copper and copper to steel connections to ground rods, ground buses, ground wires, steel beams, rebar, etc.
  1. The supplier of the equipment shall provide with no additional charge and information or supervision required for the proper installation of the equipment and training of operating personnel

2. Materials: Conductors spliced with an exothermic welded connection shall be considered as a continuous conductor, as stated in the notes accompanying NEC articles 250.50, 250.64 and IEEE Standard 80 (latest edition).
  - a. Procedures outlined in the Manufacturer's installation instruction shall be followed. Molds shall not be modified during installation in field applications.
  - b. Weld metal shall be a mixture of copper oxide and aluminum. Only one weld metal mixture shall be required for each grounding connection.
  - c. Grounding connections shall be tested and certified in accordance with IEEE 837, UL 486A and UL 467.
3. All exothermic Connections shall:
  - a. Prove to carry more current than the conductor.
  - b. Not deteriorate during the life of the connection.
  - c. Will not loosen or corrode during the life of the connection.
  - d. Resist repeated fault currents without failure.
  - e. Be of high visually discerned quality.
  - f. Eliminate electrolytic penetration of conductors (strands).

## 2.3 GROUNDING ELECTRODES

- A. Ground Rods: Ground Rods shall be Copper-clad steel; 3/4 inch by 10 feet in diameter unless otherwise specified with a tensile strength not less than 75,000 psi. Copper shall be applied electrolytically forming a metallurgical bond between the steel core and the copper
  1. Provide ground rods where shown or required to obtain the ground resistance specified in Part 3.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Install Products in accordance with manufacturer's instructions.
- B. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.
- C. Ground connection surfaces shall be cleaned prior to connections.
- D. Attach grounds permanently before building service is energized.
- E. Provide bonding to meet Regulatory Requirements.
- F. Bond together reinforcing steel and metal accessories in pool structures.
- G. Examine raceway, equipment or area to receive grounding to provide adequate sizes, placement and materials for a complete installation.
- H. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

- I. Determine numbers and sizes of screw terminals for equipment grounding bars in panelboards and other electrical equipment. Provide screw terminals for active circuits, spares and spaces.
- J. Provide equipment ground conductor in same raceway with associated phase conductors.

### 3.2 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Provide green insulated grounding conductor in nonmetallic conduits or ducts unless specified otherwise.
- C. Transformers: Step down transformers secondary's shall be grounded to the building steel, if available, or the main building service ground, or ground riser where available.
- D. Feeders: Bond all conduits carrying individual grounding or grounding electrode conductors with grounding bushing to ground bus in panel with a copper grounding conductor sized per NEC 250.102 (D). Where a panel such as a distribution panel has multiple feeders, a common ground conductor is permitted to be run from ground bushing to ground bushing and then to ground bus in panel.
- E. Underground Grounding Conductors: Install barecopper conductor, No. 2/0 AWG minimum.
  - 1. Bury at least 24 inches below grade.
  - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- F. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  - 1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
  - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- G. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

### 3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Handholes: Install a driven ground rod through handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-



shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

- C. Pad-Mounted equipment including Transformers, Generators and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items by connecting them to underground cable and grounding electrodes. Conductor shall be not less than No. 4/0 AWG for loop around pad and for taps to equipment ground pad. Bury conductors 24 inches below grade and 12 inches from the foundation. Below grade connections shall be made with Exothermic weld.
  - 1. Bond pad mounted equipment ground system to building grounding electrode system.

### 3.4 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits. Terminate each end on suitable lug, bus, enclosure or bushing, per NEC. Provide a ground wire from each device to the respective enclosure.
- B. Install equipment ground conductor in common conduit with related phase or neutral conductors, or both. Parallel feeders installed in more than one raceway shall have individual full size green insulated equipment ground conductors.
- C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Receptacle circuits.
  - 4. Single-phase motor and appliance branch circuits.
  - 5. Three-phase motor and appliance branch circuits.
  - 6. Flexible raceway runs.
  - 7. Armored and metal-clad cable runs.
- D. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- E. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

### 3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical

service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- G. Ground Ring: Install a supplementary grounding electrode consisting of ground rods and wire around the perimeter of the building and connecting to steel columns. When ground rods are not shown on the drawings provide a ground rod at every other column with a maximum spacing of 40'.
  - 1. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
  - 2. Bury ground ring not less than 24 inches from building foundation.
  - 3. The perimeter ground wire shall be bonded to each ground rod with an exothermic connection. Provide a No. 4/0 AWG copper ground wire connections from the grounding loop to columns via exothermic connections.
  - 4. Drive ground rods until tops are 24 inches below final grade unless installed in ground test well.
  - 5. Ground rods shall be driven to achieve resistance required by this Section. Provide additional rods as required to achieve specified resistance. Where geological conditions

dictate, ground wire mesh may be provided or additional rods shall be driven in compacted earth areas as require to meet resistance requirement.

6. Connections to ground loop system shall be made with Exothermic weld.
  7. Verify that final backfill and compaction has been completed before driving ground rod electrodes.
- H. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
  2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

### 3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
1. Visual inspection of all systems, raceway and equipment grounds shall be made to determine the adequacy and integrity of the grounding. All ground testing results shall be properly recorded, witnessed, and reported to the Contractor.
  2. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
      - 1) Measure ground resistance without the soil being moistened by any means other than natural precipitation or natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      - 2) Ground tests shall be performed using a low resistance, Null balance type, ground testing ohmmeter, with test lead resistance compensated for. Measure the resistance of the ground under test and remote earth or a reference ground as specified. The test instrument shall be the type which compensates for potential and current rod resistances.
      - 3) Test completed grounding system at the service disconnect enclosure grounding terminal and at ground test wells. Perform tests, by the fall-of-potential method according to IEEE 81.
      - 4) Testing record shall include drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include

the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

4. Where ground test results indicate the need for additional grounding conductors or rods that are not indicated on drawings or specified, design changes will be initiated to obtain the acceptable values. The Subcontractor is responsible for the proper installation of the grounding shown on drawings or specified and for the correction of improper installations as determined by inspections and tests.
  5. Prepare dimensioned drawings locating each ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Grounding system resistance shall be 10 ohms or less.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

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## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. RMC: Rigid metal conduit.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

#### 1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel slotted support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze hangers. Include Product Data for components.

- 2. Steel slotted channel systems. Include Product Data for components.
- 3. Equipment supports.
- C. Welding certificates.

#### 1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

#### 1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07.

### PART 2 - PRODUCTS

#### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation.
    - f. Unistrut; Tyco International, Ltd.
    - g. Wesanco, Inc.
    - h. Or approved equal.
  - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  - 4. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Hilti Inc.
      - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
      - 5) Or approved equal.
  - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc.
      - 3) Hilti Inc.
      - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 5) MKT Fastening, LLC.
      - 6) Or Approved Equal
  - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  - 6. Toggle Bolts: All-steel springhead type.
  - 7. Hanger Rods: Threaded steel.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 for steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
  - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  - 7. To Light Steel: Sheet metal screws.



8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03.
- C. Anchor equipment to concrete base.
  1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

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## **SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes:
  - 1. Metal conduit and tubing
  - 2. Metal wireways
  - 3. Surface raceways
  - 4. Boxes, enclosures, and cabinets

#### **1.3 DEFINITIONS**

- A. EMT: Electrical metallic tubing.
- B. RGS: Rigid Steel Conduit.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. LFMC: Liquid tight flexible metal conduit.

#### **1.4 SUBMITTALS**

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
  - 1. Structural members in the paths of conduit groups with common supports.
  - 2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
- D. Source quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 2. Wheatland Tube Company.
  - 3. O-Z Gedney; a unit of General Signal.
  - 4. AFC Cable Systems, Inc.
  - 5. Greenfield.
  - 6. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - 7. Electri-Flex Co.
  - 8. Permacote.
  - 9. Robroy.
  - 10. Or approved equal
- B. Rigid Steel Conduit: ANSI C80.1; zinc-coated steel.
- C. EMT: ANSI C80.3; zinc-coated steel.
- D. FMC: Spiral wrapped zinc-coated steel with insulated throats.
- E. LFMC: Highly flexible, hot-dipped galvanized steel conduit with PVC jacket with insulated throats.
- F. Fittings for Conduit (Including all Types and Flexible and Liquid tight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
  - 1. RSC: Threaded steel insulated bushings and throats. Locknuts shall be steel/zinc plated.
  - 2. EMT: Steel, set-screw type with insulated bushings and throats.
- G. Combination Expansion/Deflection Fittings
  - 1. Fittings shall be threaded, hot dipped galvanized malleable iron or steel with internal bonding jumper.
  - 2. Fittings shall include bonding jumper, insulated bushing and short nipple.
- H. Sealing Fittings

1. Threaded sealing fittings for rigid steel conduits shall be zinc- or cadmium- coated, cast or malleable iron; sealing fittings for aluminum conduit shall be threaded cast aluminum. Fittings that prevent passage of water vapor shall be continuous drain.
2. Sealing fittings shall be filled with a UL listed sealing compound.

**I. Cable Terminators**

1. Provide cable terminator assemblies by O-Z/Gedney or equal.
2. Assemblies shall have bakelite discs, neoprene rings and sealing compound within a fitting for attachment to raceway.

- J. Joint Compound for Rigid Steel Conduit:** Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

**2.2 METAL WIREWAYS**

- A. Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.
  2. Hoffman.
  3. Square D; Schneider Electric.
  4. Or approved equal
- B. Description:** Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
- C. Fittings and Accessories:** Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers:** Hinged type.
- E. Finish:** Manufacturer's standard enamel finish.

**2.3 BOXES, ENCLOSURES, AND CABINETS**

- A. Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  2. EGS/Appleton Electric.
  3. Erickson Electrical Equipment Company.
  4. Hoffman.
  5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  6. O-Z/Gedney; a unit of General Signal.
  7. RACO; a Hubbell Company.

8. Robroy Industries, Inc.; Enclosure Division.
  9. Scott Fetzer Co.; Adalet Division.
  10. Spring City Electrical Manufacturing Company.
  11. Thomas & Betts Corporation.
  12. Walker Systems, Inc.; Wiremold Company (The).
  13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
  14. Or approved equal.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.
- G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- H. Cabinets:
1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  2. Hinged door in front cover with flush latch and concealed hinge.
  3. Key latch to match panelboards.
  4. Metal barriers to separate wiring of different systems and voltage.
  5. Accessory feet where required for freestanding equipment.

## **PART 3 - EXECUTION**

### **3.1 RACEWAY APPLICATION**

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit: Rigid steel conduit
  2. Concealed Conduit, Aboveground: Rigid steel conduit.
  3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  4. Device boxes, Aboveground: Cast metal.
  5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage within Mechanical, Electrical and unfinished areas defined by architect: EMT.
  2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit with cast metal device boxes. Includes raceways in the following locations:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical and Electrical rooms, below 10'-0" AFF.
    - d. Natatorium
  3. Underground Below Slab on Grade Conduit: RNC, Type EPC-40-PVC, direct buried.
  4. Underground Below Slab on Grade, under areas of structural loading: RNC, Type EPC-80-PVC, if approved by local authorities.
  5. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  7. Damp or Wet Locations: Rigid steel conduit with cast metal device boxes.
  8. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
  9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- C. Raceways Installed Within Slabs (where approved by Project Structural Engineer)
1. Feeders, branch circuits and low voltage system: RNC, Type EPC-40-PVC.
  2. Penetrations from concrete slabs and elbows shall be made with galvanized RSC and RSC fittings only.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
- 3.2 RACEWAY INSTALLATION
- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. General
1. Check raceway sizes to determine that green equipment ground conductor fits in same raceway with phase and neutral conductors to meet NEC percentage of fill requirements. Increase duct, conduit, tubing and raceway sizes shown or specified as required to accommodate conductors.
  2. Install raceway systems complete before drawing in conductors. Blow through and swab after plaster is finished and dry, and before conductors are installed. Wire shall not be pulled into raceway until building roof and walls are weather-tight.

3. Install connectors and couplings as recommended by manufacturers. Compression fittings shall not be used with rigid steel conduit. Set screw fittings shall not be used with rigid conduit. Set-screw connectors for EMT shall be tightened to embed screws in conduit.
  4. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200 lb. Tensile strength. Provide at least 12" of slack at each end of pull wire with labels.
  5. Galvanized rigid steel conduit and intermediate metal conduit installed in corrosive environments shall have all field cut threads coated with an approved, electrically conductive, corrosion resistant compound so that the current carrying ability of the conduit is not compromised.
  6. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
  7. Penetrate waterproof walls of structural slabs and foundation walls only where approved by Construction Manager. Submit proposed penetration points, size openings and penetration methods to Construction Manager for approval.
  8. All conduit penetrations through exterior foundation walls shall be sealed. Provide sealing assemblies between conduit and sleeve. Provide cable terminators in conduit for cable seal. Provide appropriate sleeve through wall for conduit required. Assembly shall be tightened to seal out water.
  9. Raceways shall be installed in such a way as to not block exit and equipment service space. Raceway on or adjacent to equipment shall be located to allow free access to all removable panels and equipment service.
  10. Minimum Raceway Size: 3/4-inch trade size.
  11. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
  12. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 26.
- D. Raceways Installed Underground Below Slab on Grade
1. Raceways shall be located on undisturbed earth. Where the earth has been disturbed or is of poor quality excavate a trench to proper subgrade elevation. Place bedding material and compact trench bottom.
  2. Stagger conduit couplings so that couplings on adjacent conduits do not lie in same transverse plane. Provide conduit spacers every five feet.
  3. Elbows transitioning from underground to exposed shall be galvanized RSC. Provide appropriate transition fittings.
  4. Connections between conduits of different types shall be made in approved manner, using adapters and other materials and methods recommended by conduit manufacturers.
  5. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- E. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which two 90-degree bends are allowed.

- F. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- G. Raceways Installed Within Slabs
  - 1. If approved by the Project Structural Engineer, feeders, branch circuits and low voltage system conduits may be installed within concrete slabs. Penetrations from concrete slabs and elbows shall be made with galvanized RSC and RSC fittings only.
  - 2. Raceways shall not be installed within the floor slabs unless specifically allowed by the Project Structural Engineer. Refer to Division 3 for additional information.
  - 3. When raceways are allowed in slabs the following shall apply:
    - a. Installation shall conform to ACI (American Concrete Institute) 318, Paragraph 6.3, "Conduits and Pipes Embedded in Concrete".
    - b. Raceways with outside diameters larger than 1/3 slab thickness shall be run concealed in hung ceilings in finished areas, exposed in unfinished Mechanical/Electrical and storage areas, or below slabs on grade.
    - c. Maximum outside diameters of raceways in concrete shall be 1/3 slab thickness. No more than two 3/4" raceways shall cross in floor slab at a single point. Submit raceway crossing locations for approval before pouring slabs and relocate at no expense to Owner as directed by Construction Manager. Lateral spacing of parallel raceways shall be at least 6" on centers. Do not run raceway in slab less than 3" thick without express approval and direction of Construction Manager. Raceway in reinforced slabs shall be located above bottom steel reinforcing, below top reinforcing and inside beam stirrup, wall reinforcement and column ties.
    - d. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
    - e. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
    - f. Stagger conduit couplings so that couplings on adjacent conduits do not lie in same transverse plane.
    - g. All raceways penetrating the slab shall be galvanized steel.
    - h. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
    - i. Connections between conduits of different types shall be made in approved manner, using adapters and other materials and methods recommended by conduit manufacturers.
    - j. After concrete has set, nonmetallic conduits shall be cleared with mandrel of same size as conduit.



- H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- I. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- J. Terminations
  - 1. Raceway shall enter and be secured to cabinet, junction box, pull box or outlet box with locknut outside and bushing inside, or with liquid-tight, threaded, self-locking, cold-weld wedge adapter.
  - 2. Provide additional locknut for rigid conduit and wrench- tighten locknut for EMT or flexible conduit where circuit voltage exceeds 250 V. Locknuts and bushings or self-locking adapters will not be required where conduits are screwed into tapped connections.
  - 3. Vertical conduit runs that terminate in bottoms of wall boxes or cabinets shall be protected from entrance of foreign material before installation of conductors.
  - 4. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
  - 5. Provide insulated bushings on raceways entering all panels, switchboards, motor controllers, VFDs, etc. and all boxes 12" x 12" and larger to protect conductors.
- K. Raceways for Optical Fiber and Communications Cable:
  - 1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
  - 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
  - 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. In garages and other areas in which flammable gases or vapors may be present to prevent transmission of gases or vapors through conduits.
  - 3. Where otherwise required by NFPA 70.
- M. Expansion/Deflection Fittings
  - 1. Raceway buried or secured rigidly on opposite sides of building expansion joints and long runs of exposed raceway subject to stress due to thermal expansion shall have expansion/deflection fittings. Fittings shall safely deflect and expand to twice distance of structural movement.

2. Provide separate external copper bonding jumper secured with grounding straps on each end of fitting, when integral ground is not provided.
  3. Raceways buried in concrete shall cross building expansion joints at right angles; provide expansion fittings as required by manufacturer's instructions. Provide insulated bushings at ends of raceways.
  4. Coordinate location of expansion/deflection fittings with the structural and architectural drawings.
- N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
  2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.
  3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- O. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations.
- P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- Q. Box installation:
1. Determine from the drawings and by actual field conditions, the exact location of each outlet. The outlet locations shall be modified from those shown to accommodate changes in door swings or to clear other interferences that may arise from job construction details, as well as modifications to center them within the room spaces. These modifications shall be made with no change in contract price and shall be a matter of job coordination that gets reflected on the as-built drawings.
  2. Check these conditions throughout the entire job and notify the Architect/Engineer or discrepancies, as they may occur, to verify the modifications, if any, before proceeding with the installation.
  3. Install boxes where indicated, in accordance with manufacturer's written instructions, guidelines and the applicable requirements of the NEC, local codes, the National

Electrical Contractors Association's "Standard of Installation" and in accordance with recognized industry practices to ensure that products serve the intended function.

4. Coordinate location of boxes with millwork, counters, benches and back-splashes denoted on the Architectural and Electrical Drawings.
5. Coordinate box installation with electrical raceway and cable work, as necessary for proper interface.
6. Coordinate cutting of masonry walls and drywalls to achieve neat openings for boxes.
7. Provide all necessary hardware to secure boxes in place.
8. Sheet metal pull boxes shall be supported adequately to maintain shape. Larger boxes shall have structural steel bracing welded into rigid assembly formed adequately to maintain alignment in shipment and installation. Secure covers with corrosion-resistant screws or bolts.
9. Provide clamps, grids and other appurtenances to secure cables within pull boxes. No cable shall be unsupported for more than 30 inches.
10. Provide cable troughs of special shapes, design and construction required to install, support and enclose feeder cable throughout indicated routing. Troughs shall be as specified above for junction and pull boxes, with reinforcing, insulating supports and clamping for cable installation. Cables shall be continuous throughout troughs, and shall be racked in distributed phase groupings arranged with phase cables surrounding neutral conductors.
11. Location
  - a. Do not install boxes back to back in same wall.
  - b. For boxes mounted in exterior walls install insulation behind the box to prevent condensation in box.
  - c. Mount boxes flush with wall in all areas unless noted otherwise on the drawings. Boxes in mechanical rooms may be surface mounted where flush mounting is not possible due to construction.
  - d. Where boxes are positioned back to back on opposite sides of walls or partitions, and are less than 24 inches apart in wall cavities of fire rated partitions, provide firestop products suitable for the installation. Boxes shall not be installed on opposite side of walls or partitions of staggered stud construction unless a Wall Opening Protective Material is installed with the box in accordance with classification requirements for the protective materials.
  - e. Junction and pull box covers shall be readily accessible. Do not install junction or pull boxes above suspended ceilings except where ceiling is removable or where access panel is provided.
  - f. No pull box shall be within 2 feet of another.

- g. Pull boxes connected to concealed conduits shall be mounted with covers flush with finished wall or ceiling. No aluminum pull box shall be embedded in concrete.
  - h. Location of boxes shall be verified with Architect prior to rough-in. Refer to architectural details and elevations.
- 12. Application
  - a. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.
  - b. Junction or pull boxes exposed to rain or in wet locations shall be weatherproof.
- 13. Painting
  - a. Exposed conduit, junction boxes and equipment back boxes shall be painted to be as inconspicuous as possible. The Design Professional shall approve the paint color selected. The Electrical Contractor shall prepare color samples for inspection by the Design Professional prior to painting.

### 3.3 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07.

### 3.4 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION

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## SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
  - 2. Handholes and boxes.

#### 1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.
- B. RSC: Rigid Steel Conduit.

#### 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Duct-bank materials, including separators and miscellaneous components.
  - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
  - 3. Accessories for handholes and boxes.
  - 4. Warning tape.
- B. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
  - 1. Duct entry provisions, including locations and duct sizes.
  - 2. Frame and cover design.
  - 3. Grounding details.
  - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
  - 5. Joint details.

- C. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
  - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
  - 2. Drawings shall be signed and sealed by a qualified professional engineer.
- D. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.
- E. Qualification Data: For professional engineer.
- F. Source quality-control test reports.
- G. Field quality-control test reports.

#### 1.5 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Lift and support precast concrete units only at designated lifting or supporting points.

#### 1.7 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Owner no fewer than 14 days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Owner's written permission.

#### 1.8 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into handholes and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

## PART 2 - PRODUCTS

### 2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

### 2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ARNCO Corp.
  - 2. Beck Manufacturing.
  - 3. Cantex, Inc.
  - 4. CertainTeed Corp.; Pipe & Plastics Group.
  - 5. Condux International, Inc.
  - 6. ElecSys, Inc.
  - 7. Electri-Flex Company.
  - 8. IPEX Inc.
  - 9. Lamson & Sessions; Carlon Electrical Products.
  - 10. Manhattan/CDT; a division of Cable Design Technologies.
  - 11. Spiraduct/AFC Cable Systems, Inc.
  - 12. Or approved equal
- B. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
- C. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC and Type DB-120-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
- D. Duct Accessories:
  - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
  - 2. Warning Tape: Underground-line warning tape specified in Division 26.

### 2.3 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Carder Concrete Products.

2. Christy Concrete Products.
  3. Elmhurst-Chicago Stone Co.
  4. Oldcastle Precast Group.
  5. Riverton Concrete Products; a division of Cretex Companies, Inc.
  6. Utility Concrete Products, LLC.
  7. Utility Vault Co.
  8. Wausau Tile, Inc.
  9. Or approved equal
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
  2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  3. Cover Legend: Molded lettering, "ELECTRIC."
  4. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
  5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
    - a. Extension shall provide increased depth of 12 inches.
    - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
  6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
    - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
    - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
  7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
    - a. Type and size shall match fittings to duct or conduit to be terminated.
    - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
  8. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.



## **PART 3 - EXECUTION**

### **3.1 UNDERGROUND DUCT APPLICATION**

- A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank, unless otherwise indicated.
- C. Underground Ducts Crossing Driveways or Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

### **3.2 UNDERGROUND ENCLOSURE APPLICATION**

- A. Handholes and Boxes for 600 V and Less:
  - 1. Precast concrete. AASHTO HB 17, H-10 structural load rating.

### **3.3 EARTHWORK**

- A. Excavation and Backfill: Comply with Division 31, but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32.
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01.

### **3.4 DUCT INSTALLATION**

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
  - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.

2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26.
- F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.
- H. Concrete-Encased Ducts: Support ducts on duct separators.
  1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
  2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
  3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
  4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
  5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
  6. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
  7. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at equipment and at building entrances through the floor.

- a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
  - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
8. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 for pipes less than 6 inches in nominal diameter.
4. Install backfill as specified in Division 31.
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31.
6. Set elevation of bottom of duct bank below the frost line.
7. Install manufactured rigid steel conduit elbows for stub-ups at equipment and at building entrances through the floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
  - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.5 INSTALLATION OF CONCRETE HANDHOLES AND BOXES

A. Precast Concrete Handhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

**B. Elevations:**

1. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
2. Where indicated, cast handhole cover frame integrally with handhole structure.

**3.6 GROUNDING**

- A. Ground underground ducts according to Division 26.**

**3.7 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections and prepare test reports:**

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

- B. Correct deficiencies and retest as specified above to demonstrate compliance.**

**3.8 CLEANING**

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.**

**END OF SECTION**

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## SECTION 260548 - VIBRATION CONTROLS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Isolation pads.
  - 2. Spring isolators.
  - 3. Restrained spring isolators.
  - 4. Channel support systems.
  - 5. Restraint cables.
  - 6. Hanger rod stiffeners.
  - 7. Anchorage bushings and washers.

#### 1.3 DEFINITIONS

- A. The IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
  - 1. Site Design Category: B.

#### 1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
- B. Delegated-Design Submittal: For vibration isolation details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation to select vibration isolators.
    - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
  2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
  3. Field-fabricated supports.
  - C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
  - D. Welding certificates.
  - E. Qualification Data: For professional engineer.
  - F. Field quality-control test reports.
- 1.6 QUALITY ASSURANCE
- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - B. Comply with NFPA 70.

## **PART 2 - PRODUCTS**

### **2.1 VIBRATION ISOLATORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Ace Mountings Co., Inc.
  2. Amber/Booth Company, Inc.
  3. California Dynamics Corporation.
  4. Isolation Technology, Inc.
  5. Kinetics Noise Control.
  6. Mason Industries.
  7. Vibration Eliminator Co., Inc.
  8. Vibration Isolation.
  9. Vibration Mountings & Controls, Inc.
  10. Or approved equal.
- B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
  1. Resilient Material: Oil- and water-resistant neoprene.

- C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
  - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  - 2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
  - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.2 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

### 3.3 ADJUSTING

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.4 ELECTRICAL VIBRATION-CONTROL SCHEDULE

- A. Supported or Suspended Equipment: dry type transformers.
  - 1. Equipment Location: see plans.
  - 2. Pads:
    - a. Material: Neoprene.

END OF SECTION

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## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Power raceway identification materials
  - 2. Power and control cable identification materials
  - 3. Conductor identification materials
  - 4. Underground line warning tape
  - 5. Warning labels and signs
  - 6. Instruction signs
  - 7. Equipment identification labels
  - 8. Cable ties
  - 9. Miscellaneous identification products

#### 1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

#### 1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 **and IEEE C2.**
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

#### 1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's

wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

## **PART 2 - PRODUCTS**

### **2.1 POWER RACEWAY IDENTIFICATION MATERIALS**

- A. Colors for Feeder Raceways Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage.
- B. Self-Adhesive Vinyl Labels for Feeder Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

### **2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

### **2.3 CONDUCTOR IDENTIFICATION MATERIALS**

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

### **2.4 UNDERGROUND-LINE WARNING TAPE**

- A. Tape:
  - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
  - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
  - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
  - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
  - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.
  - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE,.

## 2.5 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Warning label and sign shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
- D. Arc Flash Warning Label
  - 1. Provide arc flash and electrocution hazard warning labels for switchgear, transformers, panelboards, motor starters, motor control centers, disconnect switches, and other locations as required by the NEC.
  - 2. Warning labels shall comply with ANSI Z535.4 and the NEC. Labels shall be printed on self-adhesive polyester with pressure sensitive adhesive back and covered with a clear polyester film. Outdoor labels shall be suitable for high UV environment.

## 2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

## 2.7 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
  - 1. Minimum Width: 3/16 inch.
  - 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
  - 3. Temperature Range: Minus 40 to plus 185 deg F.
  - 4. Color: Black except where used for color-coding.

## 2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.

- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. Cable Ties: For attaching tags. Use general-purpose type.
- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

### 3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. Emergency Power.
- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
  - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
    - a. Color shall be factory applied or field applied color coding conductor tape for sizes larger than No. 8 AWG.
    - b. Colors for 208/120-V Circuits:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
    - c. Colors for 480/277-V Circuits:
      - 1) Phase A: Brown.
      - 2) Phase B: Orange.
      - 3) Phase C: Yellow.
    - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- D. Conductors to Be Extended in the Future: Attach write-on tags or marker tape to conductors and list source.
- E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
  2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- G. Panelboard Circuit Identification:
1. For each panel provide typewritten directory of circuits that identifies the circuiting as well as breaker size. The directory shall be a full 8.5 inches x 11 inches sheet behind a plastic pocket that is secured to the panelboard.
  2. Panel directories shall identify the panel name, their source of power and voltage.
  3. Each circuit directory shall include load name and load location.
  4. In addition to the hard copy panel directory, the electrical contractor shall provide the electronic version in its native (word or excel) format as well as PDF format as part of the as-built documentation.
- H. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
    - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
    - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
  2. Equipment to Be Labeled:
    - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
    - b. Enclosures and electrical cabinets.

- c. Access doors and panels for concealed electrical items.
- d. Switchboards.
- e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
- f. Emergency system boxes and enclosures.
- g. Enclosed switches.
- h. Enclosed circuit breakers.
- i. Enclosed controllers.
- j. Variable-speed controllers.
- k. Power transfer equipment.

END OF SECTION

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SYSTEMS.DOC

## SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes:
  - 1. Computer software developers
  - 2. Computer software program requirements
- B. Computer-based, fault-current, overcurrent protective device coordination and arc flash hazard studies. Protective devices shall be set based on results of the protective device coordination and arc flash hazard study.
- C. The studies shall be submitted to the Design Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture. If formal completion of the studies may cause delay in equipment manufacture, approval from the Engineer may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.
- D. The studies shall include all portions of the electrical distribution system (i.e., panels, motors 10 HP and larger, VFDs, disconnects 100A and larger, etc.) from the power source or sources down to and including the smallest adjustable trip circuit breaker in the distribution system. Normal system operating connections and those which result in maximum fault conditions, such as paralleled service, shall be adequately covered in the study.
- E. Overcurrent protective devices in distribution equipment associated with Article 700, 701, and 708 of NFPA 70 are required to be selectively coordinated. The coordination study must include confirmation that equipment provided serving those systems are selectively coordinated in accordance with NFPA 70.
  - 1. Coordination of series-rated devices is permitted where indicated on Drawings.

#### 1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.

- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
  - 1. Coordination-study input data, including completed computer program input data sheets.
  - 2. Study and Equipment Evaluation Reports.
  - 3. Coordination-Study Report.
  - 4. Short Circuit Report.
  - 5. Arc Flash Analysis Report
- E. Studies shall include the following outline:
  - 1. Table of Contents
  - 2. Executive Summary
  - 3. Calculation methods and tabulations.
  - 4. System input Data
  - 5. One-line diagrams and impedance diagrams.
  - 6. Results of the study.
  - 7. Conclusions and recommendations.
  - 8. Arc flash hazard

#### 1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.
- E. As recommended in ANSI/NFPA 70B, Recommended Practice for Electrical Equipment Maintenance, short circuit studies and overcurrent protective device coordination studies should be performed when the facility electrical system is designed and these studies should be updated whenever a major modification or renovation takes place.
- F. In addition, the protection of electrical systems against damage due to short circuit faults is required in NFPA 70, National Electric Code Sections 110.9 "Interrupting Rating" and 110.10 "Circuit Impedance and Other Characteristics." Proper coordination of protective devices improves system reliability and prevents major blackouts by isolating short circuit faults with the protective device immediately on the source side of the fault. NFPA 70 and various IEEE standards contain requirements and suggested practices to coordinate electrical systems.



## PART 2 - PRODUCTS

### 2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Basis-of-Design Product: Subject to compliance with requirements, utilize software from SKM Systems Analysis, Inc. or a comparable product by one of the following:
  - 1. CGI CYME.
  - 2. EDSA Micro Corporation.
  - 3. ESA Inc.
  - 4. Operation Technology, Inc.
  - 5. SKM Systems Analysis, Inc.
  - 6. Or approved equal.

### 2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
  - 1. Optional Features:
    - a. Calculating arcing fault is a requirement.
    - b. Simultaneous faults.
    - c. Explicit negative sequence.
    - d. Mutual coupling in zero sequence.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
  - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

### 3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. The power system study analysis shall include equipment and system information for the system branch affected by the scope of work.
3. Impedance of utility service entrance.
4. Inverter contribution
5. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
  - a. Circuit-breaker and fuse-current ratings and types.
  - b. Relays and associated power and current transformer ratings and ratios.
  - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
  - d. Generator kilovolt amperes, size, voltage, and source impedance.
  - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
  - f. Busway ampacity and impedance.
  - g. Motor horsepower and code letter designation according to NEMA MG 1.
    - 1) Individually model motors 10 hp and greater.
    - 2) Where model motors less than 10 hp are fed from common distribution equipment, the motor horsepowers shall be combined into a single load.
6. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
  - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
  - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
  - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
  - d. Generator thermal-damage curve.
  - e. Ratings, types, and settings of utility company's overcurrent protective devices.
  - f. Special overcurrent protective device settings or types stipulated by utility company.
  - g. Time-current-characteristic curves of devices indicated to be coordinated.
  - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

### 3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
  - 1. Switchgear and switchboard bus.
  - 2. Medium-voltage controller.
  - 3. Motor-control center.
  - 4. Distribution panelboard.
  - 5. Branch circuit panelboard.
  - 6. ATS
  - 7. Existing to remain switchboard, panelboards, ATS
- B. There are two levels of fault current to be studied as follows:
  - 1. Level 1: Maximum fault current based on infinite bus and limited by the transformer impedance
    - a. In the case of maximum fault current, the study shall be run using the nominal transformer impedance of 5.75%. Another study shall be run when the actual impedance is known upon delivery of the building transformer.
  - 2. Level 2: Minimum fault current based on the actual available fault current.
- C. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- D. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- E. Include fault contribution of all motors 10 hp and above in the study. Variable frequency drives shall be included in the study.
- F. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
  - 1. Transformers:
    - a. ANSI C57.12.22.
    - b. IEEE C57.96.
  - 2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
  - 3. Low-Voltage Fuses: IEEE C37.46.
- G. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- H. Equipment Evaluation Report:
  1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
  2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
  3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- I. Note that Contract Documents indicate general requirements for equipment, etc., but additional specific characteristics of equipment furnished shall be determined in accordance with results of short circuit study.
  1. Equipment design discrepancies and proposed corrective modifications, if required, shall be submitted with short circuit study with variations clearly noted on subsequent shop drawings.

### 3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
  1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
  2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
  3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 242 recommendations for fault currents and time intervals.
- C. Provide a ground fault current study for the system, including the associated zero sequence impedance data. Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics.
- D. The studies shall include all portions of the electrical distribution system from the power source or sources down to and including the smallest adjustable trip circuit breaker in the distribution system. TCC curves shall be provided for each section of the distribution system that contains an adjustable setting.
- E. Transformer Primary Overcurrent Protective Devices:
  1. Device shall not operate in response to the following:
    - a. Inrush current when first energized.
    - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
  - F. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
  - G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
  - H. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
    1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
      - a. Device tag.
      - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
      - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
      - d. Fuse-current rating and type.
      - e. Ground-fault relay-pickup and time-delay settings.
    2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
      - a. Device tag.
      - b. Voltage and current ratio for curves.
      - c. Three-phase and single-phase damage points for each transformer.
      - d. No damage, melting, and clearing curves for fuses.
      - e. Cable damage curves.
      - f. Transformer inrush points.
      - g. Maximum fault-current cutoff point.
      - h. Motor starting curves.
  - I. Completed data sheets for setting of overcurrent protective devices.
- 3.5 ARC FLASH STUDY
- A. Provide an electrical arc flash hazard analysis on the Facility to determine incident energy, arc flash protection boundaries, and required personal protection equipment (PPE) for all electrical equipment in the facility. The calculations shall comply with NFPA-70E 2004, and IEEE-1584-2002. Labels shall be provided for equipment modified as a result of the scope of work for this project.

1. Equipment shall include but not be limited to individually mounted disconnects, individually mounted circuit breakers, panelboards, HVAC equipment control panels operating at 240V or above, variable frequency drives, switchboards, switchgear, inverter units, automatic transfer switches, power distribution units, etc.
  2. Equipment with multiple vertical sections such as switchboards, switchgear, multi-tab panels, etc. shall be provided with an arc flash label for each vertical section.
  3. For equipment having multiple access points (front, rear, side) a label shall be provided at each side of access.
- B. The purpose of this study is to provide a comprehensive software model of the Facility electrical distribution system, which will document facility compliance with NFPA 70E mandates as described below. This model will serve as an integral part of an ongoing safety program by providing integral work permits and arc flash calculations in compliance with NFPA-70E Article 130.1(A)(2) for each electrical equipment in the facility. The goal of this study shall be limit to arc flash incident energy to 8 calories per square centimeter or less at all locations. The study may require multiple iterations to achieve this goal by modifying settings and/or by suggesting different protective equipment. If required, the study report shall summarize and compare different scenarios where the arch flash goal maybe achieved. Consider the loss of coordination (only if not life safety) and equipment with different ratings or settings as possible ways to mitigate higher levels of incident energy.
- C. The analysis and procedures shall comply with the following standards and recommended practices for power system studies.
1. NFPA-70E, 2012 Standard for Electrical Safety in the Workplace
  2. IEEE-1584-2002
  3. IEEE-242 “Buff Book” Protection and Coordination of Industrial Power Systems
  4. IEEE-399 “Brown Book” Power System Analysis
  5. IEEE-141 “Red Book” Electric Power Distribution for Industrial Plants
- D. Method
1. A detailed arc flash study shall be performed to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protective equipment (PPE) for all energized electrical system equipment tasks for the electrical system studied. The calculations shall comply with NFPA-70E 2004, and IEEE-1584. Bolted short circuit calculations used in the above standards shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The purpose of this study is to determine arc flash hazards in conformance with NFPA-70E, and to provide a comprehensive software model of the electrical distribution system, which provides integral work permits and arc flash calculations in compliance with NFPA 70E Article 130.1(A)(2) for all equipment in the facility. The software program used in this study shall comply with the above standards. No substitutions in calculation methods will be allowed.
  2. The arc flash study shall determine the following results. The results shall be provided in spreadsheet format for each mode and electrical system location to provide easy viewing and comparison. Worst-case arc flash energy levels shall be flagged and the spreadsheet comparison table shall be capable of providing its output directly to high quality vinyl label printers. The calculations shall, as a minimum, include a comparison of both 100%


and 85% arcing currents for low voltage equipment for each electrical system configuration or operating mode, indicating worst-case arc flash hazards. The spreadsheet results shall include:

- a. Equipment name and voltage.
  - b. Upstream equipment device name and ANSI function, i.e. 51/50, etc.
  - c. Equipment type, i.e. switchgear, MCC, Panel, VFD, etc.
  - d. Equipment arc gap.
  - e. Bolted and estimated arcing fault current at the fault point (equipment) in symmetrical amperes. The estimated arcing current should be based on the arcing current equations used.
  - f. Trip time, opening time, and total clearing time (total Arc time) of the protective device.
  - g. Worst-case arc flash boundary for each bus/equipment in the model.
  - h. Worst-case arc flash hazard incident energy in cal/cm<sup>2</sup> for each bus/equipment in the model.
  - i. Worst-case personal protective equipment (PPE) for each bus/equipment in the model.
  - j. Working distances for up to five different distances showing items worst-case arc flash boundary, worst-case arc flash hazard incident energy, and worst-case personal protective equipment (PPE) for each distance.
  - k. Indicate “Danger/Hazardous” areas where incident energy is greater than 40 cal/cm<sup>2</sup> and provide recommendations to reduced arc flash energy levels for these areas.
3. Flag results where 85% arcing current provided worst-case results.
  4. Each mode of operation shall include a detailed write-up indicating areas where incident energy calculations and PPE requirements are higher than calculated in the normal operating mode.
  5. The overcurrent protection trip delay time used in the arc flash evaluation study shall be the clearing time of the circuit breaker or 2 seconds, whichever is greater as recommended by IEEE 1584 (section B1).
- E. Provide a detailed arc flash analysis report including as a minimum:
1. Introduction.
  2. Methodology.
  3. Information Sources.
  4. Key Assumptions.
  5. Arc Flash Energy and other consideration for various System Modes of Operation (maintenance mode, bus-tie, co-gen on/off, etc.).
  6. Arc Energy at 100% and reduced currents.
  7. IEEE 1584-2002 Considerations.

8. Overcurrent Protective Device Changes, Replacements or Setting Changes implemented in study to reduce arc flash hazard exposure.
  9. Explanation of Data in Arc Flash Hazard Report Tables.
  10. NFPA 70E Information.
  11. Shock Hazards with covers removed.
  12. Shock Hazard Approach Boundaries.
  13. Limited Approach Boundary.
  14. Restricted Approach Boundary.
  15. Prohibited Approach Boundary.
  16. Arc Flash Hazard Boundaries.
  17. Results of Arc flash Hazard Analysis for high voltage, medium voltage and low voltage systems, including:
    - a. Working distances.
    - b. Energy Levels.
    - c. PPE Requirements.
    - d. Recommendations to reduce arc flash hazard energy and exposure. For equipment listed in category 3, category 4 and dangerous, verify if the breaker instantaneous setting can be reduced without compromising coordination. If after adjusting instantaneous settings, for equipment in the category 3, category 4 and dangerous provide a brief narrative explaining why the category is so high
    - e. Arc Flash Hazard Report.
    - f. Electronic Copy in Adobe Acrobat format (6.0 or later)
- F. Provide and install print labels for all equipment in the system from the project study file. Assume three labels per equipment/bus using 4 inch x 6 inch labels or one 6 inch x 8 inch label per equipment bus. The labels shall be UV resistant vinyl labels (white with orange warning strip and black letters) conforming to ANSI-Z535. The labels shall be printable directly from the power system software utilized for the study. Labels shall include available fault current.
1. Transfer switches shall be provided with a label for each source.
  2. Distribution equipment served from a generator shall be provided with a label for each source.
  3. All controllers (i.e., starters, variable frequency drives, etc.) shall be provided with a label.
    - a. Self adhesive arc flash labels containing study result information. One label shall be provided for each piece of electrical distribution equipment including switchgear, switchboards, distribution panelboards, branch circuit panelboards, and disconnects. Label information shall include the following, at a minimum.
    - b. Name of Equipment
    - c. "Warning" or "Danger" reference as appropriate
    - d. Equipment Voltage Rating (Volts)



- e. Limited Approach Boundary Distance (Inches)
  - f. Restricted Approach Boundary Distance (Inches)
  - g. Prohibited Approach Boundary Distance (Inches)
  - h. Flash Hazard Boundary (inches)
  - i. Arc Flash Hazard Category
  - j. Incident Energy ( $\text{cal}/\text{cm}^2$ )
  - k. Description of PPE for head, eye, body, hand/arm, and foot protection
  - l. Date of study
4. Refer to sample label below:

 <b>WARNING</b>		
208 VAC      Arc Flash and Shock Hazard		
42 inches	Limited Approach (Qualified Persons Only)	
Avoid Contact	Restricted Approach (PPE Required)	
Avoid Contact	Prohibited Approach (PPE Required)	
61 inches	Flash Hazard Boundary (PPE Required)	
<b>Category 2</b>	<b>PPE Required</b>	<b>7.3 <math>\text{cal}/\text{cm}^2</math></b>
Eye and Head:	Hardhat + Safety Glasses or Goggles + Ear Canal Inserts	
Body:	Cotton Underwear + FR Shirt & Pants	
Hand and Arm:	Leather Gloves	
Foot:	Leather work shoes	
NORMAL 04/02/10		Bus: 198 AP-GA Prot: DP-41-SE-3 <b>AVAILABLE FAULT CURRENT: 1.40 kA</b>

5. For equipment with arc reduction provide a second blue label that notes the arc reduction levels when using the arc flash reduction feature

### 3.6 ADJUSTMENTS, SETTINGS AND MODIFICATIONS

- A. Provide necessary field settings, adjustments, minor modifications, for conformance with the study, without any additional cost to owner. Examples of minor modifications would be trip sizes within the same frame, the time curve characteristics of inductions relays, CT ranges, etc.
- B. Proposed corrective modifications will be taken under advisement and the Construction Manager will be given further instructions.

END OF SECTION

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## SECTION 260800 - COMMISSIONING OF ELECTRICAL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This section includes commissioning process requirements for Electrical systems, assemblies, and equipment.
- B. Related Sections
  - 1. Division 01 for general commissioning process requirements.

#### 1.3 DESCRIPTION

- A. Refer to Division 01 for the description of commissioning.

#### 1.4 DEFINITIONS

- A. Refer to Division 01 for definitions.

#### 1.5 SUBMITTALS

- A. Refer to Division 01 for CxA's role.
- B. Refer to Division 01 for specific requirements.
- C. In addition, provide the following:
  - 1. Certificates of readiness.
  - 2. Certificates of completion of installation, prestart, and startup activities.
  - 3. O&M manuals.
  - 4. Test reports.

#### 1.6 QUALITY ASSURANCE

- A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

## 1.7 COORDINATION

- A. Refer to Division 01 for requirements pertaining to coordination during the commissioning process.

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the electrical contractor of Division 26 shall ultimately be responsible for all standard testing equipment for the electrical systems and controls systems in Division 26. A sufficient quantity of two-way radios shall be provided by each contractor.
- B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.
- C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.
- D. Data logging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.
- E. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 deg. F and a resolution of  $\pm 0.1$  deg. F. Pressure sensors shall have an accuracy of  $\pm 2.0$  percent of the value range being measured (not full range of meter) and have been calibrated within the last year.

## PART 3 - EXECUTION

### 3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems
- B. Red-lined Drawings:
  - 1. The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.
  - 2. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
  - 3. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings.

4. The contracted party, as defined in the Contract Documents will create the as-built drawings.
- C. Operation and Maintenance Data:
1. Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.
  2. The CxA will review the O&M literature once for conformance to project requirements.
  3. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.
- D. Demonstration and Training:
1. Contractor will provide demonstration and training as required by the specifications.
  2. A complete training plan and schedule must be submitted by the Contractor to the CxA four weeks (4) prior to any training.
  3. A training agenda for each training session must be submitted to the CxA one (1) week prior the training session.
  4. The CA shall be notified at least 72 hours in advance of scheduled tests so that testing may be observed by the CA and Owner's representative. A copy of the test record shall be provided to the CA, Owner, and Architect.
  5. Engage a Factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specific equipment.
  6. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, trouble shooting, servicing, and maintaining equipment.
  7. Review data in O&M Manuals.
- E. Systems manual requirements
1. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
  2. The GC shall include final approved versions of the following information for the Systems Manual:
    - a. As-Built System Schematics.
    - b. Verified Record Drawings.
    - c. Test Results (not otherwise included in Cx Record).
    - d. Periodic Maintenance Information for computer maintenance management system.
    - e. Recommendations for recalibration frequency of sensors and actuators.
    - f. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information.
    - g. Training Records, Information on training provided, attendees list, and any on-going training.
  3. This information shall be organized and arranged by building system, such as fire alarm, chilled water, heating hot water, etc.

4. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.

### 3.2 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meetings.
- C. Participate in Electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- D. Provide information requested by the CxA for final commissioning documentation.
- E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- F. Prepare preliminary schedule for Electrical system orientations and inspections, operation and maintenance manual submissions, training sessions, equipment start-up and task completion for owner. Distribute preliminary schedule to commissioning team members.
- G. Update schedule as required throughout the construction period.
- H. During the startup and initial checkout process, execute the related portions of the prefunctional checklists for all commissioned equipment.
- I. Assist the CxA in all verification and functional performance tests.
- J. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- K. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.
- L. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
- M. Notify the CxA a minimum of two weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.
- N. Participate in, and schedule vendors and contractors to participate in the training sessions.
- O. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
  1. Electrical equipment including switchgear, panel boards, motor control centers, lighting, receptacles, dimmers and all other equipment furnished under this Division.
  2. Emergency generators, ATS switches and emergency power systems.
  3. Fire alarm system.
  4. Lightning protection.
- P. The equipment supplier shall document the performance of his equipment.

- Q. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.
- R. Provide training of the Owner's operating staff using expert qualified personnel, as specified.
- S. Equipment Suppliers
  - 1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
  - 2. Assist in equipment testing per agreements with contractors.
  - 3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
- T. Refer to Division 01, General Commissioning Requirements for additional Contractor responsibilities.

### 3.3 OWNER'S RESPONSIBILITIES

- A. Refer to Division 01, General Commissioning Requirements for Owner's Responsibilities.

### 3.4 DESIGN PROFESSIONAL'S RESPONSIBILITIES

- A. Refer to Division 01, General Commissioning Requirements for Design Professional's Responsibilities.

### 3.5 CXA'S RESPONSIBILITIES

- A. Refer to Division 01, General Commissioning Requirements for CxA's Responsibilities.

### 3.6 TESTING PREPARATION

- A. Certify in writing to the CxA that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the CxA that Electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

### 3.7 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Electrical testing shall include the entire Electrical installation, from the incoming power equipment throughout the distribution system. Testing shall include measuring, but not limited to resistance, voltage, and amperage of system(s) and devices.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the Electrical contractor and other contracted subcontractors, including the fire alarm Subcontractor shall prepare detailed testing plans, procedures, and checklists for Electrical systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

### 3.8 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 26 sections. Provide submittals, test data, inspector record, infrared camera and certifications to the CA.
- B. Electrical Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 26 Sections "Instrumentation and Control" and "Sequence of Operations" Assist the CxA with preparation of testing plans.
- C. Emergency Generator Testing and Acceptance Procedures: Provide technicians, load banks, infrared cameras, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- D. Fire Detection and Alarm System Testing: Provide technicians, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

- E. Electrical Distribution System Testing: Provide technicians, load banks, infrared cameras, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested
  - F. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.
  - G. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:
    - 1. Automatic temperature controls integrated with the electrical systems
    - 2. Coordination and functionality with the Building Automation System/Building Management Controls System.
    - 3. Access Control.
    - 4. Automatic Transfer Switch.
    - 5. Battery Monitoring System.
    - 6. CCTV.
    - 7. Emergency Generator.
    - 8. Emergency Power System.
    - 9. EPO System.
    - 10. Fire Alarm System.
    - 11. Grounding System.
    - 12. Lighting Controls.
    - 13. Lightning Protection System.
    - 14. Switchboard.
    - 15. Panelboard.
    - 16. Power Distribution System.
    - 17. Metering System.
    - 18. Security System.
    - 19. Transformer.
- 3.9 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT
- A. Refer to Division 01, General Commissioning Requirements for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.
- 3.10 APPROVAL
- A. Refer to Division 01, General Commissioning Requirements for approval procedures.



3.11 DEFERRED TESTING

- A. Refer to Division 01, General Commissioning Requirements for requirements pertaining to deferred testing.

3.12 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.
- B. Refer to Division 01, General Commissioning Requirements for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.13 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01, General Commissioning Requirements for requirements pertaining to training.
- B. Electrical Contractor. The electrical contractor shall have the following training responsibilities:
  - 1. Provide the CA with a training plan two weeks before the planned training.
  - 2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
  - 3. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
  - 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  - 5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
  - 6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
  - 7. Training shall include:
    - a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
    - b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
    - c. Discuss relevant health and safety issues and concerns.

- d. Discuss warranties and guarantees.
  - e. Cover common troubleshooting problems and solutions.
  - f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
  - g. Discuss any peculiarities of equipment installation or operation.
- 8. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance of all pieces of equipment.
  - 9. The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
  - 10. Training shall occur after functional testing is complete, unless approved otherwise by the Owner's.

END OF SECTION

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## SECTION 260943 - NETWORK LIGHTING CONTROLS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes distributed digital lighting controls with manually operated lighting controls, occupancy sensors, daylight sensors and with digital room control modules featuring relays and control models.

#### 1.3 DEFINITIONS

- A. BACnet: A networking communication protocol that complies with ASHRAE 135.
- B. BAS: Building automation system.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
- D. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- E. PC: Personal computer; sometimes plural as "PCs."
- F. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.

#### 1.4 SUBMITTALS

- A. Product Data: For control modules, power distribution components, manual switches and plates, and conductors and cables.
- B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.
  - 1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
  - 2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

3. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
- C. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
  1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
  2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
- F. Warranty: Special warranty specified in this Section.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- D. Comply with NFPA 70.

#### 1.6 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
  1. Match components and interconnections for optimum performance of lighting control functions.
  2. Coordinate lighting controls with BAS. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
- B. Coordinate lighting control components specified in this Section with components specified in Division 26.

#### 1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Failure of software input/output to execute switching or dimming commands.
    - b. Failure of modular relays to operate under manual or software commands.

- c. Damage of electronic components due to transient voltage surges.
- 2. Warranty Period: Five years from date of Substantial Completion.
- 3. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.
- 4. Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. NLight; Acuity Lighting Group, Inc.
  - 2. Watt Stopper (The).
  - 3. Or approved equal.

### **2.2 SYSTEM REQUIREMENTS**

- A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays and terminals.
- B. Performance Requirements (digital room controllers): Manual switch operation, automatic occupancy sensor operation, and automatic daylight sensors will send signals to programmable-system room control module(s) that process the signals according to its programming and routes an open or close command to one or more relays, or variable commands to one or more dimmer relays in the power-supply circuits to groups of lighting fixtures or other loads.
- C. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.
  - 1. Hardwired Points:
    - a. Monitoring: On-off status.
  - 2. ASHRAE 135 (BACnet) or Modbus communication interface with the BAS shall enable the BAS operator to remotely control and monitor lighting from a BAS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the BAS.

### **2.3 CONTROL MODULE**

- A. Digital Room Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state control unit. Unit shall be programmable for control of indicated number of output circuits. Output circuits shall be switched or dimmed as indicated on drawings by digital signals from external sources. Output circuits shall be switched or dimmed by relays. Modules shall include the following features:
  - 1. Multichannel output with indicated number of channels.

2. Multiple inputs for indicated occupancy sensors, daylight sensors and hand-held programming device.
3. 0-10V dimming: where indicated, one 0-10V analog output per relay for control of compatible ballast and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the room controller to assure the full light output from the controlled lighting. Capable of providing Class 1 or 2 wiring for 0-10V output signal.
4. Triac-based forward phase dimming: where indicated, one forward phase control line voltage output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads. The forward phase output shall automatically open upon loss of power to the room controller to assure the full light output from the controlled lighting.

## 2.4 MANUAL SWITCHES AND PLATES

- A. Push-Button Switches: Modular, momentary-contact, low-voltage type.
  1. Match color specified in Division 26.
  2. Integral green LED pilot light to indicate when circuit is on.
- B. Wall-Box Dimmers: seven bi-level LEDs to indicate load levels using 14 steps.
- C. Wall Plates: Single and multigang plates as specified in Division 26.
- D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

## 2.5 OCCUPANCY SENSORS

- A. General Description: Wall- or ceiling-mounting, solid state units with a separate relay unit.
  1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum of 1 to 15 minutes.
  2. Mounting: Suitable for mounting in any position on a standard outlet box.
  3. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
  4. Bypass switch: Override the on function in case of sensor failure.
- B. Dual-Technology Type: Wall or ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
  1. Sensitivity Adjustment: Separate for each sensing technology.
  2. Detector Sensitivity: Detect occurrences if 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or vertical manner at an approximate speed of 12 inches/s.
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sf when mounted on a 96-inch-high ceiling.

## 2.6 DAYLIGHTING SENSORS

- A. Solid-state, light-level sensor unit to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
  - 1. Light-Level Monitoring Range: 100 to 1000 fc, with an adjustment for turn-on and turn-off levels within that range.
  - 2. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with dead band adjustment.
  - 3. Indicator: Two LEDs to indicate the beginning of on-off cycles.

## 2.7 EMERGENCY BYPASS RELAY

- A. Emergency lighting control unit, UL 924 Listed, monitors a switched circuit providing normal lighting to an area. The unit provides normal on-off control of emergency lighting along with the normal lighting. Upon normal power failure, the emergency lighting circuit will close, forcing the emergency lighting on until normal power is restored.

## 2.8 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26.
- B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Division 26.
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Division 26.
- D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Division 27.

# PART 3 - EXECUTION

## 3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install wiring in raceways except where installed in accessible ceilings and gypsum board partitions. Comply with Division 26. Minimum conduit size shall be 1/2 inch.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.
- F. Identify components and power and control wiring according to Division 26.

### 3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Test for circuit continuity.
  - 2. Verify that the control module features are operational.
  - 3. Check operation of local override controls.
  - 4. Test system diagnostics by simulating improper operation of several components selected by Architect.

### 3.3 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls. Refer to Division 01.

END OF SECTION

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## SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
  - 1. Distribution transformers.

#### 1.3 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Source quality-control test reports.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. ACME Electric Corporation; Power Distribution Products Division.
  - 2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
  - 3. Controlled Power Company.
  - 4. Eaton Electrical Inc.; Cutler-Hammer Products.
  - 5. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
  - 6. ABB-General Electric.
  - 7. Hammond Co.; Matra Electric, Inc.
  - 8. Magnetek Power Electronics Group.
  - 9. Micron Industries Corp.
  - 10. Myers Power Products, Inc.
  - 11. Siemens Energy & Automation, Inc.
  - 12. Sola/Hevi-Duty.
  - 13. Square D; Schneider Electric.
  - 14. Or approved Equal

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Aluminum.

## **2.3 DISTRIBUTION TRANSFORMERS**

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 2.
  1. Core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
  1. Finish Color: Gray.
- E. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.
- F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
  1. Complying with NEMA TP 1, Class 1 efficiency levels.
  2. Tested according to NEMA TP 2.
- J. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
  1. 9 kVA and Less: 40 DBA
  2. 30 to 50 kVA: 45 DBA
  3. 51 to 150 kVA: 50 DBA

## **2.4 IDENTIFICATION DEVICES**

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26.

## **2.5 SOURCE QUALITY CONTROL**

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 have been met. Maximum ground resistance shall be 10 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Division 26.

### **3.3 CONNECTIONS**

- A. Ground equipment according to Division 26.
- B. Connect wiring according to Division 26.

### **3.4 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
  - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  - 2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
  - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

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## SECTION 262413 - SWITCHBOARDS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Service and distribution switchboards rated 600 V and less.
  - 2. Transient voltage suppression devices.
  - 3. Disconnecting and overcurrent protective devices.
  - 4. Instrumentation.
  - 5. Control power.
  - 6. Accessory components and features.
  - 7. Identification.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
  - 5. Detail utility company's metering provisions with indication of approval by utility company.
  - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit electronically; include selectable ranges for each type of overcurrent protective device.
8. Include schematic and wiring diagrams for power, signal, and control wiring.
- C. Qualification Data: For qualified Installer.
- D. Field Quality-Control Reports:
  1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
  1. Routine maintenance requirements for switchboards and all installed components.
  2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
  1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Comply with NEMA PB 2.
- G. Comply with NFPA 70.
- H. Comply with UL 891.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Handle and prepare switchboards for installation according to NEMA PB 2.1.

**1.6 PROJECT CONDITIONS**

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
  - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 104 deg F.
    - b. Altitude: Not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Owner no fewer than 14 days in advance of proposed interruption of electric service.
  - 2. Indicate method of providing temporary electric service.
  - 3. Do not proceed with interruption of electric service without Construction Manager's written permission.
  - 4. Comply with NFPA 70E.

**1.7 COORDINATION**

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

**1.8 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

**1.9 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.



1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURED UNITS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. ABB-General Electric; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
  5. Or approved equal.
- B. Front-Connected, Front-Accessible Switchboards:
  1. Main Devices: Fixed, individually mounted.
  2. Branch Devices: Panel mounted.
  3. Sections front and rear aligned.
- C. Nominal System Voltage: 208Y/120 V.
- D. Main-Bus Continuous: as shown on drawings.
- E. Indoor Enclosures: Steel, NEMA 250, Type 1.
- F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- G. Barriers: Between adjacent switchboard sections.
- H. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- I. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.
- J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- K. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- L. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, with tin-plated aluminum or copper feeder circuit-breaker line connections.
2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
3. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

## 2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. ABB-General Electric; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
  5. Or approved equal.
- B. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, plug-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
  1. Fuses, rated at 200-kA interrupting capacity.
  2. Fabrication using bolted compression lugs for internal wiring.
  3. Redundant suppression circuits.
  4. Redundant replaceable modules.
  5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
  6. LED indicator lights for power and protection status.
  7. Audible alarm, with silencing switch, to indicate when protection has failed.
  8. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

9. Six-digit, transient-event counter set to totalize transient surges.
- C. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.
- D. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
- E. Protection modes and UL 1449 SVR for grounded wye circuits with 208Y/120-V, three-phase, four-wire circuits shall be as follows:
  1. Line to Neutral: 400 V for 208Y/120.
  2. Line to Ground: 400 V for 208Y/120.
  3. Neutral to Ground: 400 V for 208Y/120.

### 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
  1. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time time adjustments.
    - d. Ground-fault pickup level, time delay, and  $I^2t$  response.
  2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
  3. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
  4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- B. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Boltswitch, Inc.

- b. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - c. Pringle Electrical Manufacturing Company, Inc.
  - d. Siemens Energy & Automation, Inc.
  - e. Square D; a brand of Schneider Electric.
  - f. Or approved equal.
- 2. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
- 3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
  - a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
  - b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
- 4. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
- 5. Service-Rated Switches: Labeled for use as service equipment.
- 6. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
  - a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
  - c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
  - d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).
- 7. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- D. Fuses are specified in Division 26.

## 2.4 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
  - 1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
  - 2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
  - 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
  1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - a. Phase Currents, Each Phase: Plus or minus 1 percent.
    - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    - d. Megawatts: Plus or minus 2 percent.
    - e. Megavars: Plus or minus 2 percent.
    - f. Power Factor: Plus or minus 2 percent.
    - g. Frequency: Plus or minus 0.5 percent.
    - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
    - i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
    - j. Contact devices to operate remote impulse-totalizing demand meter.
  2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

## 2.5 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through disconnecting devices.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

## 2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

## 2.7 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install switchboards and accessories according to NEMA PB 2.1.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03.
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
  - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Install spare-fuse cabinet.
- H. Comply with NECA 1.

### **3.3 IDENTIFICATION**

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26.
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26.

- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26.

### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION

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## SECTION 262416 - PANELBOARDS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Provide all labor, materials and equipment to furnish and install all of the items specified herein, indicated on the drawings and as necessary for the proper and complete performance of work.
- B. Panelboards shall be fully rated for available fault currents. Series ratings shall not be accepted.
- C. Emergency (NFPA 70 Article 700) and legally required (NFPA 70 Article 701), panelboards shall be equipped with devices such that selective coordination is maintained. The design intent in this specification and on the contract drawings has generally accounted for selective coordination. Illustrate the selectivity of proposed devices via the coordination study specified in Division 26.
- D. Section Includes:
  - 1. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.

#### 1.3 REFERENCES

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form part of this specification to the extent referenced. Publications are referenced in the text by the basic designations only.
  - 1. National Electrical Code (NEC)
  - 2. National Electrical Manufacturer's Association (NEMA).
    - a. PB-1 Panelboard
    - b. PB1.1 General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
  - 3. Underwriter's Laboratories (UL)
    - a. UL 50 Enclosures for Electrical Equipment
    - b. UL 67 Panelboards
    - c. UL 508 Standard for Safety Industrial Control Equipment
  - 4. American National Standard Institute (ANSI)

1.4 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.5 SUBMITTALS

- A. Panelboards shall be submitted subsequent to the fault current and coordination studies required in 260573. Equipment submittals prior to the required study shall not be reviewed by the Design Engineer and will be returned “rejected.”
- B. Panelboards shall be submitted in a logical fashion and follow the order scheduled on the drawings. Disorganized submittals shall not be reviewed by the Design Engineer and will be returned “rejected.”
- C. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- D. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus material, configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices confirming fully rated equipment (series rating of circuit breakers is not acceptable).
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 6. Include wiring diagrams for power, signal, and control wiring.
  - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit selectable ranges for each type of overcurrent protective device.
- E. Field Quality-Control Reports:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Panelboard Schedules: For installation in panelboards.
- G. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
  - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

#### 1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products in conformance with manufacturer's recommended practices as outlined in applicable Installation and Maintenance Manuals.
- B. Inspect and report concealed damage to carrier within their required time period.
- C. Protect equipment throughout construction from damage, weather, excessive temperature, and construction operations.

#### 1.8 PROJECT CONDITIONS

- A. Environmental Limitations:
  1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
    - b. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  1. Notify Owner no fewer than 14 days in advance of proposed interruption of electric service.
  2. Do not proceed with interruption of electric service without Owner's written permission.
  3. Comply with NFPA 70E.

#### 1.9 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other trades and construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to dedicated equipment space and workspace

clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

**1.10 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: One year from date of Substantial Completion.

**1.11 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Keys: Two spares for each type of panelboard cabinet lock.
  - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

**PART 2 - PRODUCTS**

**2.1 GENERAL REQUIREMENTS FOR PANELBOARDS**

- A. Manufacturers
  - 1. The design is based on Square D to establish standards of quality for materials and performance. The naming of a specific manufacturer or catalog number does not waive any requirements or performance of individual components described in the specification. Provide Square D Series NQOB and NF for 225A and below for receptacle and lighting panels and I-Line for distribution and panels above 225A.
  - 2. Eaton Cutler-Hammer panelboards shall be Type PRL-1 for 225A and below for receptacle and lighting panels, Cutler-Hammer PRL-3 for distribution to 225A and Cutler-Hammer PRL-4 for distribution to 1200A.
  - 3. ABB-General Electric panelboards shall be Series A for 225A and below for receptacle and lighting panels, ABB-General Electric Spectra Series for panelboards and distribution panels above 225A.
  - 4. Siemens panelboards Type P1, P2 or P3 for 225A and below for receptacle and lighting panels, Type P4 and P5 for panelboards and distribution panels above 225A.
  - 5. Or approved equal.
- B. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26.
- C. Enclosures: Flush- and surface-mounted cabinets as indicated in the contract documents.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - b. Outdoor Locations: NEMA 250, Type 3R.

- c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
- 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover (door in door type). Opening inner door shall expose circuit breaker operator handles and panelboard directory. Opening outer door shall expose terminals and circuit breakers in a single operation.
- 3. Where two section panels are required, bolt boxes together to form one unit. Trim shall be two-piece construction with doors of equal size over each section.
- 4. Power and lighting panels shall have heavy duty, continuous, section vertical-hinging to box section for access to wiring gutters in addition to trim door
- 5. Finishes:
  - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
  - b. Back Boxes: Galvanized steel.
- 6. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover. Directories shall be typed showing use of each circuit and the panelboard designation.
- 7. Panelboard designations shall be labeled on the front of the panel with a screw-on nameplate.
- D. Phase, Neutral, and Ground Buses:
  - 1. Material: Tin-plated aluminum.
  - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Tin-plated aluminum.
  - 2. Main and Neutral Lugs: Mechanical type.
  - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
  - 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  - 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

## 2.2 PANELBOARDS

- A. Panelboards shall meet or exceed requirements of NEMA Standard Publication PB-1 and UL-50 and 67. Provide cabinets with flush hinges and combination catch and lock. Provide wiring gutters to accommodate large multiplier feeder cables and lugs. Except as shown otherwise on

drawings, wiring gutters shall be at least 4" for lighting and 208V panels and 6" for 480V panels.

- B. Increase size of panelboard gutters to accommodate compression connectors for aluminum conductors.
- C. Panelboards shall have short circuit current rating equal to or greater than circuit breaker AIC ratings schedule on drawings.
- D. Panelboards served from transformers shall have a main breaker, unless an enclosed circuit breaker or fused switch is shown.
- E. Main bus bars shall be silver plated aluminum, sized as required by UL standards to limit temperature rise on current carrying parts to 50°C above ambient 40°C maximum. Main bus bars shall be sized at least to full rating of feeders overcurrent device that feeds the panelboard.
- F. Provide molded case, bolt-on, thermal-magnetic trip, single, two or three pole branch circuit breakers as shown on drawings. Multiple pole breakers shall be single handle, common-trip. Circuit breakers shall be listed and labeled for 75°C conductor ampacities.
- G. Provide bus connections for future overcurrent device with suitable insulation and bracing to maintain proper short circuit rating and voltage clearances, where required on drawings. Provide for ready insertion of future breaker.
- H. Provide separate equipment ground bus for each panelboard.
- I. Where shown on drawings, provide isolated ground bus in addition to the equipment ground bus. The isolated ground bus shall be insulated from panel enclosure and shall be copper.
- J. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Main and Neutral Lugs: Mechanical type.
  - 2. Ground Lugs and Bus-Configured Terminators: Mechanical type.
  - 3. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  - 4. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- K. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

### 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  - 3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
    - a. Instantaneous trip.

- b. Long- and short-time pickup levels.
  - c. Long- and short-time time adjustments.
  - d. Ground-fault pickup level, time delay, and  $I^2t$  response.
- 4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- 5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
- 6. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
- 7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
  - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
  - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - e. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
  - f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
  - g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

## 2.4 PANELBOARD SURGE PROTECTION DEVICES

- A. Surge Protection Device: Provide factory installed IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, in accordance with Division 26.

## 2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

- B. Examine panelboards at delivery before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine the areas and conditions under which panelboards are to be installed and notify engineer in writing of conditions detrimental to the proper and timely completion of work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install panelboards where indicated, in accordance with manufacturer's written instructions, guidelines and the applicable requirements of the NEC, local codes, the National Electrical Contractors Association's "Standard of Installation" and in accordance with recognized industry practices to ensure that products serve the intended function.
- B. Install all flush mounted panelboards with one spare 1½ -inch and two ¾" conduits from panel to above accessible ceiling.
- C. Location:
  - 1. Maintain the minimum NEC clearances about the equipment.
  - 2. Locate top of enclosures approximately 6'-6" above floor, at a masonry joint if applicable. Panelboard shall never be mounted such that the handle of the highest circuit breaker exceeds 6'-6" AFF.
  - 3. Provide 1/2" spacers for panelboards mounted at exterior walls below grade to establish an air space behind panel.
- D. Anchoring:
  - 1. Provide all necessary hardware to secure panelboard in place. Anchor enclosure firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.
  - 2. Mount free standing distribution panels on 6-inch high concrete pads with 1-inch chamfered edges.
  - 3. Comply with mounting and anchoring requirements specified in Division 26.
- E. Branch circuit wiring shall be peeled out of the wiring gutters at 90 degrees to circuit breakers and terminal lugs for a neat installation.
- F. Install overcurrent protective devices and controllers not already factory installed.
- G. Set field-adjustable, circuit-breaker trip ranges.
- H. Install filler plates in unused spaces.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

### 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26.
- B. Directories:
  - 1. Fill out the enclosure circuit directory card upon completion of work and install in panelboard.



2. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
  3. Incorporate Owner's final room designations. Obtain approval before installing.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26.
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26.

### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  2. Test continuity of each circuit.
- C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

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## **SECTION 262726 - WIRING DEVICES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Straight blade receptacles
  - 2. GFCI receptacles
  - 3. Twist-locking receptacles
  - 4. Wall plates
  - 5. Floor service fittings
  - 6. Poke-through assemblies
  - 7. Multi-outlet assemblies
  - 8. Finishes
- B. Related Sections include the following:
  - 1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

#### **1.3 DEFINITIONS**

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

## 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

## 1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
  - 1. Cord and Plug Sets: Match equipment requirements.
- B. Coordinate the locations of outlet boxes between the electrical drawings and any other drawings associated with the project. Discrepancies shall be brought to the attention of the Architect by formal RFI procedure. Any reasonable change in location of outlets shall not involve additional expense to Owner. The term "reasonable" shall be interpreted as moving outlet 10'-0" in any direction from the location indicated on the Electrical drawings. Refer to specifications 20 00 00 for additional information regarding discrepancies in documents.

## 1.7 EXTRA MATERIALS

- A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Floor Service Outlet Assemblies: One for every 10, but no fewer than one.
  - 2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
  - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
  - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 3. Leviton Mfg. Company Inc. (Leviton).
  - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

5. Or approved equal

## 2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cooper; 5351 (single), 5352 (duplex).
    - b. Hubbell; HBL5351 (single), CR5352 (duplex).
    - c. Leviton; 5891 (single), 5352 (duplex).
    - d. Pass & Seymour; 5361 (single), CRB5362 (duplex).
    - e. Or approved equal

## 2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, Federal Specification W-C-596 and include indicator light that is lighted when device is tripped. The device must have Self-test feature (conducts an automatic test, ensuring ground fault protection). If ground fault protection is compromised, power to the receptacle must be discontinued.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cooper; GF20.
    - b. Hubbell;
    - c. Leviton;
    - d. Pass & Seymour; 2097.
    - e. Or approved equal

## 2.4 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Cooper; L520R.
    - b. Hubbell; HBL2310.
    - c. Leviton; 2310.
    - d. Pass & Seymour; L520-R.
    - e. Or approved equal

## 2.5 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: 0.035-inch- thick, satin-finished stainless steel.
  - 3. Material for Unfinished Spaces: Galvanized steel.
  - 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

## 2.6 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, with satin finish.
- D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

## 2.7 POKE-THROUGH ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Hubbell Incorporated; Wiring Device-Kellems.
  - 2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
  - 3. Square D/ Schneider Electric.
  - 4. Thomas & Betts Corporation.
  - 5. Wiremold Company (The).
  - 6. Or approved equal
- B. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
  - 1. Service Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks.
  - 2. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
  - 3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
  - 4. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
  - 5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two, 4-pair, Category 5e voice and data communication cables.

## 2.8 MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Hubbell Incorporated; Wiring Device-Kellems.
  - 2. Mono Systems
  - 3. Wiremold Company (The).
  - 4. Or approved equal
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Wire: No. 12 AWG.

## 2.9 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
  - 1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70, device listing.
  - 2. Wiring Devices Connected to Emergency Power System: Red.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
  - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
  - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
  - a. Cut back and pigtail, or replace all damaged conductors.
  - b. Straighten conductors that remain and remove corrosion and foreign matter.
  - c. Pigtail existing conductors is permitted provided the outlet box is large enough.

**D. Device Installation:**

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

**E. Receptacle Orientation:**

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

**F. Device Plates:** Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

**G. Arrangement of Devices:** Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

**H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.**

**3.2 IDENTIFICATION**

**A. Comply with Division 26 Section "Identification for Electrical Systems."**

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.



### 3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
  - 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
  - 2. Test Instruments: Use instruments that comply with UL 1436.
  - 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
  - 1. Line Voltage: Acceptable range is 105 to 132 V.
  - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
  - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
  - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
  - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
  - 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

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## SECTION 262813 - FUSES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Cartridge fuses rated 600-V ac and less for use in enclosed switches, switchboards, and enclosed controllers.
  - 2. Spare-fuse cabinets.

#### 1.3 REFERENCES

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form part of this specification to the extent referenced. Publications are referenced in the text by the basic designations only.
  - 1. National Electrical Code (NEC)
  - 2. Underwriter's Laboratories (UL)
    - a. UL 50 Enclosures for Electrical Equipment
    - b. UL 508 Standard for Safety Industrial Control Equipment
    - c. UL 977 Fused Power Circuit Devices
  - 3. American National Standard Institute (ANSI)

#### 1.4 SUBMITTALS

- A. Product Data: For each type and rating of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  3. Current-limitation curves for fuses with current-limiting characteristics.
  4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
  5. Coordination charts and tables and related data.
  6. Fuse sizes for elevator feeders and elevator disconnect switches.
- B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
1. Ambient temperature adjustment information.
  2. Current-limitation curves for fuses with current-limiting characteristics.
  3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
  4. Coordination charts and tables and related data.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.

#### 1.6 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

#### 1.7 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

#### 1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
  - 1. Cooper Bussmann, Inc.
  - 2. Edison Fuse, Inc.
  - 3. Ferraz Shawmut, Inc.
  - 4. Littelfuse, Inc.
  - 5. Or approved equal.

### 2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

### 2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
  - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
  - 2. Finish: Gray, baked enamel.
  - 3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
  - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
  - 1. Service Entrance: Class L, time delay.
  - 2. Feeders: Class L, time delay.
  - 3. Motor Branch Circuits: Class RK1, time delay.
  - 4. Elevator Branch Circuits: Class J, time delay.
  - 5. Other Branch Circuits: Class RK1, time delay.
  - 6. Control Circuits: Class CC, fast acting.

### 3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s).

### 3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

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## SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Molded-case circuit breakers (MCCBs).
  - 3. Molded-case switches.
  - 4. Enclosures.

#### 1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
  - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.
- C. Field quality-control reports.
  1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
  1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
  2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

#### 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
  2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  1. Notify Owner no fewer than 14 days in advance of proposed interruption of electric service.
  2. Indicate method of providing temporary electric service.
  3. Do not proceed with interruption of electric service without Owner's written permission.
  4. Comply with NFPA 70E.

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Fuse Pullers: Two for each size and type.
  - 3. .

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. ABB-General Electric; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
  - 5. Or approved equal.
- B. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  - 4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.



5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.2 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. ABB-General Electric; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
  5. Or approved equal.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  1. Instantaneous trip.
  2. Long- and short-time pickup levels.
  3. Long- and short-time time adjustments.
  4. Ground-fault pickup level, time delay, and  $I^2t$  response.
- F. Features and Accessories:
  1. Standard frame sizes, trip ratings, and number of poles.
  2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
  3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
  4. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  5. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.

## 2.3 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

### **3.3 IDENTIFICATION**

- A. Comply with requirements in Division 26.
  1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### **3.4 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
  1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
  2. Test continuity of each circuit.
- C. Tests and Inspections:
  1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26.

END OF SECTION

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## SECTION 262913 - ENCLOSED CONTROLLERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
  - 1. Full-voltage manual.

#### 1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
  - 1. Show tabulations of the following:
    - a. Each installed unit's type and details.
    - b. Factory-installed devices.
    - c. Nameplate legends.
    - d. Short-circuit current rating of integrated unit.
    - e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.

- f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
    - 2. Wiring Diagrams: For power, signal, and control wiring.
  - C. Qualification Data: For qualified testing agency.
  - D. Field quality-control reports.
  - E. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 include the following:
    - 1. Routine maintenance requirements for enclosed controllers and installed components.
    - 2. Manufacturer's written instructions for setting field-adjustable overload relays.
- 1.5 QUALITY ASSURANCE
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - B. Comply with NFPA 70.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- 1.7 PROJECT CONDITIONS
- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
    - 2. Altitude: Not exceeding 6600 feet.
  - B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
    - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical systems.
    - 2. Indicate method of providing temporary utilities.
    - 3. Do not proceed with interruption of electrical systems without Owner's written permission.
    - 4. Comply with NFPA 70E.
- 1.8 COORDINATION
- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
  - B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

## PART 2 - PRODUCTS

### 2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
  - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. ABB-General Electric; GE Consumer & Industrial - Electrical Distribution.
    - c. Rockwell Automation, Inc.; Allen-Bradley brand.
    - d. Siemens Energy & Automation, Inc.
    - e. Square D; a brand of Schneider Electric.
  - 2. Configuration: Nonreversing.
  - 3. Surface mounting.
  - 4. Red pilot light.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
  - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. ABB-General Electric; GE Consumer & Industrial - Electrical Distribution.
    - c. Rockwell Automation, Inc.; Allen-Bradley brand.
    - d. Siemens Energy & Automation, Inc.
    - e. Square D; a brand of Schneider Electric.
  - 2. Configuration: Nonreversing.
  - 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
  - 4. Surface mounting.
  - 5. Red pilot light.
- D. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - b. ABB-General Electric; GE Consumer & Industrial - Electrical Distribution.
  - c. Rockwell Automation, Inc.; Allen-Bradley brand.
  - d. Siemens Energy & Automation, Inc.
  - e. Square D; a brand of Schneider Electric.
2. Fusible Disconnecting Means:
  - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.
  - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
  - c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
3. MCP Disconnecting Means:
  - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
  - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
  - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
  - d. N.O. alarm contact that operates only when MCP has tripped.

## 2.2 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
  1. Dry and Clean Indoor Locations: Type 1.
  2. Outdoor Locations: Type 3R.
  3. Kitchen Areas: Type 4X, stainless steel.
  4. Other Wet or Damp Indoor Locations: Type 4.

## 2.3 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
  1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
    - a. Push Buttons: Covered types; momentary as indicated.
    - b. Pilot Lights: LED types; colors as indicated; push to test.

- c. Selector Switches: Rotary type.
- B. Reversible N.C./N.O. auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- E. Cover gaskets for Type 1 enclosures.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in each fusible-switch enclosed controller.
- D. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26.
- E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Comply with NECA 1.

#### **3.3 IDENTIFICATION**

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26.
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.



3.4 CONTROL WIRING INSTALLATION

- A. Bundle, train, and support wiring in enclosures.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
  - 3. Test continuity of each circuit.
  - 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
  - 5. Test each motor for proper phase rotation.
  - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA

Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION

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## SECTION 262923 - VARIABLE-FREQUENCY CONTROLLERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors.

#### 1.3 DEFINITIONS

- A. BMS: Building management system.
- B. IGBT: Integrated gate bipolar transistor.
- C. LAN: Local area network.
- D. PID: Control action, proportional plus integral plus derivative.
- E. PWM: Pulse-width modulated.
- F. VFC: Variable frequency controller.

#### 1.4 SUBMITTALS

- A. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
  - 1. The VFC manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the VFC manufacturer to ensure compliance with IEEE standard 519. All VFCs shall include a minimum of 5% impedance reactors, no exceptions.
    - a. The calculations shall be performed using the harmonics analysis software SKM Power Tools for Windows Hi-Wave module or similar type analysis software. The intent is to include the entire electrical distribution system impedance in the harmonics analysis.
    - b. The Point of Common Coupling shall be the main switchboard or switchgear for the building.
- B. Product Data: For each type of VFC. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- C. Shop Drawings: For each VFC.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details.
    - b. Nameplate legends.
    - c. Short-circuit current rating of integrated unit.
    - d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
    - e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
  2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.
- D. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- E. Qualification Data
1. VFCs and options shall be UL listed as a complete assembly. VFCs that require the customer to supply external fuses for the VFC to be UL listed are not acceptable. The base VFC shall be UL listed for 100 KAIC without the need for input fuses.
  2. The VFC manufacturer shall have available a comprehensive, HVAC Drive Computer Based Training (CBT) product. The CBT product shall include detailed, interactive sections covering VFC unpacking, proper mechanical and electrical installation, and programming. The CBT product shall allow the user to provide just-in-time training to new personnel or refresher training for maintenance and repair personnel on the user's site. The CBT product shall be repeatable, precise and shall include record keeping capability. The CBT product shall record answers to simulations and tests by student ID. The CBT product must be professionally produced and have interactive sections, student tests, and include video clips of proper wiring and installation.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
1. Routine maintenance requirements for VFCs and all installed components.
- 1.5 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.
- E. Referenced Standards:
  - 1. Institute of Electrical and Electronic Engineers (IEEE)
    - a. Standard 519-1992, IEEE Guide for Harmonic Content and Control.
  - 2. Underwriters laboratories
    - a. UL508C
  - 3. National Electrical Manufacturer's Association (NEMA)
    - a. ICS 7.0, AC Adjustable Speed Drives
  - 4. IEC 16800 Parts 1 and 2

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subject to weather, cover VFCs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

#### 1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without de-rating, under the following conditions, unless otherwise indicated:
  - 1. Ambient Temperature: 0 to 40 deg C.
  - 2. Humidity: Less than 90 percent (non-condensing).
  - 3. Altitude: Not exceeding 3300 feet.

#### 1.8 COORDINATION

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07.
- D. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

- E. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

#### 1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Spare Fuses: Furnish one spare for every five installed, but no less than one set of three of each type and rating.
  - 2. Indicating Lights: Two of each type installed.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB, Inc.
  - 2. Yaskawa
  - 3. Danfoss Inc.; Danfoss Electronic Drives Div.
  - 4. Eaton Corporation; Cutler-Hammer Products.
  - 5. ABB-General Electric; GE Industrial Systems.
  - 6. Square D.
  - 7. Toshiba International Corporation.
  - 8. Or approved equal.

#### 2.2 VARIABLE FREQUENCY CONTROLLERS

- A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
  - 1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.
  - 2. VFCs shall be 6 pulse design with 5 percent input impedance. All components shall be integrally mounted and wired in a single enclosure.
- B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. The VFC package as specified herein shall be enclosed in a UL Listed Type 12 enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. The VFC tolerated voltage window shall allow the VFC to operate from a line of +30 percent nominal, and -35 percent nominal voltage as a minimum.
- D. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

- E. Unit Operating Requirements:
  - 1. Input ac voltage tolerance of 208 V, plus or minus 5, 380 to 500 V, plus or minus 10.
  - 2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
  - 3. Minimum Efficiency: 96 percent at 60 Hz, full load.
  - 4. Minimum Displacement Primary-Side Power Factor: 96 percent.
  - 5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
  - 6. Starting Torque: 100 percent of rated torque or as indicated.
  - 7. Speed Regulation: Plus or minus 1 percent.
- F. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
  - 1. Electrical Signal: 4 to 20 mA at 24 V.
- G. Internal Adjustability Capabilities:
  - 1. Minimum Speed: 5 to 25 percent of maximum rpm.
  - 2. Maximum Speed: 80 to 100 percent of maximum rpm.
  - 3. Acceleration: 2 to a minimum of 22 seconds.
  - 4. Deceleration: 2 to a minimum of 22 seconds.
  - 5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- H. Self-Protection and Reliability Features:
  - 1. Input transient protection.
    - a. The VFC shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOVs (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
  - 2. Under- and overvoltage trips; inverter over temperature, overload, and overcurrent trips.
  - 3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 10 performance.
  - 4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
  - 5. Three (3) programmable critical frequency lockout ranges to prevent the VFC from operating the load continuously at an unstable speed.
  - 6. Instantaneous line-to-line and line-to-ground overcurrent trips.
  - 7. Loss-of-phase protection.
  - 8. Reverse-phase protection.
  - 9. Short-circuit protection.
  - 10. Motor over temperature fault.
- I. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

- J. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autopsied search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- K. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- L. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- N. Input Line Conditioning
  - 1. The VFC shall have an integral 5 percent impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5 percent impedance may be from dual (positive and negative DC bus) reactors, or 5 percent AC line reactors. VFCs with only one DC reactor shall add AC line reactors.
- O. VFC Output Filtering: The VFC shall be constructed to limit output voltage spikes. Include an output DV/DT filter to limit voltage spikes at the motor. The filter shall be housed integral to the VFC or in an enclosure adjacent to the VFC.
- P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
  - 1. Power on.
  - 2. Run.
  - 3. Overvoltage.
  - 4. Line fault.
  - 5. Overcurrent.
  - 6. External fault.
- Q. Panel-Mounted Operator Station (Keypad): Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
  - 1. Output frequency (Hz).
  - 2. Motor speed (rpm).
  - 3. Motor status (running, stop, fault).
  - 4. Motor current (amperes).
  - 5. Motor torque (percent).
  - 6. Fault or alarming status (code).
  - 7. PID feedback signal (percent).
  - 8. DC-link voltage (VDC).



9. Set-point frequency (Hz).
  10. Motor output voltage (V).
- S. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
  2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
    - a. 0 to 10-V dc.
    - b. 0-20 or 4-20 mA.
    - c. Potentiometer using up/down digital inputs.
    - d. Fixed frequencies using digital inputs.
    - e. RS485.
    - f. Keypad display for local hand operation.
  3. Output Signal Interface:
    - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
      - 1) Output frequency (Hz).
      - 2) Output current (load).
      - 3) DC-link voltage (VDC).
      - 4) Motor torque (percent).
      - 5) Motor speed (rpm).
      - 6) Set-point frequency (Hz).
  4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    - a. Motor running.
    - b. Set-point speed reached.
    - c. Fault and warning indication (over temperature or overcurrent).
    - d. PID high- or low-speed limits reached.
- T. Communications
1. The VFC shall have an RS-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, BACnet, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base VFC. The use of third party gateways and multiplexers is not acceptable. All protocols shall be “certified” by the governing authority. Use of non-certified protocols is not allowed.
  2. The BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of

an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:

- a. Data Sharing – Read Property – B.
  - b. Data Sharing – Write Property – B.
  - c. Device Management – Dynamic Device Binding (Who-Is; I-AM).
  - d. Device Management – Dynamic Object Binding (Who-Has; I-Have).
  - e. Device Management – Communication Control – B.
  - f. If additional hardware is required to obtain the BACnet interface, the VFC manufacturer shall supply one BACnet gateway per drive. Multiple VFCs sharing one gateway shall not be acceptable.
3. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), percent torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFC relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFC fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad “Hand” or “Auto” selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The DDC system shall also be able to monitor if the motor is running in the VFC mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.
  4. The VFC shall allow the DDC to control the drive’s digital and analog outputs via the serial interface. This control shall be independent of any VFC function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive’s digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive’s digital and analog inputs shall be capable of being monitored by the DDC system.
  5. The VFC shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the VFC control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFC shall keep the last good set-point command and last good DO and AO commands in memory in the event the serial communications connection is lost.

## 2.3 ENCLOSURES

- A. The VFC package as specified herein shall be enclosed in a UL listed Type 12 enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. The VFC tolerated voltage window shall allow the VFC to operate from a line of +30 percent nominal voltage as a minimum.

## 2.4 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Control Relays: Auxiliary and adjustable time-delay relays.
- C. Standard Displays:
  - 1. Output frequency (Hz).
  - 2. Set-point frequency (Hz).
  - 3. Motor current (amperes).
  - 4. DC-link voltage (VDC).
  - 5. Motor torque (percent).
  - 6. Motor speed (rpm).
  - 7. Motor output voltage (V).
- D. Historical Logging Information and Displays:
  - 1. Real-time clock with current time and date.
  - 2. Running log of total power versus time.
  - 3. Total run time.
  - 4. Fault log, maintaining last four faults with time and date stamp for each.

## 2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFCs before shipping.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

- A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.
- B. Select horsepower rating of controllers to suit motor controlled.

### 3.3 INSTALLATION

- A. Anchor each VFC assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

- B. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26.

### 3.4 IDENTIFICATION

- A. Identify VFCs, components, and control wiring according to Division 26.
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

### 3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices according to Division 26.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
  - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
  - 2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.6 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 26.

### 3.7 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
  - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.
  - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  - 2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
  - 3. Report results in writing.
- C. Warranty
  - 1. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. There shall be 365/24 support available via a toll free phone number.
- D. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.8 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers. Refer to Division 01.

END OF SECTION

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## SECTION 263213 - ENGINE GENERATORS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
  - 1. Engine generator set
  - 2. Engine
  - 3. Control and monitoring
  - 4. Generator overcurrent and fault protection
  - 5. Generator exciter and voltage regulator
  - 6. Outdoor generator set enclosure
  - 7. Motors
  - 8. Vibration isolation devices
  - 9. Finishes
- B. Requirements for certification of completion (affidavit)
  - 1. Notify the Design Professional in writing that the life safety systems are complete at least five (5) working days prior to requesting final certification of completion ("affidavits") from the Architect/Engineer. The notification shall be in the form of a single formal document endorsed by an individual charged with management responsibility for all trades associated with the life safety systems.
  - 2. In order for an affidavit to be signed the generator and the emergency system shall be tested per NFPA 110
  - 3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified herein. The NFPA test generally consists of a cold start, a 2 hour load test, a 5 minute cool down, a 100 percent load test and then another 2 hour load test for a total test time of 4 hours and 5 minutes.
  - 4. All completed testing forms shall be submitted to the Design Professional a minimum of two (2) days prior to requiring affidavits.

### 1.3 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

### 1.4 SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
  - 1. Thermal damage curve for generator.
  - 2. Time-current characteristic curves for generator protective device.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
  - 2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  - 3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
  - 4. Wiring Diagrams: Power, signal, and control wiring.
  - 5. Over-current protection, relays, and control devices shall be identified and their ratings marked.
  - 6. Noise Emissions: Provide a submittal with suitably supported and documented noise emission calculations or measurement data to demonstrate compliance with noise levels outlined in the specification. The submittal shall ensure all aspects of noise emission from the unit have been included.
  - 7. Copy of blank NFPA 110 Acceptance Test form for review.
- C. Qualification Data: For installer and manufacturer.
- D. Source quality-control test reports.
  - 1. Certified summary of prototype-unit test report.
  - 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
  - 3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
  - 4. Report of sound generation.
  - 5. Report of exhaust emissions showing compliance with applicable regulations.
  - 6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
  - 1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- G. Warranty: Special warranty specified in this Section.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
  - 1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
  - 2. Engineering Responsibility: Preparation of data for vibration isolators, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with ASME B15.1.
- F. Comply with NFPA 37.
- G. Comply with NFPA 70.
- H. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- I. Comply with UL 2200.
- J. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- K. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

#### 1.6 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Owner no fewer than 14 days in advance of proposed interruption of electrical service.



2. Do not proceed with interruption of electrical service without Owner's written permission.

B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 40 deg C.
2. Altitude: Sea level to 1000 feet.

#### 1.7 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

#### 1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 2 years from date of Substantial Completion.

#### 1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

#### 1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Caterpillar; Engine Div.
2. Kohler Co.; Generator Division.

3. Onan/Cummins Power Generation; Industrial Business Group.
4. Or approved equal.

## 2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
- C. Capacities and Characteristics:
  1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
  2. Output Connections: Three-phase, four wire.
  3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- D. Generator-Set Performance:
  1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
  2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
  3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
  4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
  5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
  6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
  7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
  8. Start Time: Comply with NFPA 110, Type 10, system requirements.

## 2.3 ENGINE

- A. Fuel: Natural gas.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

- D. Lubrication System: The following items are mounted on engine or skid:
  - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  - 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
  - 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
  - 1. Natural Gas System:
    - a. Carburetor.
    - b. Secondary Gas Regulators.
    - c. Fuel-Shutoff Solenoid Valves.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- G. Governor: Mechanical.
- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
  - 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
  - 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  - 3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  - 4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
    - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
    - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
  - 1. Minimum sound attenuation of 25 dB at 500 Hz.
  - 2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.
- J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Starting System: 12-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
7. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
  - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
  - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg. C to plus 60 deg. C to prevent overcharging at high temperatures and undercharging at low temperatures.
  - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
  - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
  - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
  - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

## 2.4 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

- C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
  - 1. AC voltmeter.
  - 2. AC ammeter.
  - 3. AC frequency meter.
  - 4. DC voltmeter (alternator battery charging).
  - 5. Engine-coolant temperature gauge.
  - 6. Engine lubricating-oil pressure gauge.
  - 7. Running-time meter.
  - 8. Ammeter-voltmeter, phase-selector switch(es).
  - 9. Generator-voltage adjusting rheostat.
  - 10. Generator overload.
- D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26.
- F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
  - 1. Overcrank shutdown.
  - 2. Coolant low-temperature alarm.
  - 3. Control switch not in auto position.
  - 4. Battery-charger malfunction alarm.
  - 5. Battery low-voltage alarm.
- G. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

## 2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
  - 1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
  - 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
  - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
  - 4. Mounting: Adjacent to or integrated with control and monitoring panel.

- B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

## 2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Dripproof.
- G. Instrument Transformers: Mounted within generator enclosure.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
  - 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- J. Subtransient Reactance: 12 percent, maximum.

## 2.7 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
- B. Qualifications
  - 1. The design is based on factory sound attenuated Level 2 enclosure.
- C. Enclosure color shall be as selected by the Architect from the manufacturers standard available colors. A minimum of six colors shall be available for enclosure exterior
- D. Sound Attenuation
  - 1. The enclosure shall be designed for a 25 dBA reduction at 1 meter from the enclosure.
- E. Description: Prefabricated or pre-engineered walk-in enclosure with the following features:
  - 1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building.
  - 2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
  - 3. Space Heater: Thermostatically controlled and sized to prevent condensation.
  - 4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
  - 5. Hinged Doors: With padlocking provisions.

6. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
  7. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
  8. Muffler Location: Within enclosure.
- F. Integral Power Distribution: The enclosure shall contain a 60A, 3 phase, 208Y/120V load center with main breaker to feed all ancillary items within the enclosure. Ancillary items shall include, but not be limited to, jacket water heater, battery heater, lights, and receptacles. The enclosure shall include AC and DC lighting, duplex receptacles, unit heaters, etc. The DC lights shall have timer type switch. All devices in the enclosure, including specified generator set accessories, shall be pre-wired in EMT by enclosure manufacturer. In addition, the manufacturer shall perform the system integration of all components in the enclosure, mechanical and electrical.
- G. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
  2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
- H. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
1. AC lighting system and connection point for operation when remote source is available.
  2. DC lighting system for operation when remote source and generator are both unavailable.
- I. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.
- J. Where the generator entrance point is more than 12" above finished grade (or roof level) provide an access platform with stairs on both sides of the unit to access the generator enclosure. Materials shall be hot dipped galvanized. Stair and platform shall include the associated structural elements to support the stairs and platform. Coordinate support of stairs and platform with other Divisions. Provide shop drawing detailing materials and support points that are coordinated with the field conditions.

## 2.8 MOTORS

- A. General requirements for motors are specified in Division 23.
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

## 2.9 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of

sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Standard neoprene.

## 2.10 FINISHES

- A. Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

## 2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Report factory test results within 10 days of completion of test.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.



- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26.
- D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23.
  - 1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23.
- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect engine exhaust pipe to engine with flexible connector.
- D. Connect fuel piping to engines with a gate valve and union and flexible connector.
- E. Tank accessories, piping, valves, and specialties for fuel systems are specified in Division 23.
  - 1. Natural-gas piping, valves, and specialties for gas distribution are specified in Division 23.
- F. Ground equipment according to Division 26.
- G. Connect wiring according to Division 26.

### 3.4 WIRING

- A. Control Wiring
  - 1. Control wiring shall be provided as follows:
    - a. Between starters, and fuel solenoid.
    - b. Between each ATS and generator start panel. Wiring shall be run in 1"C and shall not be wired in parallel to each switch but separately from each ATS to generator start panel.
    - c. To remote mounted annunciator to be located adjacent to fire alarm control panel. Provide wiring from all specified alarm and indicating points.
    - d. Other control wiring as required by manufacturers shop drawings.

- e. Where required to be annunciated on building automation system (BAS), provide wiring to junction box with terminal strip and numbered connections for all generator functions. Locate junction box in generator room for BAS contractor to connect to.

**B. Power Wiring**

- 1. Power wiring shall be provided as shown on contract drawing one lines and branch circuit power to generator as follows from local emergency/normal panel.
  - a. Electric service to weatherproof enclosure sized to manufacturers recommendations.
  - b. Fuel oil pumps and louver control system.
  - c. Heaters as specified and shown on manufacturer's shop drawings.
  - d. To generator control panel.
  - e. To and from battery charger and batteries.
  - f. Other power wiring as required by manufacturers shop drawings.

- C. Generator shall be grounded in accordance with NEC. Provide ground strap from building ground to generator frame.

**3.5 IDENTIFICATION**

- A. Identify system components according to Division 23 and Division 26.

**3.6 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.

- 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

- B. Tests and Inspections:

- 1. The system shall have two tests. The first test shall be a Pre-test to verify system operation prior to the acceptance test. The second test shall be the NFPA 110 acceptance test. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- 2. Generator Pre Testing
  - a. Pre-testing is required to prepare for the Installation Acceptance Test. Prior to scheduling the Installation Acceptance Test, a Pre-Acceptance Test of the system is performed by the contractor to verify that the system is operating properly and is ready for the Installation Acceptance Test.
  - b. Pre-Acceptance Test Procedure:

- 1) The Pre-Acceptance Test is typically performed two weeks prior to scheduling the Installation Acceptance Test.
  - 2) Verify that the generator starts and runs when normal power is shut off.
  - 3) Operate the Generator long enough to assure it is operating properly, to verify it starts and transfers load to emergency loads in less than 10 seconds, and that all connected equipment is operating properly.
  - 4) Verify that dampers open and ancillaries operate properly.
  - 5) Verify that fuel delivery system is operational and functioning as designed.
  - 6) Check and adjust equipment.
  - 7) Set and verify time delays on transfer switches.
  - 8) Correct deficiencies and verify that the system is ready for the Installation Acceptance Test.
  - 9) The Owner's representative should witness this test.
3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
  4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
    - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    - c. Verify acceptance of charge for each element of the battery after discharge.
    - d. Verify that measurements are within manufacturer's specifications.
  5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
  6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
  7. Exhaust Emissions Test: Comply with applicable government test criteria.
  8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
  9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
  10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches and run them concurrently.

- D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Remove and replace malfunctioning units and retest as specified above.
- I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- K. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
  - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
  - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01.

END OF SECTION

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Project Location: \_\_\_\_\_

Project Description: \_\_\_\_\_

Date of Test: \_\_\_\_\_ Witnessed By: \_\_\_\_\_

**System Classification:** Emergency Standby Optional Standby  
(NEC) (NEC 700) (NEC 701) (NEC 702)

**Level:** Level 1 Level 2 Other  
(2002 NFPA 110 Paragraph 4.4)(Emergency)(Typically Standby) (Optional Standby)

**Classification:** Class 2 Class 6 Class 48 Class X  
(2002 NFPA 110 Table 4.1.a) (2 Hours) (6 Hours) (48 Hours) (Other  
Time, in hours)  
(Length of Time)

**Type:** Type 10 Type 60 Type 120 Type M  
(2002 NFPA 110 Table 4.1.b) (10 seconds) (60 seconds) (120 seconds)  
(Non-automatic) (Lights off till Lights on)

-----  
**Test Procedure:** Follow the sequence below. The sequence follows the NFPA 110 Acceptance Testing procedure outlined in Paragraph 7.13, Installation Acceptance, in the 2002 Edition of NFPA 110. The **Operational Test** is conducted **prior** to the **Full Load Test** (Load Bank Test) in accordance with NFPA 110.

***OPERATIONAL TEST: This phase of the test verifies operation of the generator start circuit, transfer switches, and verifies that all loads connected to the generator are energized. The load bank is not used for this part of the test.***

**Cold Start Condition:** The generator should not be run prior to the test on the day of the test.

**Normal Building Loads On:** Prior to starting the test, verify that normally operating building loads are connected and operating.

**At Time t = 0,** Open All Service Switches to the building.

Record the following:

**TIME DELAY ON START:**

**Seconds**

(From time t = 0, measure the time till the generator starts to crank. NFPA 110 7.13.4.1.3)

**CRANKING TIME FOR START/RUN:**

**Seconds**

(Time between engine starting to running per NFPA 110 7.13.4.1.4)

TIME TO REACH OPERATING SPEED: \_\_\_\_\_ Seconds

(From time t = 0, per NFPA 110 7.13.4.1.5)

**VOLTAGE OVERSHOOT:**

**Volts**

(Per NFPA 110, 7.13.4.1.6)

**FREQUENCY OVERSHOOT:** \_\_\_\_\_ **HZ**

(Per NFPA 110, 7.13.4.1.6)

**ATS TRANSFER TIMES**

(From Time t = 0, record the time for each ATS to transfer load to the generator. In general, it's the time from lights off until lights on. NFPA 110 7.13.4.1.7)

ATS 1: **Seconds**

ATS 2: \_\_\_\_\_ **Seconds**

ATS 3: **Seconds**

ATS 4: **Seconds**

**AT STEADY STATE**

(Record per NFPA 110 7.13.4.1.8, 9)

**Volts:** \_\_\_\_\_ VAB \_\_\_\_\_ VBC \_\_\_\_\_ VCA

\_\_\_\_\_ VAN \_\_\_\_\_ VBN \_\_\_\_\_ VCN

**Amperes:** \_\_\_\_\_ Ø A \_\_\_\_\_ Ø B \_\_\_\_\_ Ø C

**Oil Pressure:** **PSI**

Water Temperature: \_\_\_\_\_ ° F

**The Test Continues for 2 Hours:** During the two hours, the Owner's Representative will verify that all loads connected to the generator are energized. Exit lights and egress lighting will be checked for proper operation. The fire pump and elevators will be operated if connected to the generator. (NFPA 110 7.13.4.11)

[illegible]

At Time  $t = 2$  hours, **Restore Normal Power**

## ATS TRANSFER TIMES

ATS 1:                      seconds

ATS 2: seconds

ATS 3: seconds

ATS 4: **seconds**

**TIME DELAY FOR COOLDOWN:** \_\_\_\_\_ Minutes

(From time last transfer switch transfers back to normal power till generator shuts down. NFPA 110, 7.13.4.1(13). Delay should be 5 minutes minimum per NFPA 110 6.2.10 for units greater than or equal to 15KW.

### Cool Generator for 5 Minutes (NFPA 110 7.13.5)

**FULL LOAD TEST (Load Bank Test):** This phase of the test is an endurance test of the generator. Disconnect building load from generator and connect a load bank that is equal to 100% of the nameplate KW rating of the generator.

Connect Load Bank to the generator. Load Bank shall be equal to 100% of the generator rating (NFPA 110 7.13.6)

Initiate Full Load Test immediately after the 5 minute cool down that followed the Operational Test (NFPA 110 7.13.7). Apply 100% load as soon as the generator is running and stable.

Record the following:  
(NFPA 7.13.8)

**CRANKING TIME FOR START/RUN:** \_\_\_\_\_ **Seconds**  
(Time between engine starting to running)

**TIME TO REACH OPERATING SPEED:** \_\_\_\_\_ Seconds

**VOLTAGE OVERSHOOT:** \_\_\_\_\_ **Volts**

**FREQUENCY OVERSHOOT:** \_\_\_\_\_ **HZ**

Time minutes	Oil Pressure PSI	Water Temp ° F	Battery Charge Rate	Kilowatts	Amperes			Volts Line - Line			HZ
					Ø A	Ø B	Ø C	Vab	Vbc	Vca	
0											
15											
30											
45											
60											
75											
90											
105											
120											

Shutdown Generator. The test is complete.



## SECTION 263600 - TRANSFER SWITCHES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This section includes:
  - 1. Transfer switch product requirements
  - 2. General – automatic transfer switches
  - 3. Remote annunciator and control system
- B. Switch shall be rated for continuous duty and shall be inherently double throw. Switch shall be mechanically interlocked to ensure only one of two possible positions (except where delayed transition is required): normal or emergency. Automatic transfer switch shall be suitable for use with engine- or turbine-driven emergency generator or other utility source.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
  - 1. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch.
- C. Letter from the building automation system contractor identifying the integration protocol of either Modbus or BacNet.
- D. Qualification Data: For manufacturer.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
  - 1. Features and operating sequences, both automatic and manual.
  - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. The manufacturer of this equipment shall maintain a full-time "in-house" parts and service organization within 75 miles of the job site. The manufacturer of the equipment shall have a minimum of five (5) years of experience. Equipment offered by those who do not have an "in-house" parts and service organization and who depend on others to provide services, will not be considered. This supplier shall have his name, address, and telephone number clearly and visibly located on all equipment. Service shall be available on a 24-hour, 7-day week basis.
- C. The supplier of the equipment shall provide, at no additional charge, any information or supervision required for the proper installation of the equipment and training of operating personnel.
- D. Source Limitations: Obtain automatic transfer switches and remote annunciator and control panels through one source from a single manufacturer.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with NEMA ICS 1.
- G. Comply with NFPA 70.
- H. Comply with NFPA 110.
- I. Comply with UL 1008 unless requirements of these Specifications are stricter.

#### 1.5 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
  - 1. Notify Owner no fewer than 14 days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Owner's written permission.

#### 1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: The design is based on Russelectric Inc to establish standards of quality for materials and performance. The naming of a specific manufacturer or catalog

number does not waive any requirements or performance of individual components described in the specification. The two switch types are the following:

1. Contactor Transfer Switches UL 3 Cycle Withstand and Closing Ratings:
  - a. Emerson; ASCO Power Technologies, LP., ASCO 7000 series.
  - b. Eaton Electrical Inc; Cutler-Hammer.
  - c. Russelectric, Inc., RTS Series
  - d. Or approved equal.

## 2.2 TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
  1. As a condition of approval, the manufacturer of the automatic transfer switches shall verify that their switches are listed by Underwriters Laboratories, Inc., Standard UL-1008 with 3 cycle short circuit closing and withstand as indicated in the transfer switch schedule on drawings:
  2. During the 3 cycle closing and withstand tests, there shall be no contact welding or damage. The 3 cycle tests shall be performed without the use of current limiting fuses. The test shall verify that contact separation has not occurred, and there is contact continuity across all phases. Test procedures shall be in accordance with UL-1008, and testing shall be certified by Underwriters' Laboratories, Inc.
- C. The automatic transfer switch shall be provided with a microprocessor controller. The controller shall provide for all operational functions of the ATS and shall be programmed at the factory with standard and specified options. The controller shall be provided with TCP/IP via 10/100 base-T ethernet. An external USB communication port on the controller's faceplate shall be provided for connection to a laptop.
- D. In addition to the standard control functions of the microprocessor, the controller shall be provided with a power monitor to monitor amperes, KW, PF, and provide wave form capture. The power information shall be available at the controller and through the ethernet port for remote connection to the BMS or other device.
- E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- F. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
  1. Switch Action: Double throw; mechanically held in both directions.
  2. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

- H. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26.
  - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
  - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
  - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- K. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

## 2.3 GENERAL - AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation.
- D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- F. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.
- G. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
- H. Programmed Neutral Switch Position: All switches that are designated for optional standby branch shall be provided with a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live. These switches shall also be capable of being shed to a center off position when signaled by a remote device.
- I. A WEB server shall be provided at the ATS for remote connection to a PC.
- J. Automatic Transfer-Switch Features (Microprocessor Based):

1. Under voltage sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained under voltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
  - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
  - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
10. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
11. All elevator transfer switches shall be provided with a time delay for pre-transfer signal to operate a set of contacts in advance of transfer or retransfer. These contacts shall signal the elevator controller that a transfer is about to occur. The timing function shall be field adjustable from 0 seconds to 60 minutes.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
  - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
  - b. Push-button programming control with digital display of settings.

- c. Integral battery operation of time switch when normal control power is not available.

## **2.4 REMOTE ANNUNCIATOR AND CONTROL SYSTEM**

- A. Functional Description: Include the following functions for indicated transfer switches:
  - 1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
  - 2. Indication of switch position.
  - 3. Indication of switch in test mode.
  - 4. Indication of failure of digital communication link.
  - 5. Key-switch or user-code access to control functions of panel.
  - 6. Control of switch-test initiation.
  - 7. Control of switch operation in either direction.
  - 8. Control of time-delay bypass for transfer to normal source.
- B. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
- C. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
  - 1. Controls and indicating lights grouped together for each transfer switch.
  - 2. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
  - 3. Digital Communication Capability: Matched to that of transfer switches supervised.
  - 4. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

## **2.5 ENGINE START CIRCUIT MONITORING SYSTEM**

- A. Engine start circuit monitoring system: continually monitor engine start circuit wiring between each ATS and the generator.
  - 1. Include modules at each automatic transfer switch, including existing automatic transfer switches, and at the generator.
  - 2. Generator shall automatically start upon loss of integrity of the generator start circuit.
  - 3. Indicate on remote status panel if the generator started due to loss of start circuit integrity.

## **2.6 SOURCE QUALITY CONTROL**

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26.
- B. Floor-Mounting Switch: Anchor to floor by bolting.
  - 1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26.
- C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- D. Identify components according to Division 26.
- E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

### **3.2 CONNECTIONS**

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Ground equipment according to Division 26.
- C. Connect wiring according to Division 26.

### **3.3 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
  - 2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    - a. Check for electrical continuity of circuits and for short circuits.
    - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    - c. Verify that manual transfer warnings are properly placed.
    - d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
  - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
  - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
  - c. Verify time-delay settings.
  - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
  - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
  - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- B. Coordinate tests with tests of generator and run them concurrently.
- C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
  1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
  2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01.
- B. Coordinate this training with that for generator equipment.

END OF SECTION

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## **SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes lightning protection for structures.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminals and mounting accessories.
  - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
  - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
- C. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
- D. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
- E. Field quality-control reports.
- F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
- G. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
  - 1. Ground rods.
  - 2. Ground loop conductor.

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: Certified by UL, trained and approved for installation of units required for this Project.
- B. System Certificate:

1. UL Master Label.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

## 1.5 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
- C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

## PART 2 - PRODUCTS

### 2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96 and NFPA 780.
- B. Roof-Mounted Air Terminals: NFPA 780, Class I unless otherwise indicated.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. VFC Lightning Protection
    - b. East Coast Lightning Equipment Inc.
    - c. ERICO International Corporation.
    - d. Heary Bros. Lightning Protection Co. Inc.
    - e. Independent Protection Co.
    - f. Preferred Lightning Protection.
    - g. Robbins Lightning, Inc.
    - h. Thompson Lightning Protection, Inc.
    - i. Or approved equal.
  2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.
- C. Main and Bonding Conductors: Copper.
- D. Ground Loop Conductor: The same size and type as the main conductor except tinned.
- E. Ground Rods: Copper-clad 3/4 inch in diameter by 10 feet long.
- F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Stainless steel

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Conceal the following conductors:
  - 1. System conductors.
  - 2. Down conductors.
  - 3. Interior conductors.
  - 4. Conductors within normal view of exterior locations at grade within 200 feet of building.
- D. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
  - 1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
- E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
- F. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- G. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

### 3.2 FIELD QUALITY CONTROL

- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- B. UL Inspection: Meet requirements to obtain a UL Master Label for system.
- C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION

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STRUCTURES.DOC

PROTECTION FOR

## SECTION 265100 - INTERIOR LIGHTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Interior lighting fixtures, lamps, and ballasts.
  - 2. Emergency lighting units.
  - 3. Exit signs.
  - 4. Lighting fixture supports.

#### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. LER: Luminaire efficacy rating.
- D. Lumen: Measured output of lamp and luminaire, or both.
- E. Luminaire: Complete lighting fixture, including ballast housing if provided.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of lighting fixture including dimensions.
  - 2. Emergency lighting units including battery and charger.
  - 3. Energy-efficiency data.
  - 4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
  - 5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
    - a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

- B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Installation instructions.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Lighting fixtures.
  - 2. Suspended ceiling components.
  - 3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches of the plane of the luminaires.
  - 4. Ceiling-mounted projectors.
  - 5. Structural members to which suspension systems for lighting fixtures will be attached.
  - 6. Other items in finished ceiling including the following:
    - a. Air outlets and inlets.
    - b. Speakers.
    - c. Sprinklers.
    - d. Smoke and fire detectors.
    - e. Occupancy sensors.
    - f. Access panels.
  - 7. Perimeter moldings.
- B. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
  - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Plastic Diffusers and Lenses: 2 percent One for every 100 of each type and rating installed. Furnish at least one of each type.
2. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

#### 1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

#### 1.9 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

#### 1.10 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
- B. Philips Bodine products are fully warranted for one, two, three or five year refer to product cutsheet. This warranty covers only properly installed Philips Bodine products used under normal conditions. For the warranty period, Philips Emergency Lighting will, at its option, repair or replace without charge a defective unit, provided it is returned to the factory transportation pre-paid and our inspection determines it to be defective under terms of warranty. Repair or replacement, as stated above, shall constitute the purchaser's exclusive warranty, which does not extend to transportation, installation, labor or any other charges; nor does it apply to any equipment of another manufacturer used in conjunction with the Philips Bodine product.
  1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product indicated on Drawings or approved equal.

#### 2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

- B. Metal Parts: All sheet metal work shall be free of burrs, sharp corners and edges, tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true of adequate strength and structural rigidity to prevent any distortion after assembly.
- C. Sheet Metal Components: a minimum of #20 gauge (0.0359 inch) thick cold rolled sheet Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- E. All fixtures shall be completely wired at the factory.
- F. Mounting Frames and Rings: If ceiling system requires, each recessed and semi-recessed fixture shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed. The frames and rings shall be one piece or constructed with electrically-welded butt joints, and of sufficient size and strength to sustain the weight of the fixture.
- G. Light leaks:
  - 1. Between ceiling trims of recessed lighting equipment and the ceilings will not be accepted.
  - 2. Between lighting components within the fixtures (louvers, trims, etc) will not be accepted
  - 3. Yokes, brackets and supplementary supporting members needed to mount lighting fixtures to carrier channels or other suitable ceiling members shall be furnished and installed by the Contractor.
  - 4. Adjustable Angle Fixtures: Each lighting fixture which has a beam angle adjustment shall have reliable angle locking devices.
- H. Diffusers and Globes:
  - 1. Acrylic Lighting Diffusers: Plastic for lenses and diffusers shall be formed of colorless 100 percent virgin acrylic as manufactured by Rohm & Haas, Dupont or as acceptable. The quality of the raw material must exceed IES, SPI, and NEMA Specifications by at least 100 percent which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.
    - a. Lens Thickness: At least 1/8 inch minimum unless otherwise indicated.
    - b. UV stabilized.
  - 2. Glass: Annealed crystal glass unless otherwise indicated.

## 2.3 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
  - 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

## 2.4 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, lead-acid type.
  2. Charger: Fully automatic, solid-state type with sealed transfer relay.
  3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
  4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

## 2.5 LED LIGHTING

- A. The LED system shall be capable of at least 8-bit control of red, green and blue LEDs to produce 16.7 million colors or more and shall be digitally driven using high-speed pulse width modulation (PWM). The LED fixture shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.
- B. The LED system shall use 14-bit or greater nonlinear scaling techniques for high-resolution output. Manufacturer of LED systems shall utilize an advanced production LED binning process to maintain color consistency.
- C. The LED fixture shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.
- D. High power LED fixture shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware.
- E. LED fixture housing shall be designed to transfer heat from the LED board to the outside environment.
- F. LED fixture manufacturer must provide fixture wattage information and not LED data.
- G. For wet and damp use, LED-based fixture itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure.
- H. All hardwired connections to LED fixtures shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
- I. The LED system shall be scalable, with every LED fixture/address in the system capable of being controlled by a single, centralized controller.
- J. LED fixture shall be UL listed or UL classified, CE certified. And PSA marked. LED fixture and systems shall meet RoHS (Removal of Hazardous Substances) directives. Manufacturer



shall be able to provide supporting documentation of the product meeting third party regulatory compliance as well as environmental testing results.

- K. All LED fixtures (100 percent of each lot) shall undergo a minimum eight-hour burn-in test during manufacturing.
- L. Manufacturer shall provide optical performance, polar diagrams, and relevant luminance and illuminance photometric data based on test results from an independent testing lab
- M. All LED fixtures and power/data supplies shall be provided by a single manufacturer to ensure compatibility. Manufacturer shall have at least eight years of experience designing, selling and supporting intelligent LED systems.
- N. Rated Life: LED Fixtures shall be rated for 50,000 hour minimum performance on all LED diode components.
- O. Warranty: LED Manufacturers shall provide a minimum 5 year warranty on LED components. Along with the standard warranty, if extreme color shift occurs (+1,000 Kelvin) or extreme color inconsistency develops (+/- 500 Kelvin) within the warrantee period, this shall be considered a failure and the Manufacturer shall be responsible for replacing all affected fixtures free of charge.
- P. ANSI Standards: LED fixtures shall meet ANSI Standards C78.377-2008, Specifications for the Chromaticity of Solid State Lighting Products, and C82.37-2011, Harmonic Emission Limits – Related Power Quality Requirements for Lighting.
- Q. IES LM-79 and LM-80: LED Fixtures shall be LM-79-08, Electrical and Photometric Testing of Solid-State Lighting Devices, and LM-80-08, Measuring Lumen Depreciation of LED Light Sources, tested and approved.
- R. NEMA: LED Diodes and Electronic Drivers shall comply with NEMA guideline SSL-3-2010, High-Power White LED Binning for General Illumination, and SSL-1-2010, Electronic Drivers for LED Devices, Arrays, or Systems.

## 2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Lighting fixtures:
  - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
  - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
  - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
  - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
  - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- D. Suspended Lighting Fixture Support:
  - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
  - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
  - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
  - 5. Linear pendants: For continuous rows longer than 60 inches, where fixture is broken in sections to allow specified row length, all suspension points for that fixture shall be perfectly aligned to avoid visible bending and misalignment along the continuous row.
- E. Connect wiring according to Division 26.

### 3.2 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26.

### 3.3 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.
- C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.4 AIMING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 3 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
1. All adjustable lighting units shall be aimed, focused, locked, etc., by the Subcontractor under the supervision of the Lighting Consultant. The Lighting Consultant shall indicate the number of crews (foreman and apprentice) required. All aiming and adjusting shall be carried out after the entire installation is complete. All ladders, scaffolds, etc. required shall be furnished by the Contractor at the direction of the Lighting Consultant. As aiming and adjusting is completed, locking set-screws and bolts and nuts shall be tightened securely.
  2. Adjust aimable luminaires in the presence of Architect or and/or end user shall provide written instruction for aiming intent for all the adjustable fixture
  3. Adjust aimable luminaires in the presence of Architect.

END OF SECTION

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## **SECTION 265615 - SITE LIGHTING**

### **PART 1 GENERAL**

#### **1.01 SCOPE OF WORK**

- A. Exterior luminaries and accessories, underground conduit, wiring, and termination.
- B. Poles and foundations.
- C. Component installation and system testing.
- D. Removal of existing overhead wires, light fixtures, and light poles as shown on the Drawings.

#### **1.02 RELATED SECTIONS AND DOCUMENTS**

- A. Section 312000 - Earthwork
- B. Electrical Testing (See Electrical Specifications)
- C. Construction Documents

#### **1.03 REFERENCES**

- A. ANSI C78.379 - Electrical Lamps - Incandescent and High-Intensity Discharge Reflector Lamps -Classification of Beam Patterns
- B. ANSI/NFPA 70 - National Electrical Codes
- C. ANSI/IES RP-8 - Recommended Practice for Roadway Lighting
- D. ANSI/IES RP-20 - Lighting for Parking Facilities
- E. ASTM A 36 – Standard Specification for Carbon Structural Steel
- F. ASTM A 307 – Standard Specification for Carbon Steel Bolts and Studs
- G. IES Lighting Handbook - 2001 9th Edition or latest edition

#### **1.04 QUALITY ASSURANCE**

- A. Contractor to verify that all specified site lighting satisfies all applicable guidelines and regulations.
- B. Once Shop Drawings are approved all lighting is to be ordered in a timely manner. The Contractor is then to inform the Landscape Architect/Engineer immediately, in writing, the date when equipment orders are completed and delivery scheduled.

- C. The Owner reserve the right to request standard production model fixture samples for inspection and to order such tests as the Owner deems necessary to ensure compliance with these specifications and to reject those luminaries failing such tests, or those luminaries with improper or inadequate light distributions. The Owner shall be the sole judge as to acceptability.

#### **1.05 SUBMITTALS**

- A. When required by the Owner, each submittal transmitted for approval shall contain:
  - 1. Computer prepared photometric layout of the proposed lighted area, which indicates by isofootcandle readings the system performance.
  - 2. A photometric report from a national independent testing laboratory with report number, date, fixture catalog number, luminaire and lamp specifications; IES calculations, candlepower tabulations, zone lumen summary and isolux plot.
  - 3. The Underwriters Laboratory listing and file number for the specific fixture(s) to be utilized.
  - 4. Pole manufacturer AASHTO calculations indicating the pole and anchor bolts being submitted are capable of supporting the pole and fixture systems being utilized in accordance with specifications.
  - 5. Catalog cuts proving complete conformance to the specifications.

#### **1.06 SYSTEMS PERFORMANCE**

- A. All luminaries as indicated on the drawings shall be "cut-off luminaries". A "cut-off luminaire" is defined by the following limitations of light distributions:
  - 1. At any lateral angle around the luminaire, the candle power per 1000 lumens shall not exceed 25 lumens at an angle of 90 degrees above horizontal and 100 lumens at a vertical angle 80 degrees above horizontal.
- B. All site lighting shall minimize light trespass and spillover onto adjacent properties. Internal house-side shields shall be incorporated on all pole-mounted luminaries abutting adjacent properties.

#### **1.07 WARRANTY**

Provide Owner with one year warranty certificate signed by Contractor and by the company providing actual warranty labor. This certificate must be received by the Owner prior to final payment.

## **PART 2 PRODUCTS**

**AS SHOWN ON THE PLANS**

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Provide concrete base for light poles at location indicated on the construction documents and in accordance detail shown on the construction documents. The concrete strength shall be at least 5,000 psi.
- B. Install poles plumb. Provide shims or double nuts where necessary to adjust plumb. Grout around each base.
- C. Install lamps in each luminaire. Contractor shall exercise caution when handling lamps. Contractor shall avoid handling lamps without clean gloves or a protective cloth wrap.
- D. Bond luminaries, metal accessories and metal poles to branch circuit equipment grounding conductor. Provide supplementary grounding electrode at each pole.

### **3.02 FIELD QUALITY CONTROL**

- A. Operate each luminaire after installation and connection. Inspect for improper connections and operation.
- B. Measure illumination levels to verify conformance with performance requirements as specified on the construction drawings and/or local ordinances.
- C. Take measurements during the night sky, without moon or with heavy overcast clouds effectively obscuring the moon.
- D. Aim and adjust luminaire to provide illumination levels and distribution as indicated on the construction drawings or as directed.

### **3.03 CLEANING**

- A. Clean electrical parts to remove conductive and deleterious materials.
- B. Remove dirt and debris from enclosure.
- C. Clean photometric control surfaces as recommended by manufacturer.
- D. Clean finishes and touch up damage.

### **3.04 PROTECTION OF FINISHED WORK**

- A. Contractor shall protect all work while construction is in progress. Contractor is responsible for any damage incurred during construction.
- B. Relamp luminaries which have failed or been damaged during construction at substantial completion.

**3.05 TESTING**

Perform and record voltmeter measurements. In addition, provide labor, material, and energy to conduct a parking lot light test at least 30 days prior to Substantial Completion date. This test shall consist of continuous operation of fixtures and lamps for a time period of 100 hours. Contractor shall witness and certify the continuous operation and time duration of the test. At the end of the testing period, immediately request warranty parts and replace defective components at least three days prior to Substantial Completion date.

**END OF SECTION 265615**

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## SECTION 27 00 00

### GENERAL REQUIREMENTS FOR TELECOMMUNICATIONS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS:

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.
- B. This Section shall apply to all Divisions 26, 27, and 28 Sections of these specifications as hereinafter written.
- C. Instructions to Bidders, Bidding Forms, Forms of Agreement between Owner and Contractor, Contract Award Date, Starting and Completion Dates, Conditions of the Contract, Insurance Requirements, and other Owner Requirements will be furnished separately by Owner. These documents, as well as any addenda issued, shall form a part of these Specifications, and this contractor shall consult them in detail for instructions pertaining to this work.
- D. Each trade contractor shall receive all drawings and specification sections issued as part of the overall bid package. All contractors are to receive, review, and coordinate all of their work as shown or referenced on the other trade documents. All work shown or referenced on the other trade documents shall be included as part of the overall project scope for that particular discipline and trade.

##### 1.2 SCOPE OF WORK:

- A. These specifications and accompanying drawings are intended to cover the furnishing of all labor, material, and equipment and superintendence of the Telecommunications System.
- B. It is the intent and purpose of these specifications and accompanying drawings to cover and include each item, all materials, machinery, apparatus, and labor necessary to properly install, equip, adjust, and put into perfect operation the respective portions of the installations specified and to so interconnect the various items or sections of the work as to form a complete and properly operating whole.
- C. Any equipment, apparatus, machinery, material, and small items not mentioned in detail, and labor not hereinafter specifically mentioned, which may be found necessary to complete or perfect any portion of installation in a substantial manner, and in compliance with the requirements stated, implied, or intended in these specifications shall be furnished without extra cost. This shall include all materials, devices, or methods peculiar to the machinery, equipment, apparatus, or systems furnished and installed as part of the Telecommunications work.
- D. The term "Furnish" shall mean to obtain and supply to the job site. The term "Install" shall generally mean to fix in position and connect for use. Where language indicates that one party or trade is to "install", and another is to "connect", the term "install" shall mean only to fix in



position, and "connect" shall mean to make electrical connections to. The term "Provide" shall mean to furnish and install.

**1.3 LAWS, REGULATIONS AND CODES:**

- A. Perform all work in strict compliance with all laws, regulations, and/or codes applying, including all Federal, State and local codes and any other authority having jurisdiction. Wherever drawings or specifications conflict with such regulations they shall be made to conform, and approval of the Design Professional obtained on such changes as may be involved.
- B. All electrical and telecommunications work shall comply with the requirements of the National Electrical Code, latest revision.

**1.4 PERMITS, FEES, AND CERTIFICATES OF APPROVAL:**

- A. Unless stated otherwise in General Conditions or Division 1, obtain and pay for all permits, fees, and licenses required, including those of utilities and Agencies. Provide copies to Design Professional in the quantity requested. "Fees" shall include connection charges construction costs, and other such charges by utility companies or service providers. Ascertain such charges during bidding period and include bid price.
- B. As a prerequisite to final acceptance, supply to the Design Professional a Certificate of Inspection from an Electrical Inspection Agency acceptable to Owner and approved by the local municipality and the utility company serving the project. Certificate shall cover rough wiring, fixtures, and equipment.

**1.5 RECORD DRAWINGS:**

- A. During construction keep an accurate record of all deviations of the work as shown on the drawings and that which is actually installed.
- B. Secure from the Design Professional, a complete set of prints of the Telecommunications drawings and note changes thereon. Make a complete record in a neat and accurate manner, of all changes and revisions to original design which exist in completed work, in CAD file format.
- C. The cost of furnishing above CADD files and preparing these record drawings shall be borne by the contractor. When all revisions showing the work as finally installed are made, the corrected prints and CADD files shall be submitted for review and approval by the Design Professional.
- D. Record drawings shall be delivered to Owner within 30 days after acceptance of completed project by Owner.

**1.6 OPERATING INSTRUCTIONS:**

- A. Provide to Owner three bound copies of complete written instruction on the operation, care and maintenance of each piece of equipment and the installation as a whole. Include frequency of inspection, cleaning and adjusting and other attention as may be required in accordance with manufacturer's instructions. Material shall be manufacturer's brochures, catalog cuts, parts lists, wiring diagrams, etc. Also supply Owner with three complete sets of approved shop drawings.
- B. Furnish qualified personnel to instruct Owner's personnel in the maintenance and operation of all equipment and systems. Instructing personnel shall remain on the job continuously during working hours until such instruction is complete, but not less than 16 hours.
- C. In addition, refer to Division 1.

**1.7 CORRECTION OF WORK AFTER FINAL PAYMENT AND GUARANTEE:**

- A. This article is supplementary to Guarantee Provisions of Division 1 and General Conditions.
- B. Final payment shall not relieve the contractor of responsibility for faulty equipment, materials and workmanship, and unless otherwise specified, the contractor shall remedy any defects due thereto and pay for damage to other work resulting therefrom, which shall appear within a period of one (1) year from the date of acceptance.
- C. Include guarantees by the respective equipment manufacturers which shall be subject to the terms and time limits defined under this Article of Specifications.
- D. Guarantees furnished by Sub-contractor and/or equipment manufacturers shall be counter-signed by the related Prime Contractor for joint and/or individual responsibility for subject item.
- E. Manufacturers' equipment guarantees or warranties extending beyond the guarantee period described herein shall be transferred to Owner along with the contractor's guarantees.

**1.8 QUALITY ASSURANCE**

- A. Comply with the requirements of the following codes and/or standards:
  - 1. ANSI.
  - 2. ANSI.
  - 3. UL.
  - 4. NEMA.
  - 5. NFPA.
  - 6. NEC.
  - 7. IBC 2009.
  - 8. BICSI.
  - 9. ANSI/TIA 568-D Series.
  - 10. ANSI/TIA 569-E.
  - 11. ANSI/TIA 606-C.
  - 12. ANSI/TIA 607-D.

- B. All packaged equipment shall be independently Third Party labeled as a system for its intended use by a Nationally Recognized Testing Laboratory (NRTL) in accordance with the OSHA Federal Regulations 29CFR1910.303 and .399, as well as NFPA Pamphlet #70 and National Electric Code (NEC), Article 90-7.

## **PART 2 - MATERIALS**

### **2.1 MATERIALS AND EQUIPMENT:**

- A. All installed materials and equipment shall be new and the best of their kind and shall conform to the grade, quality and standards specified herein.
- B. Unless otherwise specifically stated, all materials and equipment offered under these specifications shall be limited to products regularly produced and recommended by the manufacturer for the service intended. This material and equipment shall have capacities and ratings sufficient to amply meet the requirements of the project. The capacities and ratings shall be in accord with engineering data or other comprehensive literature made available to the public by the manufacturer and in effect at the time of opening of bids.
- C. Equipment shall be installed in accordance with manufacturer's instructions for type and quality of each piece of equipment used. These instructions shall be obtained from the manufacturer and shall be considered part of these specifications. Type, capacity, and application of equipment shall be guaranteed suitable to operate satisfactorily. No experimental material or equipment shall be permitted.

### **2.2 WORK DESCRIPTION:**

- A. In general, the work shall consist of but not necessarily be limited to the following:
  - 1. Install Owner's pre-purchased equipment as required.
  - 2. Rough in and make final connections to equipment furnished by Owner or by other Trades.
  - 3. Installation of communications backbone cabling.
  - 4. Installation of communications horizontal cabling.
  - 5. Installation of data racks in MDF and IDF Room locations.
  - 6. Communications interface with Building Management Systems, audio visual, fire alarm, and security systems.
  - 7. Communication UL 497 bonding and grounding second level, with lightning protection.
  - 8. Outside plant low voltage service provider coordination.

### **2.3 WORK INCLUDED:**

- A. In addition to work described above under WORK DESCRIPTION, the work shall include but not necessarily be limited to the following:
  - 1. Rigging of equipment and materials related to the Telecommunications Work.
  - 2. Provide and install all telecommunications racks and cabinets.

3. Provide and install horizontal and vertical cable management.
4. Provide and install horizontal UTP cabling.
5. Provide and install backbone UTP and fiber optic cabling.
6. Provide and install grounding and bonding of all systems in accordance with National Electrical Code and ANSI/TIA-607-D Standards and Requirements
7. Provide testing of installed cabling to support telecom systems.
8. Miscellaneous steel and hangers required for support of Telecom equipment.

**2.4 CHASES AND OPENINGS:**

- A. Provide information to the appropriate trades regarding size and location of all openings and chases as required for the installation of this Telecom Work.

**2.5 CUTTING AND PATCHING:**

- A. Provide all cutting and patching required for work performed under this Contract. No holes may be cut or drilled in structural members without prior approval of Owner. Cutting shall be done by mechanics skilled in their respective trades.
- B. No cutting that may impair the strength of the building construction shall be done. No holes may be drilled in or attachments welded to the beams or other structural members without prior approval from Owner. All work shall be done by mechanics skilled in their trade.
- C. All patching shall be done in a manner to match appearances and quality of existing surfaces.
- D. Provide sleeves for conduits passing through poured concrete decks, footings, walls, etc. Cut all openings for conduits passing through precast concrete or existing concrete masonry. Such holes shall be cut with core drill or similar equipment. Sleeves shall not be cut with hammer or chisel, or with any power tool depending on impact for its cutting power.

**2.6 SUBSTITUTIONS:**

- A. Equipment may be shown or specified in several ways:
  1. Manufacturer and catalogue or model number with the words "no substitutions," "no equal," "(manufacturer) only," or words of similar respect. The contractor shall furnish the specified item.
  2. Several manufacturers and model numbers listed; or one manufacturer and model number, followed by "equals by (mfr A), (mfr B), (mfr C)," or words of similar respect.
    - a. If one of the manufacturers is listed on the drawings, that manufacturer shall be considered the basis of design. If none is so listed, the first manufacturer named in the Specification shall be considered the basis of design.
    - b. Where manufacturer's or supplier's name, style and catalog numbers are mentioned in the description of material and equipment in the specifications or on the drawings, it is to be understood that they are for the purpose of setting a standard.

- c. If the contractor elects to furnish equipment other than the basis of design, he shall verify capacities, physical size, weight, electrical requirements, methods of connection to other parts of the system, and all other relevant data.  
The contractor shall be responsible for informing the Design Professional of all changes required to other equipment, spaces, structure or systems in order to install the substituted equipment. He shall furnish all required shop drawings or sketches required for Design Professional to evaluate the required changes and shall be responsible for all costs associated with such changes, including costs of design or engineering, if such are necessary, and costs of other trades.
- 3. Where manufacturer's or supplier's names are listed in conjunction with the manufacturer or supplier that is basis of design, they are given to approve the firm name only. Equipment or material submitted by such firms must meet the detailed technical specifications written for the respective item. The contractor shall be responsible for verifying capacities, physical sizes, weights, electrical requirements, methodology for connections to other parts of the system, etc. The contractor shall furnish all required shop drawings for equipment, and for its connection and installation.
- B. If any substituted items are submitted after contracts have been awarded, and there is any question of equality of such items, samples may be required to be submitted both for the item specified and that to be substituted, or further proof of equality may be required to the entire satisfaction of the Design Professional. In no case shall additional remuneration be allowed because of the rejection of a substitute.
- C. When the equipment is relocated to a place other than that shown on the drawings, or when equipment other than that specified is used, the contractor shall pay any extra cost of required revisions such as structural steel, concrete, electrical, piping, etc.
- D. The Design Professional's costs to evaluate substitutions and to revise Drawings and Specifications because of substitutions will be paid by the contractor.

## 2.7 SHOP DRAWINGS:

- A. Refer to Division 1 and individual specification sections.
- B. Furnish shop drawings, catalog cuts, performance data and other required data to the Design Professional for approval for all material and equipment specified hereinafter. Sufficient data shall be submitted to show compliance with the requirements of the plans and specifications. All shop drawings submitted shall be first checked and corrected before submitting for approval. Approval for shop drawings by the Design Professional will not relieve the contractor from responsibility for errors or omissions therein. All such errors or omissions must be made good by the contractor irrespective of any approval by the Design Professional.
- C. The following applies to all materials and equipment being submitted for this project. Refer to the individual specification sections for additional submittal requirements.
- D. It is the responsibility of the manufacturer's representative and the installing contractor to thoroughly review all shop drawing equipment submittals and state in writing that the products meet or exceed the design specifications and design intent as indicated on the contract documents, prior to submitting them for review by the engineer.

- E. The General Contractor or Construction Manager shall review and stamp all shop drawings noting the CG/CM review process has taken place and that the shop drawings are in compliance with the design documents, prior to submitting the for review by the engineer. Any shop drawings found to not be in compliance shall be returned to the contractor stating such, with a copy of the statement (only) forwarded to the engineer.
- F. On submissions beyond the initial one, clearly identify changes made from the initial submittal other than those requested by the Design Professional will review only those changes that are requested and those identified by the contractor.
- G. The Engineer will review three submissions (one original submission and up to two revised submissions) on any single component requested for review. If the contractor and/or vendor fail to comply with the drawings, specifications, and/or review comments, and additional submissions are required, the cost for those submissions will be borne by the contractor.
- H. The design documents are based and coordinated on the scheduled manufacturers. Any substitutions of products or materials (from those approved and listed in the specifications) must be thoroughly coordinated by the submitting contractor. This includes but is not limited to power, space, structural, control and performance requirements.
- I. Shop drawings required shall include, but not necessarily be limited to, the following:
  - 1. Shop drawings, cuts and catalogue information showing appearance, dimensions, performance, weight, etc., of all equipment, fixtures, appurtenances, etc. See respective equipment or system sections for more specific requirements.
  - 2. Schedules of all materials showing type and manufacturer.
  - 3. Wiring diagrams and schematics for equipment.
  - 4. Telecommunications cabinets, racks, switchboards, panels, and other protective and distribution equipment.
  - 5. All special equipment and systems.
  - 6. Other shop drawings as may be requested.
- J. Electronic and facsimile submission of shop drawings will not be accepted as the submittal format. An advanced copy for starting the process may be E-mailed but hard copy submittals shall be submitted for actual review.
- K. Product Data: Include manufacturer's technical literature for each device. Indicate dimensions, capacities, performance characteristics, electrical characteristic, finishes for materials, and installation and startup instructions for each type of product indicated.
- L. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Schematic flow diagrams showing all controlled equipment and control devices.
  - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
  - 3. Details of control panel faces, including controls, instruments, and labeling.
  - 4. Written description of sequence of operation.
  - 5. Trunk cable schematic showing programmable control unit locations and trunk data conductors.

6. Listing of connected data points, including connected control unit and input device.
  7. System graphics indicating monitored systems, data (connected and cSMSulated) point addresses, and operator notations.
  8. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
- M. Shop Drawings shall be submitted and shall consist of a complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Shop drawings shall also contain complete wiring, routing, schematic diagrams, tag number of devices, software descriptions, calculations, and any other details required to demonstrate that the system will function properly. Drawings shall show proposed layout and installation of all equipment and the relationship to other parts of the work.
- N. Shop Drawings shall be approved before any equipment is installed. Therefore, shop drawings must be submitted in time for review so that all installations can be completed per the project completion schedule. Ten working days shall be allowed for submittals to be reviewed.
- O. All drawings shall be reviewed after the final system checkout and updated or corrected to provide "as-built" drawings to show exact installation. All shop drawings will be acknowledged in writing before installation is started and again after the final checkout of the system. The system will not be considered complete until the "as-built" drawings have received their final approval. The contractor shall deliver a complete set of "as-built" drawings.

**Shop Drawing Review Comment Definitions:**

**A> No Exception Taken:**

The shop drawing or equipment submittal as submitted is approved without exception. No changes or corrections required. The materials, equipment or system submitted can be released for fabrication and construction. No Further Submission Required

**B> Make Corrections Noted:**

The shop drawing or equipment submittal as submitted is not completely correct but is approved as noted. Make the corrections noted on the shop drawing or submittal. The materials, equipment or system submitted can be released for fabrication and construction once the corrections have been made. The submittal must be corrected and resubmitted for record unless noted by "E: Resubmit". See "E: Resubmit definition below.

**C> Submit Specified Item:**

The shop drawing or equipment submittal as submitted is missing a component of the system that it represents or is not of the approved and specified manufacturers. Submit the missing or incorrect item. The materials, equipment or system submitted cannot be released for fabrication and construction.

**D> No Further Submission Required:**

The shop drawing or equipment submittal as submitted is approved as noted. No changes or corrections required. The materials, equipment or system submitted can be released for fabrication and construction. No Further Submission Required.

**E> Resubmit:**

The shop drawing or equipment submittal as submitted is not approved. The shop drawing or equipment submittal needs significant corrections and does require another submission to verify that the comments and changes have been incorporated. Make the corrections noted on the shop drawing or submittal. The materials, equipment or system submitted cannot be released for fabrication and construction.

**F> Rejected:**

The shop drawing or equipment submitted is not as specified or a non-approved manufacturer or product and rejected.

**G> Resubmit for Record Only:**

Make the corrections noted on the shop drawing or submittal. The shop drawing or equipment submittal as submitted is approved with minor exception. Changes or corrections are required. The materials, equipment or system submitted can be released for fabrication and construction.

**PART 3 - EXECUTION**

**3.1 VISIT TO SITE:**

- A. Before submitting bid, the contractor shall visit the site of the work and be thoroughly familiarized with the conditions affecting the work. No extra payment will be allowed on account of extra work made necessary by failure to do so.

**3.2 WORKMANSHIP:**

- A. All work shall be installed in a first class, neat and professional manner by tradespeople skilled in the trade involved. All details of the installation shall be mechanically and electrically correct. Should the Design Professional direct removal, change, or installation of any equipments or systems not installed in a neat and workmanlike manner, such charges shall be made by the Electrical Contractor at no expense to Owner.
- B. Equipment shall be installed in strict accordance with manufacturer's instructions for type and capacity of each piece of equipment used. The contractor shall obtain these instructions from the manufacturer and these instructions shall be considered part of these Specifications.
- C. Drawings and specifications have been prepared with best knowledge of conditions available at the time of design. If any obscurities or discrepancies exist, they shall be brought to the attention of the Design Professional before bids are submitted. If they are not discovered before



bids are submitted, the Design Professional shall be notified and shall render decision. This decision shall be final.

1. Drawings and Specifications are intended to be complementary; items described or shown in one but not both are to be furnished as if fully shown or described in both locations.
  2. In case of conflict between provisions of the Specifications, the more stringent requirement shall govern. Where a requirement is applied to a specific product, condition, system, or Specification Section which conflicts with a more general requirement elsewhere, the specific shall supersede the general.
- D. Drawings are generally indicative of the work to be installed, but do not indicate all conduit bends, fittings, boxes, and specialties which may be required, or the exact locations of all conduits. The contractor shall investigate structure and finish conditions affecting the work and arrange this work; accordingly, furnishing such fittings as may be required to meet such conditions. The contractor is responsible for exercising proper judgment to arrange this work and materials so as to avoid interference with other trades.
1. Riser diagrams, details, and schematics generally indicate cabling to be used in various systems involved. This information may or may not be duplicated on the plans, but equipment shown on either plans or riser diagrams and schematics shall be provided as if shown on both.
  2. All grades, elevations, dimensions, and clearances of equipment shown on drawings are approximate and shall be verified at site.
  3. Where work or equipment is referred to in singular terms, such reference shall be deemed to apply to as many items of work or equipment as required to complete entire installation.

### 3.3 FIELD MEASUREMENTS:

- A. Before ordering any material or doing any work, verify all measurements at the building and site and be responsible for the correctness of same. No extra compensation will be allowed on account of differences between actual dimensions and measurements and those indicated on the drawings. Any difference which may be found shall be submitted to the Design Professional for consideration before proceeding any further with the work.

### 3.4 DELIVERY OF EQUIPMENT:

- A. Be responsible for delivery of equipment, unload, and store in a manner not to interfere with the operation of other trades. Additional expense incurred because of equipment or material delivery delays shall be assumed by the responsible contractor.

### 3.5 PROTECTION OF WORK:

- A. All work, equipment and materials shall be protected at all times. All raceway openings shall be closed with caps or plugs during the installation. All equipment shall be tightly covered and protected against dirt, water, plaster, paint and other foreign material or mechanical injury

during entire progress of installation. Make good all damage caused either directly or indirectly by workmen employed to fulfill requirements of the Electrical Work.

**3.6 REMOVAL OF RUBBISH:**

- A. During the course of construction, periodically remove from the premises all rubbish resulting from work of this trade so as to prevent its accumulation. At the completion of the work contemplated under these Specifications remove from the building and site all rubbish and accumulated materials of whatever nature not caused by the other trades and leave work, and equipment free of all foreign matter including plaster, cement, and paint and leave in a clean, orderly, acceptable, and usable condition.

**3.7 COORDINATION WITH OTHER TRADES:**

- A. Work in conjunction with each of the other trades to facilitate proper and intelligent execution of work with minimum interference.
- B. Carefully examine all architectural and structural drawings for the building and drawings for electrical trade and mechanical trades and be responsible for the proper fitting of all material and equipment into the building as planned and without interference with other piping, ductwork, conduit, or equipment. Proper judgment shall be exercised to secure best possible headroom, door and window clearance, and space conditions throughout; to secure neat arrangement for piping, equipment, and conduit, and to overcome all local difficulties and interferences to best advantage. Approval for any and all changes to plans and specifications which may thus be incurred shall be obtained from the Design Professional before proceeding.
- C. The contractor shall prepare preliminary shop drawings suitable for use in coordinating this work with the work of other trades. The HVAC section will prepare and furnish reproducible prints at an appropriate scale with all trades indicating piping, ductwork and conduit in relation to all structural elements of the construction, including floor elevations; steel locations, size, and elevations; partitions locations; door locations and direction of swing; and all other information required to assure coordination of the electrical, sheetmetal and piping trades and fire protection in relation to the Architectural function of the project. Coordination meetings will be held under the supervision of Owner's Construction Manager and General Contractor. Each trade shall have proper representation at all coordination meetings for the purpose of detailing, on a reproducible print mentioned above, the exact location and routing of their work.
- D. After the conclusion of the coordination at the working meetings, each trade shall sign the coordinated drawing, with copies being distributed by the GC to all contractors and parties concerned, including Owner. Final shop drawings of all trades shall be in accordance with the coordinated drawing, which final shop drawings shall be submitted for final approval.
- E. If contractor installs work so as to cause interference with work of other trades, he shall make necessary changes in work to correct the condition without extra charge.
- F. Dimensional layout plans of equipment rooms shall be made showing all bases, pads and inertia blocks required for mechanical equipment. Include dimensions of bases, bolt layouts, details, etc.

- G. The contractor shall furnish all necessary templates, patterns, etc. for installing work and for purpose of making adjoining work conform, furnish setting plans, and shop details to other trades as required.

**3.8 COORDINATION OF TELECOMMUNICATIONS CHARACTERISTICS:**

- A. The contractor shall carefully examine the drawings of all other trades for equipment requiring telecommunications connection and shall ascertain that all telecom characteristics of equipment scheduled thereon matches the service available. If any discrepancies are noted, he shall immediately refer to Design Professional for resolution. If characteristics are correct, the contractor is responsible for ascertaining method of connection, "rough-in" dimensions, correct plug, and receptacle configurations, etc. While Design Professional has made every effort to provide such information as is known at time of design, the contractor shall obtain final data from shop drawings before proceeding.
- B. For all equipment of other trades which electrical characteristics are not scheduled on drawings of that trade, the contractor shall assume the responsibility of notifying the General Contractor furnishing such equipment as to the characteristics required; the contractor will be held responsible for correction of all problems arising from failure to do so.

**3.9 FIRESTOPPING:**

- A. All penetrations through fire-resistance-rated floor, fire resistance rated, floor/ceiling assemblies and roof construction and through fire-resistance-rated walls and partitions shall be fire stopped.
- B. Penetrations to be fire stopped include both empty openings and those containing cables, pipes, ducts, conduits, and any other items.
- C. Fire rating of sealed penetrations shall meet or exceed the rating of the assembly being penetrated.
- D. Materials shall be installed in accordance with manufacturer's recommendations and UL listing.

**END OF SECTION 27 00 00**

**SECTION 27 05 00**

**COMMON WORK ELEMENTS FOR COMMUNICATIONS SYSTEMS**

**PART 1 - GENERAL**

**1.1 STIPULATIONS**

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.
- B. Related Specification Sections:
  - 1. Division 07 – Through-penetration Firestop Systems
  - 2. Division 26 – Common Work Results for Electrical
  - 3. Division 26 – Low Voltage Electrical Power Conductors and Cables
  - 4. Division 26 – Grounding and Bonding for Electrical Systems
  - 5. Division 26 – Hangers and Supports for Electrical Systems
  - 6. Division 26 – Raceways and Boxes for Electrical Systems
  - 7. Division 26 – Identification for Electrical Systems
  - 8. Division 27 – General Requirements for Telecommunications
  - 9. Division 27 – Common Work Elements for Communications Systems
  - 10. Division 27 – Network Communications Systems
  - 11. Division 27 – Two-Way Communications System
  - 12. Division 27 – Audiovisual Systems
  - 13. Division 28 – Common Work Elements for Electronic Safety and Security
  - 14. Division 28 – Physical Electronic Safety and Security
  - 15. Division 28 – Video Surveillance System
  - 16. Division 28 – Security Communication System
- C. Reference Symbols:
  - 1. All device symbols are defined by the appropriate symbol schedule on the symbols and abbreviations sheet in the telecommunications systems drawing package. Not all device symbols as indicated may be required for the project.
  - 2. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location. Contractor shall coordinate exact locations with all drawings and affected trades prior to submittal of shop drawings.
    - a. The Contractor shall coordinate exact locations with all security and telecommunications drawings and site plan drawings as well as all affected trades prior to submittal of any shop drawings.
- D. Abbreviations:
  - 1. ACR Attenuation to Crosstalk Ratio.
  - 2. ADA Americans with Disabilities Act
  - 3. ASTM American Society for Testing Materials
  - 4. ASIS Formerly the American Society for Industrial Security, now known simply as ASIS International

5. A/V Audio Visual Systems – For purposes of this specification section A/V systems shall include all Media Management, Video Broadcasting, Intercommunications (Paging/Public Address, Clock, Auxiliary Sound), Video Intercom, Emergency Communications, Mass Notification, Master Antenna (MATV) and Distance Learning Systems
6. AVI Audio Visual Systems Integrator: Shall be a qualified Contractor experienced in the installation and certification of A/V systems. The AVI Contractor shall be responsible for the design, testing, and certification of all audio/visual systems including, but not limited to: Intercommunications, TV Distribution, Audio Visual, Master Antenna and Bi-Directional Antenna systems as well as all structured cabling systems supporting these technologies.
7. BAS Building Automation System
8. BICSI Building Industry Consultant Services International - International organization whose primary objective is to enhance the reputation and skills of companies and individuals employed in the telecommunications and security industries by ensuring that current and developing standards are maintained.
9. CATV Community Antenna Television
10. CP Consolidation Point - Local Interconnection Point between horizontal cables from the building IDF/MDF rooms and horizontal cables for the furniture drops.
11. DDC Direct Digital Controller / Device Display Controller
12. DGP Data Gathering Panel – A component of the Physical Access Control System (PACS) located at each door or portal location that communicates, stores and processes information received from readers, reader modules, input modules, and output modules with the Security Management System CPU and software.
13. DMZ Demilitarized Zone – A firewall configuration for securing local area networks (LANs).
14. DP Demarcation Point - The point of interface between the Communications Networks, MATV, any Auxiliary Systems, and the associated Service Providers or Public Utilities. Also known as Entrance Facility. Shall also serve as the primary termination point for all incoming OSP cabling as well as the primary main grounding bus-bar for all communications systems. Refer to project documents for exact location and termination requirements.
15. ELFEXT Equal Level Far End Crosstalk.
16. EMI Electromagnetic interference.
17. EMT Electrical Metallic Tubing – Also known as thin-wall conduit.
18. FACP Fire Alarm Control Panel
19. FAS Fire Alarm System
20. FCC Federal Communications Commission
21. GFCI Ground fault circuit interrupter.
22. GUI Graphic User Interface – A specialized program employing graphical display maps of a facility and/or site which, also provides a manual user interface for all system functions and operations by utilizing control and annunciation icons from dedicated human machine interface terminals.
23. HMI Human/Machine Interface – A Computer-operated, video control terminal complying with FCC Part 15 CFR Title 47, Subparts A and B, and shall utilize multiple dynamic GUI based displays for annunciation and control LCD flat panel computer monitor or display screen as defined by related specification sections.

- 24. IBC International Building Code
- 25. ICT Information Communications Technology – For purposes of this specification section ICT shall include all communications systems including but not limited to all Data, Telephone, BAS, Intercommunications (Paging/Public Address), TV Distribution Systems (MATV) and Audio Visual Systems (A/V) Surveillance Systems and IP based Access Control.
- 26. ICTI Information Communications Technology Integrator – Shall be a qualified Contractor experienced in the installation and certification of all data, telecommunications. The ICTI shall be responsible for the design, testing, and certification of Data, Telephone communications systems and all structured cabling systems supporting these technologies.
- 27. IDF Intermediate Distribution Frame – The room/space that shall serve as the local termination point for all horizontal and backbone cabling. Also, shall be known as Equipment Room (ER), Horizontal Cross-Connect (HC) or Floor Distributor (FD).
- 28. IEEE Institute of Electrical and Electronics Engineers
- 29. IO I/O Input/Out – Commonly associated with dry contact relay-based digital integration.
- 30. IP Internet Protocol
- 31. IR Infrared
- 32. ISO International Organization for Standardization
- 33. LAN Local Area Network
- 34. LCD Liquid Crystal Display
- 35. LED Light-Emitting Diode
- 36. LV Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- 37. MDF Main Distribution Frame – The room/space that shall serve as the primary termination point for all backbone cabling to each IDF locations and horizontal connection point for local communication drops. May also serve as a local IDF location as well as the cross-connection and interconnection of all entrance cables from the DP for all PSTN and WAN connections. Also, shall be known as Main Cross Connect (MC), Telecommunications Room (TR) and/or Campus Distributor (CD)
- 38. M-JPEG Motion – Joint Photographic Experts Group
- 39. MPEG Moving picture experts' group
- 40. NEC National Electric Code
- 41. NEMA National Electrical Manufacturers Association
- 42. NEXT Near End Crosstalk
- 43. NFPA National Fire Protection Association
- 44. NTSC National Television System Committee.
- 45. NRTL Nationally Recognized Testing Laboratory
- 46. NVR Network Video Recorder
- 47. NVW Network Video Workstation
- 48. OTDR Optical Time Domain Reflectometer
- 49. OSP Outside Plant – All cabling associated with building services supporting the incoming service connections to Service Providers, Public Utilities, and Wide Area Networks.
- 50. PA Public Address or Building Intercommunications System.
- 51. PBB Telecommunications Primary Bonding Busbar
- 52. POTS Plain Old Telephone Service – Analog Telephone Circuit used for the connection of fax machines, BAS and FAS communications devices and

- shall be wired upstream of the facility's telephone switch.
- 53. PSP Physical Security Professional as registered by the American Society of Industrial Security-International (ASIS)
  - 54. PSTN Public Switched Telephone Network – Connection to local telephone utility providing local telephony communications service.
  - 55. RCDD BICSI-accredited Registered Communications Distribution Designer
  - 56. RFI Request for Information
  - 57. RGS Rigid Galvanized Steel conduit – Galvanized steel tubing, with a tubing wall that is thick enough to allow it to be threaded.
  - 58. SBB Telecommunications Secondary Bonding Busbar
  - 59. TCP/IP A standard protocol stack on which the Internet and data communications networks operate.
  - 60. TIA Telecommunications Industry Association
  - 61. TVSS Transient Voltage Surge Suppressor
  - 62. UPS Uninterruptible Power Supply
  - 63. UTP Unshielded Twisted Pair
  - 64. VoIP Voice Over IP telephone Network
  - 65. VPN Virtual Private Network
  - 66. WAN Wide Area Network
  - 67. WAP Wireless Access Point
  - 68. WLAN Wireless Local Area Network

E. Definitions:

- 1. Contract Documents: The documents consisting of the Form of Agreement between Owner and Contractor, Conditions of the Contract, (General, Supplementary, and other Conditions), Drawings, Specifications and all Addenda issued prior to the execution of the Contract.
- 2. Contract Drawings: The drawings that form a part of the Contract Documents that provides the graphical representation of the project requirements intended design and/or performance criteria to be delivered by the Contractor.
- 3. Reference Drawings: A drawing and/or set of drawings produced by a proprietary supplier, manufacturer, subContractor, or fabricator included in the Contract Documents for informational purposes, providing specific information related to the installation of related appurtenances, components, devices, hardware, products, and/or systems. Reference Drawings shall also include any Contract Drawings from prior bid packages that may have pertinent information or require coordination of trades related to this contract.
- 4. Shop Drawings: A drawing and/or set of drawings produced by the Contractor, supplier, manufacturer, subContractor, or fabricator as a detailed representation of the proper installation of the related, appurtenance, component, device, hardware, product, and/or system to be delivered in conformance to the requirements of the Contract Documents.

1.2 SUMMARY

- A. This Section contains the overall requirements associated with all Division 27 and Division 28 Specification Sections, and includes the project design intent for all data, voice, and security network communication cabling and equipment related to the installation of the following systems:

- 1. Network Communications System

2. Video Surveillance System
  3. Physical Access Control System (PACS)
  4. Audiovisual System
- B. In addition, this section shall address all requirements for submittals, quality assurance, product handling, record documents, project conditions, installation, system performance, demonstrations, testing, and certifications for all scopes of work related to network communication cabling for this project scope of work. Refer to related Division 26, 27 and 28 specification sections and all contract drawings for additional information.
1. The ICTI shall have overall responsibility for all designs, equipment and all technical support related to all Division 27 scopes of work and shall ensure full coordination of all work as required to provide the following fully operational communications network in accordance with all related specification sections and contract drawings.
    - a. The ICTI shall be responsible for providing all equipment, devices, system components, final cable terminations, programming, commissioning, and testing of all network communications cabling and equipment in accordance with all related Division 27 specification sections.
    - b. All sub-Contractors shall meet the minimum technical capabilities, certifications, and licensing requirements as defined by the "Quality Assurance" chapter.
- C. The installation, performance, features, functions, software, and programming criteria as specified herein as well as all related Division 27 specification sections have been designed to offer the maximum system efficiency, ease of operation, occupant safety and the protection of equipment as recommended by Owner and Design Professional.
1. Any deviations from the specified criteria shall be documented, reviewed and agreed to in writing by Owner and the Design Professional prior to submission of bids. Refer to Division 01, and all related Division 27 specification sections for any substitutions and/or project deviation requests.
    - a. The required information shall include but not be limited to: reason for deviation, all differences in performance, operation and function from the herein specified requirements, all benefits and added features to Owner as a result of the deviations and any additional incurred costs to Owner for maintenance and long-term Ownership.
    - b. Failure to provide Owner and Design Professional with the required information shall result in any shop drawing submissions being returned for non-conformance with the contract requirements.
  2. The Contractor and all sub-Contractors for this work shall have read all of the General Conditions, Special Requirements, General Requirements and all related specification sections and in the execution of all work shall be bound by all of the conditions and requirements therein.
  3. Prior to the submission of the Bid any discrepancies or inconsistencies noted within these specifications and/or the project drawings shall be brought to the immediate attention of Owner and Design Professional.
- D. All device symbols are defined by the appropriate symbol schedules as indicated by the symbol and abbreviation drawing sheets for each discipline. The Contractor shall coordinate exact locations with all architectural, mechanical, electrical, reflected ceiling, furniture drawings and



door hardware specifications as well as all affected trades prior to submittal of bids.

1. All symbols are shown on the contract drawings as close as possible to their intended location. Contractor shall coordinate the installation of all equipment, devices, controls, components, cabling conduits/raceways and integration of other systems with all affected trades and specified system integrators. The Contractor shall document all coordination requirements at the time of shop drawing submission.
  2. Drawings for this work are diagrammatic and intended to convey the extent, general arrangement, and locations of the work. Because of the scale of the drawings, certain basic items such as access panels, conduits, cabinet sizes, penetration sleeves, pull boxes, back-boxes and junction boxes may or may not be shown on the contract drawings. Include all items where required by code and related specification sections for proper installation of all work.
- E. Where ambiguity exists between the project specifications and the contract drawings, the superior in system performance regardless of cost shall prevail and shall be delivered by the Contractor at no additional expense to the project.
- F. Project specifications and drawings may not deal individually with every part, control, device, component, or appurtenance which may be required to produce the equipment performance for the specified system and/or as required for compliance with all specified systems integration.
1. Include such items and components, as required, for complete operational systems as defined by the project documents, whether specifically indicated or not. The Contractor shall be responsible for providing conduits/raceways, cable terminations, controls, systems, equipment, materials, devices, components, electrical power, equipment racks/cabinets, software, programming, commissioning, testing and all appurtenances as well as the integration of any ancillary systems or Owner provided equipment/components/systems.
  2. Coordinate with other applicable trades in submittal of shop drawings and the installation of all systems. All shop drawings shall detail space conditions in order to accommodate other concerned trades, all equipment locations are subject to final review by Owner and Design Professional.
- G. Use of Premises
1. General: The Contractor shall have limited use of premises for construction operations only as required to meet the scope of work as delineated by the Contract Documents.
  2. The Contractor shall design, prepare, schedule, and coordinate all scopes of work without disruption of any existing system functions or the daily operation of the facility. All communications cabling and equipment shall be installed in such a manner that all new controls, equipment and/or devices shall be installed, programmed, and tested prior to switch over and/or disconnecting of any existing communications systems.
  3. The Contractor shall coordinate all installation activities so as not to disrupt the daily routines of the facility and shall include any costs related to a phased construction methodology including but not limited all necessary temporary equipment, devices, components, or systems as well as any labor costs associated with any installation, commissioning, testing demolition of any systems required to be performed after normal business hours of the facility.
    - a. Contractor shall plan, schedule, and install all communications cabling and equipment in accordance with all requirements of the project construction

schedule. Refer to related specification sections for additional information related to project scheduling and facility access.

- b. The Contractor shall coordinate all installation and demolition activities so as not to disrupt the daily routine of the facility or negatively impact the integrity of the facility's security and life safety measures.
- c. Contractor shall demolish all existing network communications systems, cabling, devices, components and/or controls not integrated with the new telecommunications system at the completion of each project phase and only after final acceptance by Owner, and the Design Professionals. The removal or demolition of all existing system devices and/or field wiring not incorporated into the new systems shall be performed in such a manner consistent with all requirements of NFPA 70.

### 1.3 REFERENCES

- A. References to industry and trade association standards as well as all building codes are minimum installation requirements. The codes, standards, and agencies listed below shall form a part of this specification section and all work shall comply with the latest adopted standards.
- B. Where the contract drawings and specifications mandate a greater requirement or performance than those specified by any of the below referenced codes and standards, the Contract Documents shall then be the governing requirements for this project. The minimum codes and standards to be applied for this project shall be the following:
  - 1. All applicable requirements of NFPA 70 "National Electrical Code" including, but not limited to:
    - a. Article 250, Grounding
    - b. Article 300, Part A. Wiring Method
    - c. Article 310, Conductors for General Wiring
    - d. Article 725, Remote Control, Signaling Circuits
    - e. Article 770, Optical Fiber Cables, and Raceways
    - f. Article 800, Communication Systems
  - 2. National Fire Protection Association:
    - a. NFPA-72: National Fire Alarm and Signaling Code
    - b. NFPA-75: Standard for the Protection of Electronic Computer/Data Processing Equipment
    - c. NFPA 90A: Standard for the Installation of Air-Conditioning and Ventilating Systems
    - d. NFPA 92A: Standard for Smoke-Control Systems
    - e. NFPA-99: Standard for Health Care Facilities
    - f. NFPA-101: Life Safety Code
    - g. NFPA-130: Standard for Fixed Guideway Transit and Passenger Rail Systems
  - 3. ANSI/TIA Compliance: Comply with the following Electronics Industries Association Standards:
    - a. ANSI/TIA-568C: "Commercial Building Telecommunication Standard"
    - b. ANSI/TIA-569: "Commercial Building Standard for Telecommunications"

- Pathways and Spaces"
  - c. ANSI/TIA-455: "FOTP-61, Measurement of Fiber or Cable Attenuation Using an OTDR"
  - d. ANSI/TIA-606: "The Administration Standard for the Telecommunications Infrastructure of Commercial Building"
  - e. ANSI/TIA-607A: "Commercial Building Grounding and Bonding Requirements for Telecommunications"
  - f. ANSI/TIA-492A: "Detail Specification for 850-nm Laser Optimized 50- $\mu$ m Core Diameter/125 $\mu$ m Cladding Diameter Class 1a Graded Index Multi-Mode Optical Fibers"
  - g. ANSI/TIA-492CAA: Detail Specification for Single-Mode Optical Fiber
4. Underwriters Laboratories, Inc.:
- a. UL 486A: "Wire connectors and soldering lugs for use with copper conductors"
  - b. UL 1449: "Transient voltage surge suppressors"
  - c. UL 1581: "Standard for Electrical Wires, Cables, and Flexible Cords"
  - d. UL 478: "Standard for Electronic Data-Processing Units and Systems"
  - e. UL 83: "Thermoplastic-Insulated Wires and Cables,"
  - f. UL 910: "Test Method for Fire and Smoke Characteristics of Cables Used in Air-Handling Spaces." Provide products which are UL-listed and labeled.
  - g. UL 1069: Hospital Signaling and Nurse Call Equipment
5. Federal Communications Commission:
- a. FCC Regulations Part 15 Title 47.
6. Institute of Electrical and Electronic Engineers (IEEE)
- a. IEEE 802.3 - "Carrier Sense Multiple Access with Collision Detection," and all applicable supplements a through af".
  - b. IEEE 802.3.u-100 - "Base T/100-Base-TX, Fast Ethernet"
  - c. IEEE 802.3.z - "Gigabit Ethernet"
  - d. IEEE 802.3.ab - "1000 Base T"
  - e. IEEE 802.3.ae - "10 Gigabit Ethernet"
  - f. IEEE 802.3.af - "Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI) that"
  - g. IEEE 802.11.ax - "Wireless Transmission Standard"
  - h. IEEE 802.11.bt - "Power over Ethernet"
7. ISO/TC - International Organization for Standardization's (ISO) Technical Committee (TC)
- a. 21730 - Health informatics - Use of mobile wireless communication and computing technology in healthcare facilities.
8. NEMA/ICEA Compliance:
- a. WC-5 - "Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy,"
  - b. WC30 - "Color Coding of Wires and Cables," pertaining to control and signal transmission media.

9. ASTM Compliance: Comply with applicable requirements of D-2219 and D-2220. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
10. BICSI -TDMM 13th edition
11. ADA Standards for Accessible Design
12. Local Authority Having Jurisdiction
13. National Electrical Manufacturers Association (NEMA)

#### 1.4 SUBMITTALS

- A. In addition to all submittal requirements as stipulated by Division 01 specifications sections, the Contractor shall provide all shop drawing submittals in accordance with the following:
1. Owner and Design Professional approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage, or installation of equipment or material which has not had prior approval will not be permitted at the job site.
  2. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for Owner to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
  3. Submittals shall be provided as a complete submission; no partial submissions will be accepted. Failure to provide a complete submission shall result in all submittals being returned for resubmission.
    - a. In addition to all paper submission requirements as stipulated by Division 01 the Contractor shall also submit one complete set of electronic submittals in a PDF format.
  4. No substituted equipment shall be reviewed without prior approval in accordance with the requirements of "substitutions" under Division 1 specification section.
  5. Mark the submittals, "SUBMITTED UNDER SECTION\_\_\_\_\_."
  - a. Submittals shall be marked to show specification reference including the section and paragraph numbers.
  6. The Contractor shall schedule submittals in order to maintain the project schedule. For coordination requirements refer to Division 01 Specification Sections, which outline basic submittal requirements and coordination. All Division 01 Specification Sections requirements shall be used in conjunction with this specification section.
  7. Prior to any submission the Contractor shall be responsible for performing the following quality control items to ensure compliance with all project requirements:
    - a. Review all Shop Drawings and Product Data
    - b. Review all field measurement criteria.
    - c. Review all field construction criteria and methodologies.
    - d. Review all catalog numbers and similar data.
    - e. Review all coordination requirements of affected trades.
    - f. Review conformance to all appropriate specification sections.
  8. All shop drawings shall be prepared using computer aided design software, drawn accurately, and in accordance with Owner's Standards. The Contractor shall not reproduce the Contract Documents or copy standard information as the basis of the

technical data, hand drawn mark-ups of the original project drawings shall not be acceptable. Failure to provide a complete set of "Contractor prepared" installation drawings at the time of submittal shall result in all submittals being returned for resubmission.

9. Submission Packaging: The Contractor shall organize the submissions according to the following packaging requirements.
  - a. Electronic Copy Submission: One complete set of electronic equipment data sheets and drawings submitted in PDF format and collated in two distinct files:
    - 1) Equipment Data Sheets, equipment schedules, alarm matrixes cable termination spread sheets, and all related pertinent information.
    - 2) Drawings including all site plans, floor plans, risers, point to point wiring, grounding, installation details and mounting elevations.
  - b. Hard Copy Submission: Submit hardcopies of all shop drawings and product datasheets in accordance with the requirements the of Division 01 specifications.
10. The ICTI shall have an RCDD professional review all shop drawings related to network designs, installations, testing, certifications, and structured cabling layouts for communications systems. Failure to provide RCDD sealed shop drawings shall result in all shop drawings being returned for resubmission without any reviews taking place.
11. Owner's and the Design Professional's review of the shop drawings and/or samples does not relieve the Contractor from compliance with the requirements of the project documents. Unless the Contractor has informed Owner and the Design Professional in writing of such deviation at the time of submission, has noted the deviation on the shop drawings, and Owner and the Design Professional has given written approval of the specific deviation to the project document.
  - a. All project requirements shall stand. Owner's and the Design Professional's review does not relieve the Contractor from responsibility for any errors of omission in the submission of shop drawings and/or samples.
12. Submit all system testing, commissioning, and startup procedures to be employed. Include all estimated times for performance of all tests, all test equipment and workforce necessary for testing.
13. Submit all qualifications and certifications in accordance with the requirements as specified elsewhere in this specification section.
14. Submit project schedule outlining the time frames for all equipment with long lead times for equipment deliveries; include all system commissioning, testing, and training time expectations. Project schedule shall be submitted as CPM schedule and shall utilize a software-based project management program.

**B. Shop Drawings:**

1. All shop drawings shall include sufficient information, clearly presented, to determine full compliance with all project drawings and specifications. Include the following information as applicable for review; failure to provide all information listed below shall result in all shop drawing submittals being returned for resubmission:
  - a. All Building Floor and Site Plans.
  - b. All equipment, devices and components with manufacturer's name(s), model

- numbers,
  - c. All equipment, device and component electrical ratings and power requirements
  - d. All equipment, device, and component performance ratings.
  - e. All equipment /device cable voltage drop calculations,
  - f. All dB losses for all fiber optic devices and cabling,
  - g. All Speaker taps, voltages, and zoning.
  - h. All equipment rack/cabinet layouts and rack/cabinet sizes.
  - i. All device-mounting elevations.
  - j. All device wiring details.
  - l. All grounding and bonding connections.
  - m. Complete point-to-point-wiring diagrams for all systems. Include all equipment and wiring termination schedules and/or matrices.
2. Provide a complete set of “Contractor prepared” installation drawings. Drawings at the minimum shall consist of floor plans indicating all; passive and active electronic component locations, field devices, device identifications, distribution racks, patch panels, control panels, auxiliary control panels, power supplies, conduit, and cable requirements as well as all 120-volt electrical circuit locations and designations.
- a. Drawings shall include at the minimum the following:
    - 1) Detailed equipment layouts for all communications rooms. Coordinate all room layouts with affected trades.
    - 2) Floor plan drawings showing locations of all equipment, devices, equipment cabinets and/or rack locations. Identify type and sizes of all equipment cabinets and/or racks.
    - 3) All cable tray layouts, and conduit routing of all conduits 2 inches in diameter or greater.
    - 4) System riser diagrams and single line drawings
    - 5) Equipment wattage for each location and estimated BTU production.
    - 6) Detailed equipment layouts for all equipment consoles. Indicate all equipment locations, power connections and installation details.
    - 7) All equipment mounting hardware/brackets and installation details. Identify type size, load capacities of all mounting hardware/brackets; include all mounting and installation details, all space requirements, any special architectural modifications required.
    - 8) Outline drawings of all equipment cabinets/racks showing the relative position of all major components, all-wiring and grounding terminations. Include all panel, cabinet and/or rack dimensions.
    - 9) All grounding and bonding termination points
3. Provide a complete termination schedule of all communications device drop/outlet locations; indicate on the installation drawings all device drops/outlets’ unique identification which shall correspond with schedule and drawings.

**C. Equipment Submittals:**

- 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - a. Include all equipment data sheets pertinent to equipment provided. All data sheets shall be highlighted and annotated indicating specific equipment and options

supplied. Failure to provide the proper annotation of all equipment shall result in submittals being returned for resubmission.

2. Submit complete technical data necessary to evaluate the material and equipment. Include a complete technical specification for the submitted equipment, noting differences and adherence to this Section. Failure to provide the required data will result in all submittals being returned for resubmission.
  3. Submit performance data, equipment ratings, cable requirements, control sequences, GUI based control panels, programming matrixes, logic diagrams and all other descriptive data necessary to describe the installation and operations of the system being provided. Failure to provide the required data will result in all submittals being returned for resubmission.
  4. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price, and availability of each part.
- D. Maintenance and Operation Manuals: Submit in accordance with all requirements of Division 01 specification sections and as herein specified.
1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish in electronic format. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test and furnish the remaining manuals prior to contract completion.
  2. Inscribe the following identification on the cover: the words "Maintenance and Operations Manual", include the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subContractor installing the system or equipment and the local representatives for the system or equipment.
  3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
  4. Furnish (1) digital copy of all Maintenance and Operation Manuals in PDF format.
  5. The manuals shall include:
    - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
    - b. A control sequence describing start-up, operation, and shutdown.
    - c. Description of the function of each principal item of equipment.
    - d. Installation and maintenance instructions.
    - e. Safety precautions.
    - f. Diagrams and illustrations.
    - g. Testing methods.
    - h. Performance data.
    - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
    - j. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
  6. Approvals will be based on complete submission of manuals together with shop

drawings.

## 1.5 QUALITY ASSURANCE

- A. Integrator Qualifications: The projects' Information Communication Technology Integrator (ICTI) shall be an accredited and authorized distributor of the appropriate equipment manufacturer and shall be fully certified in the installation, testing and programming of all equipment being provided.
1. The ICTI shall be capable of providing documented successful work experience of at least three (3) facilities of equivalent size and technical requirements utilizing the proposed equipment being provided and have on staff a minimum of one full time individual that holds a current RCDD registration.
  2. Cable Installer Qualifications: The cable installation Contractor shall demonstrate not less than three (3) years' experience in the installation of structured cabling systems and shall have on staff a minimum of one full time member that holds a current BICSI level II installer credential.
    - a. NOTE: The installation of all communications cabling shall be under the direct supervision of a current BICSI level II installer who shall be knowledgeable in the following technical applications:
      - 1) The Routing and installation of shielded, unshielded, twisted pair, coaxial and fiber optic cables.
      - 2) Bonding and grounding of cable tray and equipment racks.
      - 3) Fusion splicing of fiber optic cabling.
      - 4) Testing copper conductors for electrical continuity.
      - 5) Testing and Certifying of UTP structured cabling for attenuation and worst case near end cross talk.
      - 6) Testing and Certifying of ALL fiber optic cabling employing an Optical Time Domain Reflectometer (OTDR) in accordance with TIA protocols.
      - 7) Testing and Certifying of coaxial cable networks for RF leakage
      - 8) Termination, connection, and testing of shielded and un- shielded twisted pair cable, coaxial cabling and fiber optic cabling on all specified connectors, electrical protection blocks, termination blocks and patch panels.
      - 9) Generally accepted industry standards, as well as manufacturers written installation instructions, will be used for in-process quality control and final acceptance of the work installation.
  3. Owner and the Design Professional reserve the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
    - a. Experience shall be defined as the completion of the specific system being provided, with that system being successfully operated by Owner for its intended purpose for at least three (3) years.
    - b. In addition to the above, "Experience" shall also be defined as the completion of modifications and renovations to any associated system being provided in any existing occupied facility of this size and magnitude.
    - c. For each facility submit the following:
      - 1) Name and location of facility



- 2) Date of Occupancy or beneficial use by Owner
  - 3) Construction Manager or General Contractor
  - 4) Project Architect or Engineer
  - 5) Provide information on the installed locations with operational equipment.
  - 6) Registration number and expiration date of RCDD professional
  - 7) Registration number and expiration date of Level II installer.
4. Service Qualifications: The ICTI shall be a permanent service organization maintained and/or trained by the product manufacturer on the products being provided for this project.
- a. The ICTI shall be (where required) properly licensed by the governing municipality to provide the services and work for the specific system being installed. In addition, all integrators shall be capable of providing full service for the entire warranty period within an 8-hour response time upon notification of a service emergency.
- B. Manufacturer's Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and materials specified for this project, and shall have manufactured the items for at least three years.
1. Product Qualification: The Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
    - a. The manufacturers shall submit the appropriate documentation certifying that the project ICTI is a qualified service provider of all manufacturers' products being provided for this project.

#### 1.6 RECORD DOCUMENTS

- A. In addition to all general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections include the following project requirements:
1. Provide complete set of finalized copies of record documents prior to final acceptance of the project by Owner and the Design Professional in accordance with all requirements of Division 01 specification sections. At the minimum the record documents shall contain all information, data and drawings as described in Chapter 1.4 "Submittals" of this specification section.
    - a. As-built documents shall be submitted in both paper and electronic media formats in the quantities as specified by Division 01 specification requirements.
      - 1) All electronic data sheets, control sequences, programming matrixes and other descriptive data shall be provided in PDF formatted documents.
      - 2) Copies of all current system programming and associated software shall be provided on downloadable media formatted for the use in restoration all system operations and functionality in the event of a catastrophic failure.

#### 1.7 EXTRA MATERIAL

- A. In addition to all general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections refer to related specification sections “Extra Material” for specific requirements.
- B. All Extra materials shall be provided at the time of final acceptance of the project and a signed packing list shall be obtained at the time of delivery. At no time is the Contractor to use the extra materials provided for this project to replace malfunctioning or damaged equipment and or components.
- C. Provide 5% of all material as “Extra Material.”

## **PART 2 – PRODUCTS**

### **2.1 MANUFACTURED PRODUCTS**

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, that meet and/or exceed the specified performance and features of the equipment and/or systems and for which replacement parts shall be readily available to the system integrator and/or Owner.
  - 1. When more than one unit, device, or component of the same class of equipment is required, such units, devices or components shall be the product of a single manufacturer.
  - 2. Acceptable manufacturers for each system shall be as specified and shall be provided in full compliance with the requirements of this and all related specification sections and contract drawings.
    - a. Manufacturers listed as acceptable shall not negate the Contractors’ responsibility for providing all equipment, devices, components and/or systems, in accordance with all functions and performance requirements of the Contract Documents.
    - b. Where manufacturer and/or manufacturer model numbers reference specific system components in the related specification sections, it is to establish the performance requirements and quality of the systems and components only.
      - 1) It is in no way an inference that the referenced model numbers are the manufacturer’s current product and are the only acceptable components for this project unless specifically referenced as “no substitutions.”
    - c. The Contractor shall provide the manufacturers’ most current product that shall meet and/or exceed the specified performance and features of the equipment and/or systems.
    - d. Equivalent UL-listed equipment may be substituted for the approved manufacturers unless stipulated by other specification sections as “No Substitutions.” All substitutions shall be submitted for approval by Owner and the Design Professional in accordance with all requirements of Division 01 specification sections and Chapter 1.4 “Submittals” of this specification section.
      - 1) Where systems and/or components are referenced as “no substitutions” the specific system and/or components shall be provided.
      - 2) All substitutions shall comply with all requirements as specified above and

- all system performance standards shall be maintained.
- 3) The Contractor shall stipulate the following information impacted by such a substitution.
    - a) Any and all extensions in time impacted by the substitution.
    - b) Any changes to the architectural or structural elements to the project
    - c) Differences in operation and/or performance from intended system criteria.
  - 4) Failure to provide the required substitution information shall result in “without consideration” the immediate rejection of the substituted equipment and/or systems.
- B. Equipment Assemblies and Components:
1. Components of an assembled unit need not be products of the same manufacturer.
    - a. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
    - b. Components shall be compatible with each other and with the total assembly for the intended service.
    - c. Constituent parts which are similar shall be the product of a single manufacturer.
    - d. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- C. Compatibility and Interoperability of System Components and Devices
1. Where multiple components, devices and/or systems are intended to be interconnected and components of a complete system in accordance with any related specification sections, it shall be the Contractor’s responsibility to verify interoperability and compatibility of said components, devices and/or systems in full conformance to the specified performance criteria prior to the submission of shop drawings.
  2. Where specified devices are found to be incompatible or incapable of performing as specified in a seamless manner, the Contractor shall notify the Engineer in writing prior to submission of shop drawings. Failure to properly identify such functional discrepancies shall not relieve the Contractor from providing a complete and fully functional system in accordance with the requirements of all related specification sections.
- D. Where Factory or Off-Premises Testing of any equipment, product or assembly is recommended by the product manufacturer or where specified as part of this section and/or any related specification section:
1. Owner and Design Professional shall have the option of witnessing all factory tests. The Contractor shall notify Owner and the Design Professional at a minimum of thirty (30) working days prior to the performance of any factory or off-premises tests.
    - a. Where the factory or assembly point for all off-premises testing is not within two (2) hours driving time from the project location, the system integrator shall include as part of this project all per diem costs (travel, meals, and lodging) for a minimum

of two representatives from Owner and the project Design Professional to witness all testing.

2. Provide four (4) copies of certified test reports containing all preliminary test data and testing procedures shall be furnished to Owner and the Design Professional prior to any final testing and not more than ninety (90) days after completion of any tests.
3. When equipment, product or assembly fails to meet any factory or off-premises tests, retesting of equipment, product or assembly shall be mandated, the Contractor shall be liable for all additional expenses, including all expenses incurred by Owner and the Design Professional for witnessing the retesting of any equipment, product, or assembly.

### **PART 3 – EXECUTION**

#### **3.1 EQUIPMENT PROTECTION**

- A. Protect all materials, equipment, devices, or components permanently installed and/or stored on the job site. Protect all materials, equipment, cabling, devices, or components during construction and after installation. Provide appropriate protection of all materials, equipment, components and/or devices until time of substantial completion. All materials, equipment, components and/or devices shall be protected during shipment and storage against any physical damage, dirt, moisture, cold, snow, wind, or rain:
  1. During installation, enclosures, racks/cabinets, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of any foreign matter; and shall be vacuum cleaned both inside and outside before testing and operating and repainting if required.
  2. Any materials, equipment, components and/or devices, stored on site, which have been deemed by Owner or the Design Professional to exhibit any indications of damage or exposure dust or moisture shall not be installed and shall returned to the source of supply for immediate replacement.
    - a. The use of spare parts or the return of defective equipment for repair to mitigate the damage of defective materials, equipment, components and/or devices shall not be acceptable. All materials, equipment, components and/or devices shall be new and unused until final acceptance by the Design Professional.
  3. Provide and apply protective material immediately upon receiving the products and maintain throughout the construction process.
    - a. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
    - b. Any damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired area is not obvious or detectable.
  4. Failure to properly protect all materials, equipment, components and/or devices prior to final acceptance shall constitute sufficient cause for rejection of materials, equipment, components and/or devices should any defects, damage or degradation in performance is observed.

- B. Seismic Performance: All equipment, bracing, and anchoring shall be rated for the seismic zone of the geographical area in which the project resides and shall withstand the effects of earthquake motion and wind forces in accordance with the current editions of the IBC and ASCE/SEI 7. Refer to Division 01 and Division 26 – Hangers and Supports for additional seismic information and requirements.
  - 1. Equipment shall include, but not be limited to, racks/cabinets, cable/basket/ladder tray, conduit, cameras, and all appurtenances.
- C. Immediately replace all malfunctioning materials, equipment, components and/or devices with new unused products up until the time the Design Professional issues final acceptance of the system. The returning of any malfunctioning equipment, devices and/or components to the manufacturer for repair and then reinstallation at the project site shall not be acceptable.
  - 1. All replacement materials, equipment, components and/or devices shall be factory new and not scavenged from the Project's spare parts inventory or factory recycled products unless expressly identified by Contractor prior to replacement and approved beforehand by the Design Professional.

### 3.2 WORK PERFORMANCE

- A. Installation, final termination, testing, start-up and commissioning of all systems, system components and cabling infrastructures shall be under the direct supervision of the appropriate system integrator. The integrator shall be an accredited and authorized distributor of the appropriate equipment manufacturer and shall be fully certified in the installation, testing, commissioning, and programming of all equipment, devices, components and/or systems being provided as part of this project.
- B. Job site safety and worker safety is the responsibility of the Contractor. Ensure that safe access and egress from all work areas is maintained during movement and installation of materials. Clean up all debris generated by installation activities. Keep all communication equipment rooms free of debris at all times.
- C. Pre-installation Conferences: Include provisions to attend all pre- installation conferences at Project site in compliance with all requirements in Division 01 specification section and as herein specified. Review methods and procedures related to installation and operations of all communications systems, including, but not limited to, the following:
  - 1. Inspect and discuss electrical and equipment roughing-in related to all communications systems as well as other preparatory work required to be performed by other trades.
  - 2. Review and discuss all work, equipment deliveries, installation procedures and related scopes as required to conform to the phased construction schedule.
  - 3. Review sequence of operations for each type of system, control, cabling and/or integration to any systems and/or equipment provided by other trades
  - 4. Review and finalize construction schedule and verify availability of materials, installation personnel, equipment, and any preparatory work by other trades needed to make progress and avoid delays.
  - 5. Review required start-up, testing, commissioning, and certifying procedures to be employed for each system and any impacts to other trades.
- D. For work on existing facilities, arrange, phase, and perform work to assure the operation of all

communications systems for other buildings and contiguous spaces at all times. Refer to Division 01 specification section for additional information.

- E. All new work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Division 01 specification sections.
  - F. Coordinate the installation of all cabling, conduits/raceways and cable trays and equipment with applicable trades to ensure proper operation and function of all integrated systems in accordance with all related specification sections. Refer to Division 01 specification section for additional project coordination requirements.
    - 1. Coordinate with all trades at the time of shop drawing submission detailing all space and/or room conditions. The Contractor shall coordinate with the appropriate trade all conditions impacting the installation of any system, conduit or cable tray including but not limited to all equipment locations, site conditions, ceilings, lighting fixtures, fire protection piping and ductwork layouts to the satisfaction of all concerned trades, subject to final review by the Design Professional.
      - a. Coordinate exact location of all desktop/counter/wall mounted equipment with Owner, the Design Professional, and all affected trades prior to the installation of any equipment and/or cabling.
      - b. Coordinate exact location(s) of all cable, conduits, equipment and/or devices installations with all architectural plans, site plans, reflected ceiling plans and affected trades prior to installation.
        - 1) Equipment installations requiring coordination with other trades the Contractor shall provide all templates, back- boxes and equipment anchor bolts for mounting or flush mounting preparation, (e.g., pedestals or other devices requiring mounting on walls, concrete pads, or other materials). Coordinate delivery of templates and equipment anchor bolts to preclude any delay in the construction schedule or the work of the affected trade.
      - c. If installation of equipment, devices, cabling, raceways, cable trays and/or conduit is performed prior to coordination with other trades, which interferes with work of other trades or operation and maintenance of the facility, make necessary changes to correct the condition at no additional cost to Owner.
      - d. Prior to the final programming of any systems review with Owner and the Design Professional all system features, functions, system operations, network mapping, system integrated responses and all related programming as required for the proper operation of the respective communications systems.
- 3.3 The Contractor shall maintain a complete set of current and up to date set of shop drawings and equipment submissions at the job site at all times. The Shop drawings and all other submissions shall be marked up to reflect all as-built conditions and shall be made available for review by the Design Professional at request.
- 3.4 EQUIPMENT INSTALLATION AND REQUIREMENTS
- A. All system equipment installations shall be in accordance with good engineering practices,

NEC, local building codes, and all manufacturer's requirements. Cable terminations at all equipment locations shall comply with all state and local electrical codes. All wiring shall test free from all grounds, shorts, stray voltages, and EMI.

- B. Follow manufacturers' instructions for installing, components and adjusting all equipment and cabling. Submit one (1) copy of such instructions to Owner and the Design Professional before installing any equipment. Provide an additional copy of such instructions at the equipment during any work on the equipment. Where no instructions are included with the equipment, follow accepted industry practices and workmanlike installation standards.
- C. Equipment location shall be as close as practical to locations as indicated on the contract drawings.
  - 1. Provide all equipment clearances in accordance with NEC requirements. Arrange equipment to facilitate unrestricted access for maintenance and service around all equipment, components and/or cable terminations.
- D. Inaccessible Equipment:
  - 1. Where Owner and the Design Professional determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the project.
    - a. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

### 3.5 COMMUNICATIONS CABLING REQUIREMENTS

- A. Cabling shall be sized to support the appropriate communication system. All communications cable installations shall be in accordance with good engineering practices as established by the IEEE and the NEC. All cabling shall meet all state and local electrical codes.
  - 1. Contractors shall have the option to combine all cable home runs and conductors of same type and voltage "class" in accordance with NEC requirements unless specified elsewhere. Size all conduits and install all conductors in accordance with NEC requirements and manufacturers recommendations.
    - a. All communications cabling located above inaccessible ceilings, exposed ceilings, areas outside of tenant spaces shall be installed in conduit and routed to nearest cable tray or J-hook system in accessible ceiling areas.
    - b. All conduit shall run parallel and perpendicular to building column lines.
    - c. Cabling installed above hard ceiling spaces shall be installed in dedicated conduits.
    - d. No exposed cabling will be acceptable in finished or occupied spaces of the facility without approval by Owner and the Design Professional.
    - e. Any communications system cabling installed exterior to the building and/or all cabling being routed from the facility to any remote location external to the project location shall utilize OSP rated fiber optic cable installed in conduit system.

2. Do not install bruised, kinked, scored, deformed, abraded, or otherwise damaged cable. Do not splice cable between indicated terminations, taps, or junction points. Remove and discard cable where damaged during installation and replace it with new cable.
3. Ensure that all communications cabling supports (conduits, support grips, cable trays and cable termination panels) are fully installed before proceeding with cable installation.
4. At no time shall any cables be installed and left unsupported, nor shall cables be tie-wrapped to any other supporting structure in lieu of specified cable supports. Do not tie-wrap or permanently affix cable bundles to approved cable supports.
  - a. NOTE: Cable bundles shall not be cinched too tightly; all cable ties shall be hook-and-loop tie-wraps only.
5. The Contractor shall not permit any communications cabling to lie unprotected on the floor at any time. If cables must be left on any floor, protect the cables so that they may not be walked on or have any material or equipment placed or rolled on top. Replace all damaged cables from demarcation to termination point; no splicing of damaged cables shall be permitted.
6. Maintain manufacturers recommended minimum bend radii of all cabling. Do not stretch, stress, tightly coil, bend or crimp cables. The Contractor shall keep all cabling out of the way of other trades during staging of any work. The Contractor at the Contractor's expense will replace all severely stressed or damaged cables, equipment, and materials as determined by Owner and the Design Professional.

**B. Unshielded Twisted Pair (UTP) Cable**

1. Refer to specification section 271100 for material.
2. All data TCP/IP based copper network cabling shall be concealed above suspended ceilings, bundled, and independently supported to the building structure. All cabling bundles shall be plenum rated and shall not contain any AC carrying conductors or non-associated network cables.
  - a. All cabling shall be terminated onto patch panels matching the rating of the cable and installed in the 19" equipment racks/cabinets.
  - b. Copper station cabling may be run outside of conduits and above suspended ceilings only between the cable tray and the conduit wall stub-up.
  - c. All horizontal and backbone cable installed above accessible ceilings shall be installed on J-hooks, cable trays, dedicated conduits, or in cable chases and/or a combination thereof as indicated contract drawing or specified. In no case shall cable be supported on ceiling tiles, T-bars, or tie-wrapped to any conduit or pipes.
    - 1) Cables shall not be cinched too tightly; cable ties shall be hook and loop tie-wraps only. Plastic wire ties shall not be accepted on any cabling.
    - 2) Horizontal network cabling shall not exceed a maximum distance of 295 feet from the associated communications room termination point to the furthestmost work area outlet termination point.
    - 3) Cable Support: Properly secure independently to the permanent building structure where not installed in raceway. Provide J-hooks at regular intervals appropriate to the cable and wire size. See drawing details for spacing requirements.
    - 4) Cables shall not lay loose on ceiling tiles or grids. Cables must be supported



in all areas. Bridle rings and tie-wrapped supporting methods are not acceptable.

- 5) Install all cabling parallel to building lines and follow building structure. Use cable support equipment/hardware recommended by the manufacturer and/or as herein specified.
- 6) Provide all terminations, cross-connects, wire management, surge protectors, etc. For a complete and operational system.
- 7) Any copper data communications system cabling installed exterior to the building and/or all cabling being routed from the facility to any remote location external to the project location shall be outside rated (OSP), unless specified otherwise. Outside plant cable shall not extend more than fifty (50) feet into a building interior before terminating on surge protection and transitioning to indoor plenum cable.

**C. Fiber Optic Cabling**

1. Refer to specification section 271100 for material.
2. All fiber optic cabling shall be provided to meet the communications requirements for all network communications systems, at the minimum all fiber optic cabling shall be sized in accordance with the project documents.
3. All fiber optic cable connectors, terminations and patch panel ports shall be SC/APC-type.
4. All fiber optic cabling shall be a continuous segment from demarcation to termination point. Splices shall not be permitted except at transition points and for termination purposes.
5. All fiber optic cabling shall be installed above accessible ceilings wherever possible.
6. All fiber not installed in conduit or innerduct shall be supported to the building structure and shall be plenum rated armored type cabling installed on J-hooks or in cable trays or shall be standard type fiber optic cable which shall be installed in dedicated conduits.
7. Installation of all fiber optic cabling shall be in accordance with all guidelines established by the product manufacturer and all referenced industry standards.
8. Where fiber cable segments are installed in conduits, special care shall be taken to avoid damage to the cable.
  - a. While under pulling tension, the cable shall not be bent into a curve with a radius of less than twenty (20) times the cable diameter, or no less than manufacturers minimum.
  - b. Pulling tension shall not exceed manufacturer's recommended maximum tensile load. Contractor shall utilize a winch with tension control, or a "break-away" link designed to break away at or below the recommended maximum pulling tension.
  - c. Use methods and lubricating compounds on cables and wires to prevent damage to material and products during pulling-in. Provide compounds that are not injurious to the cable and wire jackets that do not harden or become adhesive.
9. J-hooks supporting fiber optic cabling shall not exceed a maximum of 2 armored fiber cables per 2" J-hook, or 4 per 4" J-hook.
10. Provide a minimum of twenty (20) feet of slack at each end of each fiber optic cable install. Slack shall be neatly bundled in a "figure-8" style loop mechanically secured independent of other systems.
11. All exterior fiber optic cabling shall be rated for exterior outside plant (OSP) applications

and installed in dedicated inner-duct conduit system and routed in the exterior conduit ducts in accordance with the requirements of the contract documents. Outside plant cable shall not extend more than fifty (50) feet into a building interior before terminating and transitioning to plenum indoor fiber optic cable.

12. Fiber optic cabling shall be provided as the primary media for any exterior network components installed remote to building, as well as all network communications links for all backbone communications.
  - a. The Contractor shall be responsible for the determination of actual segment lengths. Actual quantities will be calculated by the routing as indicated on the contract drawings and/or in the field based on existing conditions.
13. All splices shall be fusion type. Mechanical splices shall not be acceptable except for termination purposes.
14. Refer to related specification sections for additional information related to cabling types, sizes, and testing requirements.

**D. Environmental Conditions:**

1. Systems, components, devices materials and equipment shall be capable of withstanding the environmental conditions of the space without mechanical or electrical damage or degradation of operating capabilities or performance.
  - a. Interior, Controlled Environment: System components, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 2 to 50 deg C (36 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing and shall utilize NEMA 250, Type 1 enclosures.
  - b. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of -18 to 50 deg C (0 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing and shall utilize NEMA 250, Type 4X enclosures.
  - c. Exterior Environment: System components, conduits and back boxes installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of -34 to 50 deg C (-30 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, condensing. Rated for continuous operation where exposed to rain as specified in NEMA 250, winds up to 137 km/h (85 mph) and snow cover up to 610 mm (24 in) thick shall utilize NEMA 250, Type 4X enclosures.
  - d. Hazardous Environment: System components, conduits and back boxes located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
  - e. Corrosive Environment: System components, conduits and back boxes subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, shall utilize NEMA 250, Type 4X enclosures.
  - f. Submersible Environment: System components, conduits and back-boxes subjected to prolonged submersion in water, shall utilize NEMA 250, Type 6P enclosures.
  - g. Areas where equipment and devices may be subject to damage by the general population shall be installed in vandal resistant enclosures; all fire alarm system and related devices shall be provided with wire guards.
  - h. Console: All console equipment shall, unless noted otherwise, be rated for

continuous operation under ambient environmental conditions of 15.6 to 29.4 deg C (60 to 85 deg F) and a relative humidity of 20 to 80 percent.

**E. Conduits/Raceway/Cable Trays:**

1. Provide conduit and raceway systems for all communications networks as indicated below. Refer to all related specification sections for additional conduit and raceway information.
  - a. Accessible suspended ceilings: Provide conduit stub-up from each outlet location to space above ceiling. All conduit stub-up shall include nylon bushing at exposed edge of conduit for protection of all cabling.
  - b. Exposed structure: Provide conduit run from each drop to a height of 12 feet to cable tray or J-hooks where provided.
  - c. Vertical Wire runway shall be installed in dedicated conduits and shall be supported any/all risers between floors in closets or accessible locations; in no case shall any cable risers be unsupported.
  - d. Cables entering all communications equipment rooms shall be supported with Cable tray from entrance to rack/cabinet location as indicated on the contract drawings and/or herein specified.
  - e. Wire basket cable tray system shall be provided in all corridors as indicated on the contract drawings and installed as herein specified.
2. All conduits/raceways shall be concealed and shall be installed above accessible finished ceilings and/or in walls. Any conduits/raceways installed in areas requiring installation to be exposed, shall be installed tight to ceilings and at right angles to walls/building lines and shall not obstruct any access hatches, equipment service panels, lighting or other equipment and/or devices. No exposed conduits/raceways shall be installed without prior approval of Owner and the Design Professional.
  - a. Where conduits cannot be concealed above ceilings or in walls and must be installed in finished or occupied areas of the building, all conduits shall be finished wire-mold type raceways or approved equal. Finished wire-mold type raceways shall not be installed without prior approval in writing by Owner and the Design Professional.
  - b. Where any equipment and/or junction boxes are installed above non-accessible finished ceilings, the Contractor shall provide access hatches listed for the intended application. Access hatches shall be located so that service access to the equipment and/or junction boxes is unimpeded.
    - 1) Access hatches shall not obstruct any equipment, service panels, lighting equipment, devices, or any architectural elements of the ceiling. At the time of submittals, the Contractor shall submit all proposed access hatch locations for review by the Design Professional.
  - c. All conduits/raceways shall be supported in accordance with NEC requirements and shall be affixed in such a manner that tampering and/or removal without the use of specialized tools shall be prevented.
  - d. All conduits/raceways shall be installed in a manner that prevents tampering or removal when installed in areas exposed to the general population.

- 1) Provide tamper-resistant installation utilizing “torx with peg” security-fastening devices for all conduits/raceways, equipment, devices, and appurtenances in all areas accessible to the general population and/or areas subjected to tampering or vandalism.
- e. Interior raceways shall be a minimum 1 inch unless otherwise noted. Exterior raceways shall be a minimum 1 1/4-inch. Size all raceways and install conductors in accordance with NEC requirements. Fill ratio shall not exceed 40 percent for indoor or exterior raceways.
  - 1) EMT conduit with compression fittings and/or MC cabling may be utilized in all inaccessible ceiling areas unless otherwise restricted by code.
  - 2) Threaded Rigid metal conduit shall be used on all exterior applications, stub-ups and all interior areas where concealed conduit requirements cannot be met and are exposed to tampering or damage by the general population.
    - a) All areas considered being of high risk due to the nature of the occupancy or the need to protect and maintain the integrity of the cabling shall be installed in rigid threaded conduits.
- f. Conduits shall be continuous. Conduit runs shall not exceed two (2) 90 degree bends and/or 100 feet without a pull/junction box.
- g. All conduits and pull/junction boxes shall be concealed in walls or ceilings unless otherwise noted.
- h. Conduits shall be connected to pull/junction boxes with set screw connectors and nylon screw on bushings.
- i. Conduit inside bend radius for 2” conduits or less shall be 6 times the internal diameter. Conduit inside bend radius for sizes over 2” shall be 10 times the internal diameter. The use of condulets (lb’s) is prohibited.
- j. Pull/junction boxes shall not be used in lieu of a bend.
- k. Firestop all annular space around conduits at through-wall and through-floor penetrations match the rating of the penetrated wall and floor.
- l. Field coordinate installation and exact placement with all trades.
- m. Conduit expansion couplings shall be provided in all areas where expansion/contraction may occur to couple together two sections of a conduit run subject to longitudinal movement. The Contractor shall refer to architectural drawings for exact locations of all building expansion joints. Conduit expansion couplings shall be consistent with the size the conduit being installed, shall be steel electrogalvanized, and shall meet all environmental and seismic conditions.
  - 1) Expansion couplings shall be weatherproof and approved for use indoors or outdoors without an external bonding jumper.
  - 2) Expansion couplings shall be UL Listed and approved for use in wet locations.
  - 3) Expansion couplings shall comply with UL 514B, CSA 22.2 No. 18 3-12, NEMA FB1.
- n. Exterior raceways: PVC schedule 40 conduit at the minimum shall be utilized in all underground applications unless otherwise specified by related specification sections. The conduit shall be buried at a minimum 36” below grade. Warning

flagging tape shall be buried 12" below grade to indicate the conduit routing location. Refer to related specification sections for additional information.

- 1) All exterior conduits larger than 2" in diameter shall be provided with dedicated inner-duct conduit systems, segregated by network type (i.e. security, etc.) and shall include a minimum of one spare empty inner-duct per conduit.
  - 2) The Contractor shall have the option to utilize the same trench/routing location as other utilities. In no case shall any system conduits or duct banks be combined with other electrical utilities without providing the required separation between conduits as necessary to ensure the minimal transmission or conduction of any RF and/or EMI signals.
- o. Outlet Boxes: shall be 4 x 4 x 2-1/8 inches deep with single gang reducer plate where required for all data outlet locations and single gang for wall-mounted telephone locations.
    - 1) All outlet boxes shall be provided with single or dual gang device mud-rings flush to finished wall as required based on type and configuration of outlet and type of wall construction.
    - 2) Use deep masonry boxes at masonry construction. T-Bar hangers or other appropriate mounting hardware shall be utilized to support boxes mounted in the ceiling.
3. Cable Trays (Communications Rooms): Provide cable trays in all communications rooms and closets for routing horizontal and vertical distribution and backbone communications cables. All cable trays shall be constructed of aluminum with two side rails and 9" rung spacing. Cable tray shall be complete with all materials, miscellaneous hardware and all appurtenances required for a complete cable distribution and support system.
  - a. All cable tray widths shall be sized according to the total number of cables to be supported within the various trays plus an additional 100% spare capacity for future expansion capability. At the minimum all cable trays installed in communications rooms and closets shall be a minimum of 12" wide by 1.25" deep, unless otherwise noted.
  - b. Install cable tray in a manner ensuring that all circuits fully comply with all ANSI/TIA standards.
    - 1) Maintain a minimum clearance of 24" between top of cable tray and ceiling structure or other equipment or raceway.
    - 2) Maintain a minimum clearance of 12" between bottom of cable tray and top ceiling grid or other equipment or raceway.
    - 3) Maintain a minimum clearance of 24" from all conduits or cables used for electrical power distribution.
    - 4) Maintain a minimum clearance of 12" between bottom of cable tray and top of equipment racks and/or cabinets.
    - 5) Maintain a minimum clearance of 24" from fluorescent lighting. All Pathways shall cross perpendicular to fluorescent lighting and electrical power cables or conduits.
    - 6) Cable tray supports shall be attached to the structural ceiling or walls with hardware or other installation and support aids specifically designed for the cable tray and designed to support the cable tray's weight and required cable

- weight and volume.
  - 7) Do not attach cable tray supports to ceiling support system or other mechanical support systems.
  - 8) Load span criteria: Install tray supports in accordance with the load criteria of L/240.
  - 9) Cable Trays shall be supported at 5-foot intervals.
  - 10) All Cable trays shall be installed without burrs, sharp edges, or projections, which may damage cable insulation.
  - 11) All lengths or sections of cable tray shall be bonded and grounded in accordance with NEC, TIA, IEEE.
- c. Follow manufacturers' instructions for installing, components and adjusting all equipment and cabling. Submit two (2) copies of such instructions to the Architect before installing any equipment. Provide a copy of such instructions at the equipment during any work on the equipment. Where no instructions are included with the equipment, follow accepted industry practices and workmanlike installation standards.

F. Penetrations of Walls and Floors:

1. All wall/floor penetrations are to be sleeved and fire stopped with approved fire stopping material or sealant as applicable for the type of penetration. Coordinate all cable and conduit penetrations of building with all affected trades. Refer to all related specification sections for additional wall/floor penetration requirements.
  - a. All penetrations of rated walls and floors shall be firestopped in accordance with the ASTM and NFPA standards. Refer to related specification sections for additional information.
  - b. Floor penetrations shall be sleeved with a minimum sleeve diameter of 4 inches. An additional penetration shall be provided for future use, sleeved, and capped and fire stopped as required.
  - c. Coordinate size of wall penetration with conduit size, number of conductors. Comply with all NEC requirements.
  - d. The fire rating of all penetrated walls, floors, and ceiling structures shall be strictly maintained. All penetrations shall be firestopped and sealed by the Contractor.
  - e. Install firestopping in open penetrations and in the annular space of penetrations for fire-rated barriers.
  - f. Installation of firestops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
  - g. Installation of all firestopping shall be in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and shall be installed in a manner acceptable to the authority having jurisdiction.

3.6 ELECTRICAL POWER DISTRIBUTION

- A. Refer to division 26 contract documents for circuiting information.

- B. Refer to specification section 271100 for UPS and PDU material.

### 3.7 TRANSIENT VOLTAGE SUPPRESSION

- A. Transient Voltage Surge Suppression: All cables and conductors extending beyond building façade, except nonconductive fiber optic cables, which serve as communications, control, or signaling circuits shall be protected against Transient Voltage surges and have Transient Voltage Surge Suppression (TVSS) protection.
1. The TVSS device shall be UL listed in accordance with Standard TIA 497B installed at each end. Lighting and surge suppression shall be a multi-strike variety and include a fault indicator.
  2. Protection shall be furnished at the equipment and additional triple solid state surge protectors rated for the application on each wire line circuit shall be installed within 914.4 mm (3 ft) of the building cable entrance. Fuses shall not be acceptable for surge protection applications. All inputs and outputs shall be tested in both normal mode and common mode to verify there is no interference at the minimum surge suppression test shall meet the following criteria.
    - a. All system power supplies serving exterior system components or devices shall be provided with the appropriate transient surge suppression protection on both the line side as well as the load side.
      - 1) A 10-microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes shall be the minimum performance requirements. Provide surge suppression in accordance with all manufacturers' requirements.
      - 2) An 8-microsecond rise time by 20-microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes shall be the minimum performance requirements. Provide surge suppression in accordance with all manufacturers' requirements.
      - 3) Maximum series current: 2 AMPS. Provide units manufactured by Advanced Protection Technologies, model # TE/FA 10B or TE/FA 20B or approved equal.
      - 4) Operating Temperature and Humidity: -40 to 85 degrees C (-40 to 185 degrees) shall be the minimum performance requirements. Provide surge suppression in accordance with all manufacturers' requirements.

### 3.8 GROUNDING AND BONDING

- A. All electronic equipment, conduits, cable trays, racks/cabinets and cable shields shall be properly grounded and bonded in accordance with all requirements of EIA/TIA 607-A, NEC 250 and IEEE 1100. Where identified as applicable to the project, all equipment grounding and bonding shall be in accordance with all related specification sections and Motorola R56 Standards and Guidelines for Communications Sites.
1. A Telecommunications Grounding System shall be installed in all communications equipment rooms. Grounding system shall provide equalization of the grounding potentials between the building power system and the telecommunications main grounding bus-bar (TMGB) as well as all telecommunications grounding bus-bars (TGB). Grounding bus-bar

shall provide the diversion of electrical transients from the telecommunications cables and to provide a safety ground for all equipment racks/cabinets, conduits, cable trays and cable shields as well as providing the required coupling to cancel and/or reduce transients.

- a. The TMGB and each TGB shall be provided where indicated on the drawings and shall provide an effective bonding connection to the nearest approved building grounding electrode (e.g., structural steel) as well as to the local power distribution panel grounding system (e.g., ac branch circuit panel board's equipment grounding busbar).
  - 1) The minimum bonding shall be #6 AWG copper conductor connected to the TMGB and all TGB's. Connections shall be 2-hole NEMA type compression or exothermic welded connections.
2. All grounding connections shall provide the equalization of all grounding potentials between the building power system and the grounding terminations at the communications equipment in order to provide the diversion of electrical transients as well as providing the necessary coupling in order to cancel and/or reduce any voltage transients.
  - a. Equipment Grounding: Metallic structures, equipment racks, cabinets, and enclosures as well as all raceways, cable trays, junction boxes, outlet boxes, machine frames, and other conductive items shall be bonded and grounded.
  - b. Duct Banks and Manholes: Provide an insulated equipment grounding conductor in each duct containing any voltage conductors, sized per NEC except that minimum size shall be No. 2 AWG. Bond the equipment grounding conductors to the grounding bus, to all manhole hardware and ground rods, to the cable shielding grounding provisions for all cable splices, terminations, and equipment enclosures.
  - c. Metallic Fences equipped with communications equipment: Fences shall be grounded with a ground rod at each fixed gate post and at each corner post.
    - 1) Drive ground rods until the top is 300 mm (12 inches) below grade. Attach a No. 4 AWG copper conductor, by exothermic weld to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 300 mm (12 inches) of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond wire to fence.
    - 2) Each gate section shall be bonded to its gatepost by a 3 by 25 mm (1/8 by one inch) flexible braided copper strap and ground post clamps. Clamps shall be of the anti- electrolysis type.
3. All connections of grounding conductors to ground rods, bus bars, rebar, structural members, pipes, and fences, as well as splices of any ground conductors, shall be made by exothermic welds except where otherwise noted. All connections to bar lugs shall be exothermic weld or compression type connections. Bolted type connection of ground conductors may only be made where terminal lugs or blocks have been furnished and installed in equipment by the manufacturer.
  - a. Equipment grounding conductors shall be insulated stranded copper, except for sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be permitted to be identified per the NEC.



- 1) At the minimum bonding connection shall be a #6 AWG copper conductor. All grounding shall provide an effective bonding connection between the protected equipment to the nearest approved building grounding electrode (structural steel) as well as to the local power distribution panel grounding system (e.g., ac branch circuit panel board's equipment grounding busbar). All bonding and grounding connections shall be NEMA type compression or exothermic welded connections.
4. Refer to related specification sections for any additional grounding and bonding requirements.

### 3.9 EQUIPMENT IDENTIFICATION

- A. Identify all system controls, components and equipment cabinets using plastic laminate engraved ("limacoid") labels or approved equal. Firmly affix to the panel, device and/or component. Refer to all related specification sections for additional information.
  1. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item or where other method of identification is herein specified. Dymo or Kroy tape adhesive-backed lettering shall not be acceptable.
  2. Color-code all junction boxes and enclosures per NEC recommendations. At the minimum provide all communications junction boxes as follows:
    - a. Color for Data/Telecommunications circuits - Yellow.
    - b. Color for Audio/Visual circuits – White
    - c. Letter all pull boxes and junction boxes located in service areas, tunnels, above accessible ceilings, and pipe chases with laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws.
  3. Permanently label all cabling at both ends with self-adhering plastic labels.
    - a. Labeling: hand-written labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or type written onto adhesive labels. The font shall be at least one-eighth inch (1/8") in height, block characters, and legible.
      - 1) The text shall be of a color contrasting with the label such that it may be easily read. If labeling tape is utilized, the width of the tape shall not exceed 3/8," and the font color shall contrast with the background.
      - 2) All data patch panels shall exhibit data drop numbers, in sequential order, for all workstations served by the associated network equipment.
      - 3) Each fiber optic cable segment shall be labeled at each end with its respective communications network identifier.
      - 4) Warning Tags: At each location where the fiber cable is exposed to human intrusion, it shall be marked with warning tags. These tags shall be yellow or orange in color and shall contain the warning: "CAUTION FIBER OPTIC CABLE." The text shall be permanent, black, block characters, and at least 3/16" high.

- a) A warning tag shall be permanently affixed to each exposed cable or bundle of cables, at intervals of not more than five (5) feet. Any section of exposed cable which is less than five (5) feet in length shall have at least one warning tag affixed to it.
4. Provide typewritten circuit directories installed in 3-ring binders with transparent page protectors in each control and sub control cabinet and/or equipment rack.

### 3.10 WARRANTY

- A. Warrant material and workmanship for a period as specified in Division 1 of the contract documents and all related specification sections. The warranty period shall commence from the date the Contactor received written notification of final acceptance from Owner. At the minimum the Contractor shall provide warranty provisions:
  1. Warrant the replacement of defective components/materials and/or correct defective work when given notice by Owner during the warranty period.
    - a. At no time is the Contractor to use the extra materials provided under the scope of this project to replace malfunctioning or damaged equipment and or components. The Contractor shall replace all malfunctioning or damaged equipment and or components with new. The repair and then reinstallation of malfunctioning or damaged equipment shall not be acceptable.
  2. Warranty excludes liability for consequential incidental, or special damages due to vandalism, misuse, or acts of God.
  3. On-site warranty response time by qualified technician shall be within 8 hours upon receipt of request from Owner.
  4. Warranty repairs shall be provided to Owner at no cost. This shall include but not limited to replacement of all defective components/materials, all labor charges, all travel costs, and all vehicle charges.
  5. Response time shall be 7 days a week / 24 hours a day / 365 days a Year.
  6. Provide test, inspection, and service of each system on a semi-annual basis at six month intervals.
  7. Contractor must provide verification that they maintain their principle base of operation along with the personnel that will be responsible for providing service within 3 hours driving time to the project site. This tenet of the warranty shall remain in effect for the life of the warranty.
  8. All TCP/IP based communications systems cabling, and related appurtenances shall be provided with the manufacturers 25 year extended warranty in addition to all requirements above.
- B. The Contractor shall, as a condition of final payment, execute a written warranty certifying all contract requirements have been completed according to all requirements of the Contract Documents.
  1. All system testing, commissioning, demonstration, and training shall be performed prior to final system acceptance. All defects or damages due to faulty materials or workmanship shall be replaced without delay, to the satisfaction of Owner, at the Contractor's expense.
    - a. The Contractor shall provide written documentation of test results and stating what

was done to correct any deficiencies. The first inspection shall occur 90 calendar days after the acceptance date. The last inspection shall occur 30 calendar days prior to the end of the warranty.

- b. The warranty period shall be extended until the last inspection and associated corrective actions are complete. Where any equipment and/or labor covered by Contractor's or manufacturer's warranty, has been replaced, due to failure, the warranty period for any replaced equipment or restored work shall be reinstated for a period equal to the original warranty period, and commencing with the date of completion of the replacement or restoration work.
2. In the event any manufacturer customarily provides a warranty period greater than one (1) year, the Contractor's warranty shall be for the same duration for that component.

### **3.11 FIELD SERVICES AND TESTING**

- A. Notify Owner and the Design professional in writing, prior to the closing of any ceilings and ten (10) days advance of testing all system cabling to prevent delays in construction schedules.

1. Test all cabling to confirm that no grounds, shorts, sneak currents, RFI and EMI conditions exist prior to start-up and commissioning of all, components, devices, equipment and/or systems.
  - a. Before requesting a final inspection, the Contractor shall perform a series of end to end installation performance tests. The Contractor shall submit for approval by the Project Engineer and Design Professional all test procedures to be employed, test result forms, and timetable for testing all fiber optic and structured copper wiring.
  - b. Acceptance of the simple test procedures discussed below is predicated on the Contractor's use of the recommended products including but not limited to, fiber optic cable, category structured cable, cross-connect blocks, patch panels, and outlet devices specified and adherence to the inspection requirements and practices set forth. Acceptance of the completed installation will be evaluated in the context of each of these factors.

- B. Balanced Twisted Pair Cable Testing

1. Minimum Test Parameter requirements for Category horizontal cabling.
  - a. Each wire/pair shall be tested at both ends for the following utilizing Contractor generated test results forms:
    - 1) Wire Map.
    - 2) Length.
    - 3) Insertion Loss.
    - 4) Near-end crosstalk (NEXT) loss.
    - 5) Power sum near-end crosstalk (PSNEXT).
    - 6) Equal-level far-end crosstalk (ELFEXT).
    - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
    - 8) Return loss.
    - 9) Propagation delay.
    - 10) Delay Skew.
    - 11) Power Sum ACR.

- b. All balanced twisted pair cable testing described herein shall exceed specified cabling transmission requirements of ANSI/TIA-568-C.
2. When errors are found, the source of each error shall be determined, corrected, and the cable re-tested. All defective components shall be replaced and retested. Defective components not corrected shall be reported to Owner and the Design professional with explanations of the corrective actions attempted.
3. Test records shall be maintained using the approved test result forms. The form shall record closet number, riser pair number or outlet ID, outcome of test, indication of errors found (e.g., a, b, c, d, or e) cable length, re-test results after problem resolution and signature of the technician completing the tests.
4. Test results for each cable must be submitted with identification to match labels on all patch panel ports and 8 position modular jacks, and identification to match as-built drawings associated with that cable.
5. Owner and the Design Professional shall observe and verify the accuracy of test results submitted.
6. Contractor shall submit both hardcopy printouts and electronic copy of all trace test results.

**C. Fiber Optic Testing**

1. Contractor shall test each fiber strand. Owner and the Design Professional reserve the right to have a representative present during all or a portion of the testing process. If Owner and the Design Professional elect to be present during testing, test results will only be acceptable when conducted in the presence of Owner and the Design Professional.
2. Fiber optic cable: each fiber strand shall undergo bi-directional testing for signal attenuation losses.
  - a. Test Equipment
    - 1) Optical Power Meter (OPM)
    - 2) Optical Time-Domain Reflectometer (OTDR)
  - b. Tests:
    - 1) All fiber strands shall be tested for attenuation using an Optical Power Meter in both directions at 1310 nm and 1550 nm.
    - 2) Test all fiber cable on the reel before installation, with a light source and an OTDR if necessary, to ensure fiber continuity and no factory defects.
3. Fiber Optic Testing Specifications
  - a. All testing shall be performed by factory trained and certified personnel.
  - b. For all installed fiber optic cable EIA 455-171 Method D procedures will be adhered to (Bi-directionally).
  - c. Loss Limits:
    - 1) Connector loss shall not exceed 0.5 dB per connector pair
    - 2) Cable loss shall not exceed 1.0 dB per kilometer tested at 1310 nm and 1550 nm for premises/inside plant single mode fiber optic cable.
    - 3) Cable loss shall not exceed 0.5 dB per kilometer tested at 1310 nm and 1550

- nm for outside plant single mode fiber optic cable.
    - 4) Fiber optic cable tests shall meet all other requirements as specified in TIA 568.C.
  - d. The Contractor is responsible for obtaining minimum loss in fiber connections.
  - e. Pre-installation tests of Inter-plant fiber: pre-test each reel:
    - 1) Test each fiber strand of each reel for continuity with a light source.
    - 2) If a problem is found, test with an OTDR to determine the nature and location of the defect: Measure end-to end attenuation and the distance to a high attenuation point.
    - 3) If it is determined by Design Professional that the fiber is defective the Contractor shall contact the manufacturer and provide a completely new fiber reel.
  - f. Tests for installed Inter-plant and Intra-plant fiber optic cable:
    - 1) Intra-plant and Inter-plant Single-mode: Bi-directional signal attenuation at 1310 and 1550 nm power meter.
    - 2) Inter-plant Single-mode: Bi-directional OTDR trace at 1310 and 1550 nm.  
OSP ONLY

NOTE: Obtain the actual index of refraction from the cable Manufacturer before testing.
  - g. Single-mode backbone links shall be tested as listed above and in accordance with ANSI/TIA-526-7, Method A.1, using not more than one reference jumper. All multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with ANSI/TIA-526-14A, Method A.1, using not more than one reference jumper.
- 4. Power and Link Loss Budgets
  - a. Contractor shall prepare and submit a fiber optic power and link loss budget report for all backbone fiber optic cabling links as part of shop drawing submissions.
  - b. The report shall include the Power Budget, Link Loss, and Power Margin utilizing industry-standard formulas for each backbone fiber optic link.
  - c. Submit all test reports for approval; an OTDR trace/signature report for every optical fiber strand and a fiber optic link attenuation record report for every cable by strand.
- D. Notify Owner and the Design Professional in writing, ten (10) days advance of testing of all equipment and/or components to prevent delays in construction schedules.
  - 1. Perform all tests, as required, by authorities having jurisdiction throughout the facility.
  - 2. Test system for grounds to demonstrate that the ground resistance does not exceed the requirements of the National Electric Codes (NEC).
  - 3. Test all cabling to confirm that no grounds, shorts, sneak currents, RFI and EMI conditions exist prior to start-up and commissioning of all, components, devices, equipment and/or systems.
  - 4. Test all systems and components for proper function and operation; certify that all systems are in proper working operation in accordance with the Contract Documents prior to scheduling any system demonstrations.

5. Test all fiber optic cabling as shown in Section C above.
6. Testing of all communications systems shall be in the presence of Owner and the Design Professional (if they so choose) as well as all appropriate representatives of the authorities having jurisdiction.
  - a. All completed communications systems shall be fully tested in accordance with all requirements of TIA. Upon completion of a successful testing, the Contractor shall so certify in writing to Owner and the Design Professional that all testing was completed, certified, and left in first-class operational condition, include all completed copper and fiber testing read-outs, certifications, and test reports.
  - b. The service of a competent, factory-trained engineer or technician authorized by the equipment manufacturer shall be provided to technically supervise installation and participate during initial system programming, start-up, final testing, assist in the final acceptance testing and demonstrations.
7. Provide all testing, commissioning and certifications as specified by Division 01 and this specification section, as well as any manufacturer's recommendations or requirements.

E. Tester Criteria

1. General
  - a. Tester shall employ a modular platform with a minimum of a 2.0 Ghz processor.
  - b. Tester shall be Level IV/V ETL Verified.
  - c. Tester shall have hot swappable fiber modules and employ modules for:
    - 1) Multi-Mode capable of testing at 850 & 1300 nm
    - 2) Single Mode modules capable of testing at 1310 & 1550 nm
  - d. Tester shall have a current calibration date. If testing will go past calibration date, Contractor shall have tester re-calibrated.
  - e. Tester shall be running current firmware.
  - f. Tester will be capable of performing 1,2 & 3 jumper set reference. One jumper is recommended.
  - g. Set reference shall be done with factory provided test reference cords (TRC's)
2. The field-test instrument shall be within a 12-month calibration period.
3. Certification tester
  - a. Accuracy
    - 1) Level IV/V accuracy in accordance with ANSI/TIA-1152-A
    - 2) Independent verification of accuracy shall be provided.
4. Permanent Link Adapters
  - a. RJ45 plug must meet the requirements for NEXT, FEXT and Return Loss in accordance with ANSI/TIA-568-C.2 Annex C
  - b. Contractor shall perform a successful set reference prior to the start of any project.
  - c. Twisted pair Category 5e, 6, 6A, cords are not permitted as their performance degrades with use and can cause false Return Loss failures.
5. Results Storage

- a. Must be capable of storing > 5000 results for all measurements.
6. Reporting:
- a. Tester shall be capable of exporting raw data files in native format.
  - b. Reporting Software shall be capable of producing.
    - 1) Detailed Fiber Certification reports in .PDF format
    - 2) Summary fiber reports in .PDF
    - 3) Fiber reports in CSV format.

### 3.12 TRAINING

- A. In addition to all demonstration and training as specified by Division 01 specification section and all related Division 27 specification sections, system demonstrations and training shall be provided in accordance with all requirements of this section.
- 1. Prior to acceptance of the work, the System Integrator shall demonstrate to Owner and the Design Professional, all systems and sub-systems all features and functions of each system and shall instruct Owner in the proper operation, event sequences, programming and maintenance of all systems and sub-systems.
  - 2. The ICTI shall furnish the necessary trained personnel to perform all demonstrations and instructions and arrange to have the manufacturer's representatives present to assist with the demonstrations.
  - 3. Training time shall include, as a minimum, the total time determined by the sum of the times per system as specified in this and related specification sections, for performing the prescribed demonstrations/training. Refer to related specification sections for additional training requirements.
    - a. Allow a minimum of 16 hours' time for each system provided for performing the prescribed demonstrations/training.
  - 4. Provide operation, parts and maintenance manuals defining operation and troubleshooting methods of all systems and review with Owner's User/Operators as part of training demonstrations.
  - 5. Provide detailed video recordings in high quality digitally formatted media of all demonstration and training of all systems and system operations.
    - a. Utilize remote microphones as may be required to ensure high quality audio of the recorded demonstrations.
    - b. Permanently and professionally label all recorded materials and provide self-sealing plastic cases.
- B. Inspections
- 1. At the completion of the project and prior to final acceptance of the Work, provide evidence of final inspections and approvals to Owner and the Design Professional, in accordance with all requirements of the Contract Documents as well as required by the authorities having jurisdiction.

**END OF SECTION 27 05 00**

**SECTION 27 11 00**

**NETWORK COMMUNICATIONS SYSTEMS**

**PART 1 - GENERAL**

**1.1 STIPULATIONS**

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.
- B. Related Sections:
  - 1. Division 07 – Through-penetration Firestop Systems
  - 2. Division 26 – Common Work Results for Electrical
  - 3. Division 26 – Low Voltage Electrical Power Conductors and Cables
  - 4. Division 26 – Grounding and Bonding for Electrical Systems
  - 5. Division 26 – Hangers and Supports for Electrical Systems
  - 6. Division 26 – Raceways and Boxes for Electrical Systems
  - 7. Division 26 – Identification for Electrical Systems
  - 8. Division 27 – General Requirements for Telecommunications
  - 9. Division 27 – Common Work Elements for Communications Systems
  - 10. Division 27 – Network Communications Systems
  - 11. Division 27 – Two-Way Communications System
  - 12. Division 27 – Audiovisual Systems
  - 13. Division 28 – Common Work Elements for Electronic Safety and Security
  - 14. Division 28 – Physical Electronic Safety and Security
  - 15. Division 28 – Video Surveillance System
- C. Reference Symbols:
  - 1. All device symbols are defined by the appropriate symbol schedules. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location.
    - a. Contractor shall coordinate exact locations with all architectural drawings, site plans, reflected ceiling plans, furniture plans, mechanical and electrical drawings as well as all affected trades prior to submittal of any shop drawings.
- D. Abbreviations:
  - 1. Refer to Specification Section 27 05 00 for additional information.
- E. Definitions:
  - 1. Refer to Specification Section 27 05 00 for additional information.



## 1.2 SUMMARY

- A. The intent of this specification is to establish a standard of quality, overall system configuration and equipment requirements for the installation of a new structured cabling system and audio/visual equipment in support of a facility TCP/IP network and specified Audio/Visual systems. The contractor shall be responsible for providing all design, installation, programming, commissioning, testing and certifications as necessary to provide complete infrastructure to support all TCP/IP telecommunications networks in accordance with the Contract Drawings and/or as herein specified.
- B. All communications network cabling for TCP/IP-based Security systems as specified in Division 28 shall also meet the requirements of this section.
  - 1. The installation, performance, features, functions, software, and programming criteria as specified herein as well as all related specification sections have been designed to offer the maximum system efficiency ease of operation, occupant safety and the protection of equipment as recommended by the design Professional.
    - a. Any deviations from the specified criteria shall be documented, reviewed, and agreed to in writing by Owner and the Design Professional prior to submission of bids. Refer to Division 01, Division 28, and all related Division 27 specification section for product substitutions.
  - 2. It is the responsibility of the contractor to ensure that the installed system meets or exceeds every standard set forth in these specifications. The contractor shall provide all cabling, communications outlets, conduits, system components, termination equipment, racks/cabinets, emergency electrical power, software, programming, and all appurtenances as well as all necessary testing, commissioning and certifications as required to provide a complete and fully operational TCP/IP based network, whether such items are specifically included in this section or not.
- C. The contractor shall furnish all labor, equipment, materials, testing, commissioning, programming, and certification in connection with the installation of a complete premises communications network system as indicated on the drawings and as herein specified.
  - 1. The systems shall be complete with all equipment as indicated on the contract drawings and/or described herein.
    - a. The systems shall include at the minimum but not limited to the following:
      - 1) Plenum rated cabling.
      - 2) Fiber Optic Cabling (Network Backbone)
      - 3) Coaxial Cabling (MATV/CATV distribution)
      - 4) Conduit/Duct/Raceway/Cable Tray Systems
      - 5) Distribution/Termination Patch Panels
      - 6) Equipment Racks/Cabinets
      - 7) Communications Outlets/Jacks
      - 8) Equipment bonding and grounding.

- D. The contractor and all sub-contractors for this work shall have read all of the General Conditions, Special Requirements, General Requirements and all applicable related specification sections and in the execution of all work shall be bound by all of the conditions and requirements therein.
- E. Prior to the submission of the Bid, any discrepancies or inconsistencies noted within these specifications and/or the project drawings shall be brought to the immediate attention of Owner and the Design Professional.
  - 1. Project specifications and drawings may not deal individually with every component, control, device, or appurtenance, which may be required to produce the specified system configuration, and/or as necessary to meet the equipment and cabling requirements. Coordinate all integration requirements with Owner and the Design Professional and all appropriate systems providers.
  - 2. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location. The contractor shall coordinate the installation of all cabling, materials, equipment, devices, jacks, cable trays and conduits with all affected trades and document all coordination at the time of shop drawing submittals.
- F. This contractor shall assume total responsibility for coordinating all inter-building wiring, any common carrier provided network equipment, and/or Owner provided equipment as it relates to the operation of these systems.

### 1.3 SCOPE OF WORK

- A. The contractor shall furnish all labor, equipment, materials, cabling, and the performance of all testing, commissioning, and certification in connection with the installation of a complete premises TCP/IP-based communications network structured cabling system and specified audio/visual systems in accordance with all requirements of the project drawings and/or as herein specified.
  - 1. Provide and install all equipment described herein, including, but not limited to all, jacks/outlets, Category-6 & Category-6A cabling, fiber optic cabling, coaxial cabling, patch panels, distribution hardware, and patch cables as well as all conduits, outlet boxes and appurtenances necessary to provide complete and fully operating network communications structured cabling system.
  - 2. Provide and install all equipment described herein, including, but not limited to all, video displays, projectors, video signal encoders, audio equipment and video processing equipment.
- B. Communications Systems Design Requirements:
  - 1. Provide a complete operational communications network infrastructure including but not limited to all cabling, jacks, cabling distribution and termination components as indicated on the contract drawings and as herein specified.
    - a. All horizontal network connections shall utilize copper cabling and hardware for distribution to all control equipment as indicated on the contract drawings. All horizontal cabling shall be bundled and routed through the facility on "J" hooks sized to support the network cabling requirements and shall terminate on

Category-6 and Category 6A patch panels in the communications equipment enclosures.

- 1) NOTE: Cables shall not be cinched too tightly; cable ties at patch panel locations shall be hook-and-loop type tie-wraps only. Plastic wire ties shall not be accepted on any cabling.
- b. All communications cabling shall be terminated at both ends of the permanent link at all equipment locations, fiber optic, coaxial and patch panels.
- c. The Contractor is responsible for the installation of the entire network communications infrastructure: including all workmanship, standards of quality, adherence to the contract documents, certification testing, as-built documentation, labeling, and final warranty in relationship to the performance and installation of the structured cabling systems in accordance with the contract drawings and/or as herein specified.

C. Backbone Performance Requirements:

1. The intended function of the communications network is to transmit data communications signals from a central location to several individual data drop locations. Upon completion of the work in accordance with the contract documents, the system shall be capable of transmitting data signals at a rate of 1000 Mbps minimum over Category-6 & Category-6A cable and a minimum of 10Gbps over single-mode fiber optic cables based upon the transmitting distance, laser attenuation and number of links.
  - a. Multimode OM4 50/125 micron (nominal) optical fiber cable.
  - b. Single-mode OS2 8.3/125 micron (nominal) optical fiber cable shall be capable of transmitting signals at both 1310 and 1550 nm capable of providing a nominal 5km @ 1GBPS @1000 Base LX and nominal 10km @ 10GBPS @10GBASE-LX4 transmission rates.
  - c. All fiber optic cable shall be terminated on LC-type connectors and ports.
2. The Contractor must certify in writing that the structured cabling system(s) are installed in accordance to the project documents, the referenced standards as well as all manufacturer requirements.
3. In addition, the contractor shall provide in writing all extended manufacturers' warranties for matching compatibility of the structured cabling system as well as all as-built drawings and field test reports for both the fiber and copper cabling systems before Owner and the Design Professional will accept the installation.

1.4 SUBMITTALS

- A. Refer to Specification Section 27 05 00 for additional information.

1.5 RECORD DOCUMENTS

- A. Provide Owner with complete set of record drawings in accordance with the requirements of Section 27 05 00.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Manufacturers listed as acceptable or equal shall not negate the contractor's responsibility for providing all systems in accordance with all functions and performance requirements of the Contract Documents.
- B. Where manufacturer and/or model numbers reference specific system components in this specification, it is to establish the performance requirements and quality of the systems and components only.
  - 1. It is in no way an inference that the referenced model numbers are the manufacturer's current product and are the only acceptable components for this project unless specifically referenced as "no substitutions."
  - 2. Contractor shall provide the manufacturers' most current product that shall meet and/or exceed the specified performance and features of all data, and telecommunications equipment and/or systems.
  - 3. Equivalent UL- listed equipment may be substituted for the approved manufacturers in accordance with all requirements of Division 01 specification section titled "Substitutions" and/or General Conditions to the Construction Contract and where approved equal is referenced in the specific specification section.
    - a. Where systems and/or components are referenced as "no substitutions," the specific system and/or components shall be provided.
    - b. All substitutions shall comply with all requirements as specified in related specification sections and all system performance standards shall be maintained.
    - c. The contractor shall stipulate at the time of submission of bid the following information impacted by such a substitution.
      - 1) Any and all extensions in time impacted by the substitution.
      - 2) Any changes to the architectural or structural elements to the project.
      - 3) Differences in operation and/or performance from intended system criteria.
    - d. Failure to provide the required substitution information shall result in, without consideration, the immediate rejection of the substituted equipment and/or systems.
- C. Unless specified otherwise, the equipment furnished shall fall into six classes, and with the exception of Class 6, all of the material within a single class shall be the standard product of one manufacturer. Exceptions are noted as "Class Exempt." The six classes are as follows:
  - 1. CLASS ONE-A (1A): Category-6, Category-6A and Category-3 UTP, and Category-6 F/UTP copper cables (both horizontal and backbone), Category-6 patch cords, blocking kits, interconnection devices, connectors, wiring blocks, patch panels, and telecommunications outlets. Refer to applicable specification paragraphs for acceptable product manufacturers.

- a. Note: All material covered in “Class One-A” shall conform to all manufacturers’ cable/component matching connectivity requirements for the connection of all communications outlets, patch panels and cabling appurtenances provided as part of this project.
    - b. Other cabling systems meeting the listed performance and warranty requirements will be considered following compliance with all substitution requirements in accordance with Division 1 specification section titled “Substitutions.”
  2. CLASS ONE-B (1B): Fiber Optic Cable (both horizontal and backbone), fiber optic jumpers, interconnection devices, connectors, wiring blocks, patch panels, and telecommunications outlets. Refer to applicable specification paragraphs for acceptable product manufacturers.
    - a. Note: All material covered in “Class One-B” shall conform to all manufacturers’ cable/component matching connectivity requirements for the connection of all communications outlets, patch panels and cabling appurtenances provided as part of this project.
    - b. Other cabling systems meeting the listed performance and warranty requirements will be considered following compliance with all substitution requirements in accordance with Division 1 specification section titled “Substitutions.”
  3. CLASS TWO: Inner-duct systems. All material covered in “Class Two” shall be equal in quality and performance to that manufactured by Carlon, Eastern Wire+Conduit, Endot or approved equal.
  4. CLASS THREE: Equipment racks, Wire Management Systems and Cable Trays. All material covered in “Class Three” shall be equal in quality and performance to that manufactured by Eaton (Formerly Cooper) B-Line, Chatsworth Products Inc., Legrand or approved equal.
  5. CLASS FOUR: Communications Equipment Cabinets and Wire Management Panels.
  6. CLASS FIVE: hook and loop wire ties/cable wraps, storage rings, labels, "D" rings (metal only), nuts, bolts, screws, and other miscellaneous and hardware.
  7. CLASS SIX: Active network systems/Equipment/Hardware
- D. All equipment and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name on each component.

## 2.2 COMMUNICATIONS NETWORK EQUIPMENT AND COMPONENTS

- A. Data Communications Outlets (Category 6 & 6A)
1. Data Jacks/Faceplates: 4 pair, TIA/EIA-568B pinning, Category-6 compliant.
  2. Modular Outlet Jacks & Faceplates: Standard 8-position, RJ-45 style, un-keyed, designed for 4-pair, 100 ohm balanced unshielded twisted pair (UTP) cable, 26-22 AWG solid or stranded conductors.
  3. Acceptable manufacturers for this project shall include Commscope Uniprise, or approved equal.
  4. Accessories: Category-6 & Category-6A Jacks or approved equal include a translucent stuffer cap for wire retention and to permit visual inspection. Jacks shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.

- a. Modular Mounting Plates:
  - 1) All mounting plates shall be supplied with mounting screws, clear screw covers and paper labels, and color matched screw covers. Office White – flush mounted with screws. Coordinate final color selection with architect.
- B. Equipment Cabinets/Patch Panels/Appurtenances
  - 1. Approved Manufacturers:
    - a. Commscope Uniprise
    - b. Or approved equal
  - 2. Provide wall-mounted communications equipment enclosures where indicated for all locations as indicated on the contract drawings. All wall-mounted enclosures shall meet the following requirements:
    - a. The enclosure shall be a UL listed; EIA compliant 19” horizontal distribution rack.
    - b. Minimum (26) EIA standard 19” rack units (RU)
    - c. 30” minimum usable equipment mounting depth
    - d. Front mesh door with lock
    - e. Locking swing-open center section for front and rear access
    - f. Adjustable rack rail
    - g. Integrated cable management
    - h. Electrical knock-outs for conduits on rear section/pan
    - i. UPS sized for all equipment with floor-standing or rack-mounted options.
    - j. Horizontal Power Distribution Unit (PDU)
    - k. Position and install rack so as to permit full swing of rack away from wall without obstruction.
  - 3. Provide floor-mounted communications open frame equipment racks where indicated for all locations as indicated on the contract drawings. All racks shall meet the following requirements:
    - a. The rack shall be a UL listed; EIA compliant 19” horizontal distribution black in color.
    - b. 2-post with top plates and bottom plates for use with ½” anchoring hardware consisting of drop-in anchors, hex head bolts and fender washers on all mounting holes.
    - c. Double-sided vertical wire managers on both sides as indicated on the contract drawings.
    - d. Rack-mounted UPS sized for all equipment.
    - e. Vertical Power Distribution Unit (PDU)
    - f. Grounding busbar
  - 4. Provide Fiber Optic Patch Panels (FOPP’s) in sufficient quantities to support all fiber terminations as indicated on the contract drawings:
    - a. Commscope or approved equal

- b. All housings: Provide with pigtailed cassettes, (6) duplex LC ports per cassette (12 strands per panel), Single-Mode. Provide cassettes in sufficient quantities to terminate all incoming fiber optic strands.
    - c. Furnish housings with minimum 20% spare cassette slot capacity for addition of future panels.
  - 5. Provide Modular Category 6 and Category 6A copper patch panels in sufficient quantities to support all Category 6 and 6A cabling terminations as indicated on the contract drawings:
    - a. Patch panels shall contain 110-block rear terminations for horizontal cabling and RJ-45 front connections for patch cords.
    - b. Patch Panels shall be 24-port and 48-port TIA-568B wired Category 6 rated.
  - 6. Patch Cables, Category 6, high performance: Commscope Uniprise or approved equal.
    - a. Patch cables shall be provided in standard lengths of three (03), five (05), seven (07), ten (10) or (15) feet.
    - b. Provide Two (2) patch cables for each populated patch panel port; one in the communications room, and one in the work area/space.
      - 1) Patch cables in the communications room shall be of minimum length to permit installation without stress or strain at connection points to equipment, to permit relocation of cable to a different port on the same device, and to permit neat and workmanlike cable routing through cable management devices.
      - 2) Patch cables in the work area/workspace shall be (15) feet in length.
    - c. All patch cables shall be TIA-568B compliant and meet all product matching criteria.
    - d. All patch cables shall be provided with jacket colors as specified elsewhere in this section.
    - e. All Category 6 Patch cords must be provided by the same manufacturer as part of a certified structured cabling system and shall be color coordinated in accordance with cable and jack color coding requirements.
  - 7. Network equipment cabinet wire management: Provide wire management devices in network equipment cabinets as shown on the drawings and described in these specifications:
    - a. 1 Rack Unit (RU) Horizontal Wire Manager:
    - b. 2 Rack Unit (RU) Horizontal Wire Manager:
    - c. Provide hook-and-loop tie-wraps as required for neat and tidy rear cable management.
- C. Category 6 Cable – Data Network Communications
  - 1. Category 6 Cable shall be “CAT6” cable tested to a minimum of 250Mhz, plenum-rated (CMP):

1. Provide fiber cabling in accordance with the requirements of all related specification sections, at the minimum 12-strand single-mode cable unless otherwise indicated by the contract drawings.
  - a. Premise Distribution Interlocking-Armored plenum.
  - b. Acceptable manufacturers shall include Commscope or approved equal.
2. Fiber Optic Cable Terminations
  - a. All fiber optic cable shall be spliced on to splice-on connectors in the equipment racks.
  - b. All splices shall be fusion type. Mechanical splices shall not be acceptable.
  - c. All fiber optic connectors and patch panel ports shall be duplex SC/APC type.

**D. Coaxial Cable (MATV/CATV Distribution)**

1. Use RG-6/U cable for horizontal cable distribution drops to TV drop locations or as recommended by manufacturer.
2. Use RG-11/U cable for drops to TV locations or as recommended by manufacturer.
3. All coaxial cabling must be UL Listed, NEC type CL2 or CATV, Tri Shield, 75-Ohm cable installed in dedicated conduits.
4. Terminate all coaxial cable on coax patch panels in the equipment cabinet. At TV locations, terminate coaxial cable on single-gang wall plates with F-type connectors as shown on the contract drawings.

**2.3 EQUIPMENT POWER DISTRIBUTION**

**A. Uninterruptable Power Supply (UPS)**

1. Provide minimum 6kVA UPS at the bottom of each rack/cabinet, unless otherwise specified.
2. UPS shall be high density, double-conversion on-line power protection with scalable runtime. Runtime shall be minimum 30 minutes at full load.
3. UPS shall include web-based network management card with SNMP.
4. Provide all mounting hardware and cables.
5. Include floor-standing and rack-mounted options.

**B. Rack Mounted Power Distribution Unit (PDU)**

1. Provide rack mounted power distribution switch with surge protection for the distribution of all UPS connected power for each rack. The unit shall consist of a minimum of 12 AC power outlets, dual fed A/B circuiting, rated at 15 amps each and shall be equipped with integral surge protection circuitry (with bypass switch) capable of auto-resetting over-voltage and under-voltage protection.
2. The unit shall include a front mounted power switch (with guard) which shall control all 12 outlets. The four front mounted power outlets shall be spaced as transformer convenience outlets. The overall unit shall be single-height rack mountable chassis (1U) with three front panel indicator lights: (Power, Ground OK and Unsafe Voltage) and shall



include front panel circuit breaker for protect or disconnect circuitry and dual 10-foot power cords for electrical power connectivity. The rear panel grounding lug shall be provided.

3. In addition to the above requirement the power distribution unit shall meet the following minimum requirements:
  - a. Integral Surge Protection Circuitry (with by-pass switch): Yes
  - b. Dual A/B Incoming Power Circuiting
  - c. Protect or Disconnect Circuitry: Yes
  - d. Thermal Fusing: Yes
  - e. Catastrophic Surge Circuit: Yes
  - f. Over/Under voltage Protection: Yes
  - g. Overvoltage Shutoff Gate: 144V  $\pm$ 11V
  - h. Under voltage Shutoff Gate: 84V  $\pm$ 6V
  - i. Single Pulse Energy Dissipation: 1350 Joules
  - j. Peak Impulse Current: 32,000A
  - k. EMI/RFI Noise Filtration: 50db (99.7%)
  - l. Line Voltage: 120VAC, 50/60Hz
  - m. Initial Clamping Level: 200V Peak, 141 Rms
  - n. UL 1449 Rating: 500V L-N, 500V L-G, 400V N-G
  - o. Protection Modes: L-N, L-G, N-G
  - p. Maximum Current Rating: 15A (1800W)
  - q. Response Time: 1-5 Nanoseconds
  - r. Plug Configuration: Straight
  - s. Number of Outlets: 12 (4 front, 8 rear)
  - t. Switched Outlets: All

### **PART 3 – EXECUTION**

#### **3.1 EQUIPMENT PROTECTION**

- A. Comply with all requirements of Specification Section 270500.
  1. Examine all physical and environmental conditions, equipment and device locations, auxiliary system connectivity requirements impacting the installation of all network systems and report any unsatisfactory conditions in writing to Owner and the Design Professional.

#### **3.2 WORK PERFORMANCE**

- A. In addition to all requirements as specified by Specification Section 270500 the network communications systems shall also be provided in accordance with the following requirements:
  1. Prior to the final commissioning and/or programming of any network communications components, the Contractor shall provide a review with Owner and the Design Professional addressing all network integrations, programming, and related operational connectivity.

- a. Failure to provide this review and get final sign-off prior to programming shall result in any costs related to changes requested by Owner and the Design Professional as not being charged to the project.

### 3.3 EQUIPMENT/CABLE INSTALLATION AND REQUIREMENTS

- A. In addition to all requirements as specified by Specification Section 270500 the network communications systems shall also be provided in accordance with the following requirements:
  1. All system cabling shall be of the type, size and specification as required by all contract documents as well as stipulated by all codes and standards as specified by Specification Section 270500.
  2. All network communications cabling shall be installed in accordance with the requirements of Specification Section 270500. All network cabling bundles shall not contain any AC carrying conductors or non-associated network communications cables within the cable raceways/conduits or cable bundles.
    - a. In addition, all structured cabling associated with the installation of any network communications system shall comply with all requirements of TIA standards for the proper installation, termination and testing of all fiber optic and UTP cabling.
    - b. Contractor shall provide all equipment, components, devices, hardware, equipment racks/cabinets, patch panels and all appurtenances necessary to provide fully operational network communications systems utilizing a UTP cabling topography. Coordinate all structured cabling with all trades and contractors prior to shop drawing submission.

### 3.4 ELECTRICAL POWER DISTRIBUTION

- A. Comply with all requirements of Specification Section 270500.
  1. All system power supplies serving system components or devices on the exterior of the facility shall be provided with the appropriate transient surge and suppression protection on both the line side as well as the load side. Refer to specification section 27 05 00 for additional requirements.
  2. Installation of all equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate trade contractors.

### 3.5 TRANSIENT VOLTAGE SUPPRESSION

- A. Comply with all requirements of Specification Section 270500.

### 3.6 GROUNDING AND BONDING

- A. Comply with all requirements of Specification Section 270500.

### 3.7 EQUIPMENT IDENTIFICATION

- A. Comply with all requirements of Specification Section 270500.

### 3.8 MAINTENANCE & SERVICE

- A. Comply with all requirements of Specification Section 270500.

### 3.9 WARRANTY

- A. Comply with all requirements of Specification Section 270500
- B. Provide all manufacturers extended cable warranties based on matching wire to component compatibility requirements. All cable warranties shall be in effect for a period of not less than 20 years.
- C. The warranty must include the following statements regarding the cabling system:
  - 1. "That all communications networks have been certified and will support and conform to ANSI/TIA-568-C specifications covering any current or future application which supports transmission over a properly constructed and horizontal cabling system premises network which meets the channel and/or basic link performance as described in ANSI/TIA-568-C."
  - 2. "That all communications networks are free from defects in material or faulty workmanship."

### 3.10 FIELD SERVICES

- A. Comply with all requirements of Specification Section 270500

### 3.11 TRAINING

- A. Comply with all requirements of Specification Section 270500.
- B. Documentation:
  - 1. Contractor shall provide documentation to include all test results and as-built drawings, test results shall be computer generated and shall include all trace reports indicating each pair tested in accordance with all requirements of Specification Section 270500.
    - a. One Hard Copy shall also be provided to Owner and the Design Professional. Software for viewing the test results shall also be provided in the soft copy package.
- C. Final Acceptance
  - 1. Acceptance of all network communications systems, by Owner and the Design Professional, shall be based on the results of testing, functionality, and the receipt of documentation. The testing of all UTP cabling, fiber segments and all security and data network cables must meet the criteria established in the Specification Sections 270500.

2. The Contractor must demonstrate to Owner and the Design Professional that 1000 Mbps data signals can be successfully transmitted, bi-directionally, from the communications room patch panels to and from a minimum of 10% of individual data drops on each floor, witness tested by Owner and the Design Professional. The number of data drop locations to be tested shall be determined by Owner and the Design Professional. With regard to documentation, all required documentation shall be submitted to Owner and the Design Professional.

**D. As-Built Documentation:**

1. Contractor shall provide clean copies of the technology drawings depicting all as-built conditions for all data drop locations, cable routing and identification, patch panel, data switch port terminations, component layouts and all information as required by Division 01 specification section.

**END OF SECTION 27 11 00**

**SECTION 27 4100 - AUDIOVISUAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Division 1 Specifications, General and Supplemental Requirements apply to this section with additions and modifications specified herein.
- B. Instructions to Bidders, Bidding Forms, Forms of Agreement between Owner and Contractor, Contract Award Date, Starting and Completion Dates, Conditions of the Contract, Insurance Requirements, and other Owner Requirements will be furnished separately by Owner. These documents, as well as any addenda issued, shall form a part of these Specifications, and this Contractor shall consult them in detail for instructions pertaining to his work.
- C. Each trade Contractor shall receive all drawings and specification sections issued as part of the overall bid package. All Contractors are to receive, review, and coordinate all of their work as shown or referenced on the other trade documents. All work shown or referenced on the other trade documents shall be included as part of the overall project scope for that particular discipline and trade.
- D. All other Division 27 Specifications.

**1.2 SUMMARY**

- A. These specifications and accompanying drawings are intended to cover the furnishing of all labor, material, and equipment and superintendence of the Audiovisual (AV) Systems.
- B. It is the intent and purpose of this specification and accompanying drawings to cover and include each item, all materials, machinery, apparatus, and labor necessary to properly install, equip, adjust, and put into perfect operation the respective portions of the installations specified and to so interconnect the various items or sections of the work as to form a complete and properly operating whole.
- C. Any equipment, apparatus, machinery, material, and small items not mentioned in detail, and labor not hereinafter specifically mentioned, which may be found necessary to complete or perfect any portion of installation in a substantial manner, and in compliance with the requirements stated, implied or intended in these specifications shall be furnished without extra cost. This shall include all materials, devices, or methods peculiar to the machinery, equipment, apparatus, or systems furnished and installed as part of the AV Systems work.
- D. Drawings and this Section outline the performance requirements of the AV system. The Drawings are diagrammatic in nature and are meant to convey the performance intent of the system. Contractor shall develop a solution for each portion of the AV system and submit detailed shop drawings and product datasheets to indicate the proposed approach.
- E. The following major system components may be specified under this section:
  - 1. Signal Switching Transport
  - 2. Controllers and Control Interfaces
  - 3. IP encoders, decoders and network hardware to support AV systems
  - 4. Signal Processing Systems

5. Signal Recording and Storage
6. Cabling and Connectors
7. Racks and Connection Panels
8. Displays
9. Projectors and Projection Screens
10. Collaboration Systems and Appliances
11. Collaboration and Event Cameras
12. Wireless Presentation System
13. Wired and Wireless microphone system
14. Loudspeakers

**1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION**

- A. No products have been identified to be furnished but not installed.

**1.4 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION**

- A. Products installed but not furnished include all Owner Furnished Equipment (OFE) items which shall be configured and installed as part of a complete and working system as identified in the section summary.
- B. Refer to the audiovisual systems equipment list on the TA series drawing set for equipment identified as OFE.
- C. All Owner Furnished Equipment, with the exception of Room PCs imaged with Owner's standard user desktop profile, shall be maintained as part of the labor portion of the system warrantee.
1. Contractor shall assist in initial troubleshooting of Owner Furnished Equipment and if necessary, manage the equipment replacement process within the existing manufacturer warrantee period.
- D. New OFE Items
1. Contractor shall take receipt of any new equipment procured by Owner for this project, including Room PCs, Mini PCs, CATV Tuners, etc. as indicated in the Audiovisual Systems Equipment list.
    - a. If necessary for shop fabrication and testing, Contractor shall take receipt of equipment at Contractor's system staging location and transport the complete AV assemblies to the project site.
- E. Existing OFE Items:
1. No existing OFE equipment has been identified for this project.

**1.5 WORK NOT INCLUDED IN SCOPE**

- A. Contractor shall coordinate with associated trades providing all work outside of this scope which may be necessary for a complete and working system.
- B. Work not included in scope includes:

1. AV empty conduit, junction boxes, floor boxes, poke-thrus and other pathways for AV low voltage cabling unless otherwise specified in this section.
2. Display in-wall boxes.
3. Power receptacles supporting AV equipment.
4. AV furniture including tables, lecterns, and credenzas
5. Table hatches or table connectivity enclosures
  - a. Contractor to coordinate and provide all hatch and enclosure faceplates, connectors, and cabling.
6. Architectural or event lighting control interfaces
  - a. Contractor to coordinate and provide all cabling between AV and lighting controllers.
7. Owner network horizontal cabling and ports between an AV device and Owner's IDF/MDF/Network rack.
  - a. Contractor to coordinate and provide all patch cabling between Owner network drop termination points and AV devices including.
    - 1) Includes patch cabling run in glass front extrusions for use with room scheduling devices.
  - b. Contractor to coordinate and provide all network drops between AV devices or between an AV device and Contractor provided network switch.

**1.6 LAWS, REGULATIONS AND CODES:**

- A. Perform all work in strict compliance with all laws, regulations, and/or codes applying, including all Federal, State, and local codes and any other authority having jurisdiction. Wherever drawings or specifications conflict with such regulations they shall be made to conform, and approval of the Design Professional obtained on such changes as may be involved.
- B. All electrical and telecommunications work shall comply with the requirements of the National Electrical Code, latest accepted revision.

**1.7 PERMITS, FEES, AND CERTIFICATES OF APPROVAL:**

- A. Unless stated otherwise in General Conditions or Division 1, obtain, and pay for all permits, fees, and licenses required, including those of utilities and Agencies. Provide copies to Design Professional in the quantity requested. "Fees" shall include connection charges construction costs, and other such charges by utility companies or service providers. Ascertain such charges during bidding period and include bid price.

**1.8 REFERENCES**

- A. The publications list below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Conflicts:
  - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
  - 2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.
- D. References:
  - 1. General: The system shall comply with all applicable codes, ordinances and standards as interpreted and enforced by the local authority having jurisdiction.
  - 2. Avixa (Audiovisual and Integrated Experience Association, previously InfoComm) standards including:
    - a. Display Image Size for 2D Content in Audiovisual Systems
    - b. Cable Labeling for Audiovisual Systems
    - c. Audio Coverage Uniformity in Listener Areas
    - d. Standard Guide for Audiovisual Systems Design and Coordination Processes
    - e. Projected Image System Contrast Ratio
    - f. Audiovisual Systems Energy Management
    - g. AV Systems Performance Verification
    - h. Audio, Video and Control Architectural Drawing Symbols Standard
    - i. Electronic Symbol Files - Audio, Video and Control Architectural Drawing Symbols
  - 3. American Society for Testing and Materials (ASTM)
  - 4. ANSI standards including:
    - a. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements
    - b. ANSI/TIA/EIA-568-B.3 Commercial Building Telecommunications Cabling Standard, Part 3: Optical Fiber Cabling Components Standard
    - c. ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
    - d. ANSI/TIA/EIA-606-A The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
    - e. J-STD-607-A Commercial Building Grounding and Bonding Requirements for Telecommunications
    - f. ANSI/TIA/EIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
    - g. ANSI/TIA/EIA-526-14A Measurement of Optical Power Loss of Installed Multimode Fiber Cable Plant
  - 5. BICSI -- Telecommunications Distribution Methods Manual
  - 6. BICSI -- Cabling Installation Manual
  - 7. Underwriters Laboratories Listed, UL Certified
  - 8. National Electrical Code Articles 770 and 800.
  - 9. NFPA 780 - 2005 or newer.
  - 10. RUS Standards (formerly REA)
  - 11. Local State Uniform Fire Prevention and Building Code.
  - 12. Local State Department of Labor Rules and Regulations
  - 13. Local State Department of Health
  - 14. Code of Federal Regulations (CFR) [Telecommunications] Title 47 Part 90



15. Code of Federal Regulations (CFR) [Telecommunications] Title 47 Part 15

1.9 DEFINITIONS

- A. The term "Furnish" shall mean to obtain and supply to the job site. The term "Install" shall generally mean to fix in position and connect for use. Where language indicates that one party or trade is to "install", and another is to "connect", the term "install" shall mean only to fix in position, and "connect" shall mean to make electrical connections. The term "Provide" shall mean to furnish and install.
- B. ANSI – American National Standards Institute
- C. AV – Audio / Visual, audiovisual, audio visual
- D. Avixa - Audiovisual and Integrated Experience Association, formerly InfoComm
- E. HTML – HyperText Markup Language
- F. IP – Internet Protocol
- G. ISO – International Organization for Standardization
- H. NEC – National Electrical Code
- I. NEMA – National Electrical Manufacturing Association
- J. SNMP – Simple Network Management Protocol
- K. TCP – Transmission Control Protocol
- L. TIA – Telecommunications Industry Association
- M. UL – Underwriters Laboratories
- N. VLAN – Virtual Local Area Network
- O. VoIP – Voice over Internet Protocol
- P. VPN – Virtual Private Network

1.10 RECORD DRAWINGS:

- A. During construction keep an accurate record of all deviations of the work as shown on the drawings and that which is actually installed.
- B. Secure from the Design Professional a complete set of prints of the AV drawings and note changes thereon. Make a complete record in a neat and accurate manner, of all changes and revisions to original design which exist in completed work, in the file format originally received.
- C. The cost of furnishing above drawing files and preparing these record drawings shall be borne by the Contractor. When all revisions showing the work as finally installed are made, the corrected prints and drawings files shall be submitted for review and approval by the Design Professional.

- D. Record drawings shall be delivered to Owner within 30 days after acceptance of completed project by Owner.

**1.11 OPERATING INSTRUCTIONS:**

- A. Provide to Owner three bound copies of complete written instruction on the operation, care and maintenance of each piece of equipment and the installation as a whole. Include frequency of inspection, cleaning and adjusting and other attention as may be required in accordance with manufacturer's instructions. Material shall be manufacturer's brochures, catalog cuts, parts lists, wiring diagrams, etc. Also supply Owner with three complete sets of approved shop drawings.
- B. Furnish qualified personnel to instruct Owner's personnel in the maintenance and operation of all equipment and systems. Instructing personnel shall remain on the job continuously during working hours until such instruction is complete, but not less than 16 hours.

**1.12 PERFORMANCE REQUIREMENTS**

- A. Provide a complete, fully functional installation of the AV System and associated components including:
  - 1. Engineering and installation services aligning to the published project schedule.
  - 2. Coordination with Owner, Architect, Design Professionals, General Contractor and all associated trades.
  - 3. Creation, submission, and revision to the point of receiving approval of an AV Systems Submittals package.
  - 4. Equipment procurement.
  - 5. Equipment delivery to the site and removal of all trash.
  - 6. Provide all installation tools and materials necessary to complete all equipment installation tasks including ladders, scaffolding and lifts.
  - 7. Equipment installation.
  - 8. Systems setup, configuration, and commissioning.
  - 9. Systems demonstration to Owner and Design Professional.
  - 10. Remediation of any systems identified by Owner and Design Professional as not meeting published equipment specifications or the requirements as set out in this scope of work.
  - 11. As-built documentation.
  - 12. End User Training.
  - 13. AV Systems Warranty.
- B. Provide all equipment accessories, manuals, mounting hardware, remotes and other ancillary pieces furnished by the manufacturer but not required for installation.
- C. Provide all AV low-voltage cabling, connectors, connector plates, patch bays and patch cables.
  - 1. Confirm cable types and verify required length of all installed and portable premanufactured cables and assemblies prior to order.
- D. Terminate and test all AV low-voltage field connections.
  - 1. Provide all connectorized plates, connectors, cable labels and plate labels.
  - 2. Confirm finish of all plates and labels with Design Professionals.
- E. Install and configure Owner Furnished Equipment.

- F. Confirm color selection of all exposed AV equipment with Owner prior to order.
- G. Confirm required openings, recesses and mounting locations of all AV equipment to meet manufacturer requirements. Verify onsite prior to completion of wall framing and electrical rough-in.
- H. Contractor to include manufacturer onsite oversight labor including commissioning services and end user training for any systems which Contractor does not have staff with relevant manufacturer training and any available manufacturer certifications.
- I. Provision all video conferencing, wireless presentation and other collaboration hardware endpoints with Owner's network and collaboration system registration information.
- J. Coordinate AV equipment blocking requirements with the General Contractor prior to installing AV equipment.
  - 1. All wall or ceiling mounted equipment to be provided with hardware sized for a 5:1 safe working load limit.
  - 2. All ceiling mounted equipment to be provided with a safety cable or redundant support system attached to building structure and sized for the equipment by the equipment manufacturer.
- K. Install all AV rack hardware including rack bases and wall supports.
  - 1. Confirm that all AV rack locations will allow proper clearances.
  - 2. Coordinate with the General Contractor location of all AV rack power receptacles, data jacks, CATV jacks and empty AV low voltage junction boxes.
  - 3. Confirm sufficient heat exhaust and cooling systems have been provided to meet systems demand loads.
  - 4. Request of the General Contractor a normally-closed fire alarm mute contact for all event systems as identified in the Audiovisual Drawings.
  - 5. Provide rack hardware, cable management hardware and rack accessories as necessary to meet rack and equipment manufacturer recommended configurations.
- L. Provide all necessary copper and fiber patch cables for making all device interconnections. Patch cable type and color shall be coordinated with the structured cabling package to match project standards.
- M. Provide an AV equipment network coordination submittal for Owner completion. Configure all AV equipment with the confirmed network settings and test operation on Owner network.
- N. Loudspeakers
  - 1. Coordinate location of all wall and ceiling speaker systems including location of low voltage and power infrastructure.
  - 2. Review all ceiling speaker mounting conditions and provide ceiling speakers with a tile bridge or other relevant manufacturer support system.
  - 3. Where indicated in the specification, paint all exposed speaker grills with a custom color as confirmed by Owner.
- O. Furniture
  - 1. Coordinate with furniture providers all AV equipment installation requirements including cutout sizes, connector/plate openings, wiring openings, raceways, methods of affixing cables and equipment.

- a. All equipment and cabling shall be installed in a neat and professional manner with the intention of limiting visibility of supporting hardware and cabling.
  - b. All table cabling shall be secured to the table or hidden in a plinth, cloth wrap or articulating cable manager.
2. For all technical furniture provided under this scope of work, coordinate equipment layouts, and finishes with Owner and Design Professional prior to ordering.

**P. Wireless Systems**

1. Coordinate wireless frequency selection based on a site survey and relevant government agency requirements. Address any wireless channel conflicts prior to equipment ordering.
  - a. For meeting or event space wireless microphone and in-ear monitor systems, provide Owner with a system capable of adjusting wireless frequency as necessary to maintain reliable system operation in the installed environment.
2. Coordinate placement of wireless antennas and provide antenna splitting, combining and amplification as necessary to operate within manufacturer required signal strength ranges.

**Q. Control Systems**

1. Coordinate with the General Contractor the location of all external system interfaces including lighting, shades, occupancy, BMS as required.
  - a. Provide cabling between AV controllers and external system interfaces.
2. Provide custom AV control system code development as necessary to operate all AV equipment user controls per specification.
  - a. Manage a control interface confirmation process with Owner and Design Professional as outlined in the AV submittal requirements.
3. Configure all digital signal processors, content management systems, scheduling systems and other processor-based platforms to optimize to the spaces and systems being served.

**1.13 QUALITY ASSURANCE**

**A. Comply with the requirements of the following codes and/or standards:**

1. ANSI.
2. UL.
3. NEMA.
4. NFPA.
5. NEC.
6. IBC 2009.
7. BICSI.
8. ANSI/TIA 568-D Series.
9. ANSI/TIA 569-E.
10. ANSI/TIA 606-C.
11. ANSI/TIA 607-D.

**B. All packaged equipment shall be independently Third Party labeled as a system for its intended use by a Nationally Recognized Testing Laboratory (NRTL) in accordance with the OSHA Federal**

Regulations 29CFR1910.303 and .399, as well as NFPA Pamphlet #70 and National Electric Code (NEC), Article 90-7.

- C. The Contractor shall be certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures, and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
- D. All members of the installation team shall be certified by the manufacturer as having completed the necessary training to complete their part of the installation. Resumes of the entire team shall be provided along with documentation of completed training courses. Submit resume and copy of technician's license including:
  - 1. A Technical resume of the Contractor's Project Manager and Field Supervisor documenting a minimum of five (5) years of experience installing similar size projects.
  - 2. Matching documentation for any Sub-Contractor who will assist the Contractor in performance of this work.
- E. All hardware, software, firmware, and/or operating system requirements given are the minimum requirements. The Contractor's product shall meet or exceed these requirements. The product selected shall meet the operational, functional, and performance requirements specified herein.
- F. Manufacturer: Where Contractor has the ability to select a preferred manufacturer for items not specifically covered in the Appendix A Audiovisual Systems Equipment list, the manufacturing company selected shall have a minimum of five years of experience in producing the products.

#### 1.14 SUBMITTALS

- A. Contractor must receive approval from Owner or Design Professional of a submittal before procuring equipment or performing services related to the submittal.
- B. All submittals shall be provided in electronic format.
  - 1. Provide one full size paper submittal if requested by Owner.
  - 2. Confirmation of the submittal schedule and submission format must be obtained by Owner prior to creating individual submissions.
- C. Revised submittals shall include clouding or other method to indicate revisions since the prior submission.
- D. Project Status Report
  - 1. A project status report shall be sent to Owner and Design Professional weekly starting within two weeks of award. The project status report shall be used as the basis for Contractor coordination meetings and shall include:
    - a. Team member contact information
    - b. Project overall schedule
      - 1) Highlight changes to the schedule since last issuance
      - 2) Identify critical schedule items
      - 3) Identify opportunities to improve on the current schedule
    - c. Action items from prior coordination meeting and status of each item
    - d. Installation schedule and status for each unique space or system in the project.

- e. Outstanding Owner coordination items.
  - f. Outstanding Design Professional coordination items.
  - g. Change Order Status
  - h. Submittal Approval Status
- E. Within five business days of award, submit an installation schedule including major milestone dates for construction phasing based on overall project construction schedule (along with separate phases where applicable), system and device configuration, testing and training. Include the following milestones:
  - 1. Separate milestones for each submittal.
  - 2. Signage content and system configuration coordination session.
  - 3. Required date for receipt of all OFE equipment per project phase or equipment type.
  - 4. Required data for receipt of any Owner furnished signage content
  - 5. AV project manager onsite.
  - 6. Delivery of all Furnished but not Installed equipment to site
  - 7. Cable pulls start and complete
  - 8. Mount and speaker installation start and complete
  - 9. Equipment installation start and complete
  - 10. Systems configuration and testing start and complete
  - 11. Systems ready for checkout and punch list
  - 12. Owner training
  - 13. As-built submission
- F. Within 30 business days of award submit an AV infrastructure review memo confirming infrastructure shown on the AV, Architectural, Telecom, Mechanical and Electrical design packages meets AV equipment installation requirements or identifying specific adjustments necessary to support the specified AV equipment.
  - 1. Verify AV conduit sizing and pathways
  - 2. Verify architectural recesses and ADA clearances
  - 3. Verify data drops to support AV network connectivity
  - 4. Verify AV power receptacles and multi-discipline shared services device requirements (in-wall boxes, floor boxes, poke-thrus.
  - 5. Verify AV enclosure cooling/exhaust
  - 6. Verify ceiling device layouts and clearances, projector, and projection screen orientation
- G. Qualifications: The Contractor shall submit qualification data sheets for firms and persons as specified in the "Quality Assurance: section of this specification to demonstrate their capabilities and experience.
- H. Submit proposed product data sheets: The Contractor shall submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified or selected for use in the project.
  - 1. Model number shall be highlighted to indicate exact selection per system type.
  - 2. Product data sheets shall be organized with separate folders per system type with a master equipment list broken into three sections:
    - a. System types and quantities of systems
    - b. Equipment and equipment quantities per system type
    - c. Master project equipment list and quantities
  - 3. Confirm manufacturer master quote numbers and the accuracy of the master quotes against the specified equipment.

- I. Submit shop drawings detailing proposed system architecture and interconnectivity.
  - 1. All shop drawings sheets shall be sized to match the project architects drawing format.
  - 2. Shop drawings shall include the following drawing information.
    - a. Scaled floorplans indicating the area of work and room types.
    - b. Enlarged plans indicating equipment locations, mounting requirements, clearances, infrastructure requirements, and cable routing.
      - 1) Provide projector and projection screen throw distance calculations.
      - 2) Provide display elevations and sections.
      - 3) Identify any details which do not meet minimum ADA clearance requirements.
      - 4) Identify equipment centerline coordinated with furniture and main display wall.
    - c. Device details indicating mounting requirements for each unique equipment type in the project.
      - 1) All overhead equipment details must identify the safe working load and manufacturer provided safety hardware. Where a custom mounting detail is required using fabricated components or components provided by multiple manufacturers a structural detail, reviewed and stamped by a Structural Engineer license in the project state, must be provided.
      - 2) Copies of manufacturer cut sheet details shall not be considered sufficiently coordinated.
    - d. Rack elevations and mounting details with clearances and infrastructure requirements
    - e. System flow diagrams with cable labels and corresponding cable schedule indicating wiring interconnections between all AV devices and Owner's network.
    - f. Wiring termination details.
      - 1) Include cable labelling standards and materials
    - g. Panel details showing all prefabricated and custom connector panels, connector types, labels and required backbox.
    - h. Technical Furniture details indicating the location, required openings and cable management of all AV equipment in furniture and millwork regardless of what scope the furniture is provided under.
- J. Control Systems
  - 1. Owner or Design Professional approval of all Control Systems submittals is required prior to installation. Failure to secure approval shall not be grounds for project schedule delay or Contractor change order.
  - 2. Submit button panel layouts with labelling/engraving and sequence of operations.
  - 3. Submit audio DSP configuration files.
  - 4. Submit an initial and up to two revised set of touch panel user interface submittals.
    - a. Contractor shall lead a user interface review session with Owner and Design Professional prior to start of touch panel user interface design. Contractor shall provide up to three design samples in advance of the user interface session for Owner and Design Professional review.

- b. User interface layouts shall follow the best practices laid out in the InfoComm *Dashboard for Controls*
- c. The overall user interface design process shall reflect the current draft Avixa UX 701.01 *User Experience Design for AV* recommendations
- d. User interfaces shall include the following basic features:
  - 1) Control of all local AV equipment addressable parameters required during the specified use cases.
  - 2) Call controls, transport controls, source selection, volume controls as appropriate.
  - 3) Standard controls formatted to match industry standard applications (knobs, sliders, buttons, interactive menus, etc.)
  - 4) A password protected advanced section allowing for control of individual device parameters (power, channel level controls, input selection, etc.)
  - 5) Utilize stock manufacturer pages and capabilities where possible. Custom scripting shall be avoided unless where required as part of this specification.

**K. Network Coordination Submittal**

- 1. Submit a detailed list of all network enabled AV devices detailing:
  - a. MAC address
  - b. IP Address (for Owner to complete)
  - c. Subnet (for Owner to complete)
  - d. Wired and Wireless VLANs
  - e. DHCP requirement
  - f. Unique network requirements including firewall exceptions, port forwarding and Qos
- 2. Lead an AV network coordination session with Owner and Design Professional to confirm overall project AV network requirements and set a schedule for completion and return of the Network Coordination Submittal by Owner.

**L. Owner Training Plan**

- 1. Identify specific systems to be trained on and training durations.
- 2. Identify required project stakeholders.
- 3. Identify training status and provide training sign-off sheets.
- 4. Provide training materials and user one-page operations sheets for each system types.

**M. Operations and Maintenance Manuals:**

- 1. This Section requires complete documentation of the AV System for the purpose of system operation and maintenance during and after the Warranty period. It is intended that the operation and maintenance manuals be exhaustive in the coverage of the system to the extent that they may be used as the sole guide to the troubleshooting, identification, and repair of defective parts. All documentation, as described here-in shall be submitted to Owner for approval sixty (60) days prior to final submission.
- 2. Scope: These manuals shall include basic wiring diagrams, schematics, and functional details such that any component, wire, or piece of equipment in the system may be easily identified by going to the actual equipment and making reference to this manual. It is required that everything in the system be neatly labeled and easily identifiable. Every terminal, wire, component, or piece of equipment, and other such items shall have a



number or letter designation. All of these identification characteristics shall be included in the maintenance and operation manuals.

3. The maintenance manual requirement of this Section is in addition to Shop Drawing requirements. Maintenance manuals and Drawing sets shall be compiled after system fabrication and testing and shall incorporate any changes made after Shop Drawing submittal. The maintenance manuals and drawing books shall be permanently bound in hard plastic covers.
4. Maintenance Manuals, Manufacturer's Literature: Provide manufacturer's standard literature, covering all equipment included in the system. The maintenance manuals shall contain specifications, adjustment procedures, circuit schematics, component location diagrams, and replacement parts identification. All references to equipment not supplied on this Project shall be crossed out.
5. System Administrator Documentation: This documentation shall provide complete information on the configuration, business rules, operation, maintenance, and troubleshooting of the system.

**N. Testing Plan**

1. Submit a systems testing and verification plan for approval by Owner and Design Professional.
2. The approved Testing Plan shall be completed and provided to Owner and Design Professional prior to commencement of Owner testing and punch list efforts.

**O. As-Built Documentation**

1. Submit an updated version of all submittals revised to match installed conditions.
2. Submit the native version of all drawing, control programming, digital signal processing and other systems configuration files.

**P. Warranty**

1. Within 30 business days of award, provide a summary of the systems warrantee including all optional services for final Owner confirmation.
2. At time of as-built documentation submission provide two physical copies of the hardware and software warranty certifying that the final as-built installation is fully warranted by the manufacturer.

**1.15 GENERAL WARRANTY**

- A. The system warranty shall commence on the date of Substantial Completion unless otherwise provided for in the Contract.
- B. The system warranty shall be for a period of one year
- C. Hardware Warranty:
  1. Contractor shall warrant that all components meet or exceed the specifications provided in the product data submittal.
  2. The Contractor shall warrant that the proposed merchandise will conform to its description and any applicable specifications and shall be of good quality for the known purpose for which it is intended.
  3. The warranty shall cover material and labor for the replacement or repair of defective products.

4. Regardless of manufacturer warranties expiring before the full system warranty period, Contractor shall be responsible for extending any manufacturer warranties for the full length of the system warranty.

D. Software Warranty:

1. The warranty shall allow for replacement or repair at the discretion of Owner. All software necessary to compile, modify, and maintain software developed for this specification shall be included in this warranty.
2. The warranties shall include the price of all software upgrades during the warranty period. If a new version of the system software becomes available during the warranty period, it shall be upgraded as part of the warranty.

1.16 MAINTENANCE AND SUPPORT SERVICES

- A. Description of Work: During the warranty period provide customer service for subscriber issues Monday – Friday, 9am – 5pm local time. Provide quarterly system inspections, checks and updates during the warranty and maintenance period.
- B. Personnel: Service personnel shall be certified in the maintenance and repair of similar types of equipment and qualified to accomplish work promptly and satisfactorily. Service personnel shall hold a valid Airport security credential. Owner or Owner's Designated Representative shall be advised in writing of the name of the designated service representative, and of any change in personnel.
- C. Schedule of Work: The Contractor shall perform quarterly inspections of the installed system. Inspections shall be in accordance with manufacturer and Contractor recommendations. The adjustment and repair of the system shall include visual checks of installed equipment and inspection of system health logs and software. Recommended software updates shall be applied on the system at these pre-defined quarterly periods.
- D. Scheduled Work: Scheduled work shall be performed during regular working hours, Monday through Friday, excluding holidays.
- E. Emergency Service: Owner will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system repair. Owner shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at site within 4 hours after receiving a request for service. The system shall be restored to proper operating condition within 8 hours after service personnel arrive onsite.
- F. Records and Logs: The Contractor shall keep records and logs of each task, and shall organize cumulative records for each component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain all initial settings. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the system.
- G. Work Requests: The Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the material to be used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within 5 days after work is accomplished.

- H. System Modifications: The Contractor shall make any recommendations for system modification in writing to Owner. System modifications shall not be made without prior approval of Owner. Any modifications made to the system shall be incorporated into the operation and maintenance manuals, and other documentation affected.

- I. Spare Equipment:

- 1. Provide spare equipment where indicated in the 27 41 00 Appendix A.

**1.17 DELIVERY, STORAGE, AND HANDLING**

- A. Audiovisual Equipment waiting install onsite shall be maintained in a secure storage area. Contractor and is responsible for the safe delivery, storage and handling of all equipment covered in this scope of work through substantial completion of the work.

**1.18 PROJECT CONDITIONS**

- A. Environmental Limitations: System components shall be equipped and rated for the environments where installed.
- B. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
- C. Interior, Controlled Environment: System components shall be rated for continuous operation in ambient conditions of 2 to 40 deg C dry bulb and 20 to 90 percent relative humidity, noncondensing.
- D. Interior, Uncontrolled Environment: System components installed in non-air-conditioned interior environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
- E. Verify that field measurements are as shown on Drawings; no media, fiber, or copper, shall be installed in lengths surpassing Standards based length requirements.
- F. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project conditions.
- G. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required. Record actual routing on as-builts for all conduit larger than one inch.

**1.19 PROJECT COORDINATION**

- A. Determine required separation between cable and other work.
- B. Coordinate cable routing to avoid interference with other work disciplines.
- C. Coordinate grounding and bonding with Section 270527 Contractor.
- D. Coordinate use of fiber optic cabling infrastructure with Section 271310 Contractor.
- E. Coordinate network configuration requirements with Section 272000 Contractor.

## PART 2 - PRODUCTS

### 2.1 AUDIOVISUAL SYSTEMS EQUIPMENT LIST

- A. Refer to the TA series drawings audiovisual systems equipment list for product information.

### 2.2 SUBSTITUTIONS

- A. Contractor requests for substitutions shall be made in writing and shall include:
  - 1. The equipment or process requested for substitution and a summary of the reason for substitution.
  - 2. The requested equipment or process to substitute with and a feature comparison with the base scope of work.
  - 3. Proposed cost and schedule impacts.
- B. No substitution shall be allowed without written approval of Owner or Design Professional.
- C. Cost and schedule impacts will only be considered for approval in the event that the substitution is due to factors outside of the control of the Contractor.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and shall furnish all cables, connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.
- B. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
- C. Contractor shall adhere to the following during installation of the system:
  - 1. Underwriters Laboratories (UL) listing for restricted access installations in business and customer premises applications. This listing is required by the National Electric Code for customer premise installations.
  - 2. Fire resistance requirements specified by Underwriters Laboratories in UL 1459, 2nd edition.
- D. Where undefined by codes and standards, Contractor shall apply a safe working load of at least five (5) times the rated load to all fastenings and supports of system components.
- E. The Contractor shall adhere to the installation schedule of the General Contractor and should attend all construction meetings scheduled by the General Contractor.
- F. Contractor shall place materials only in those locations that have been previously approved. Any other locations shall be approved, in writing, by Owner.
- G. All wiring and cables shall be properly dressed and/or bundled with Velcro straps. Twisted wire, tape, rope, twine, phone wire and similar bits of debris usually available on site are not acceptable

substitutes for proper securing hardware. All inter-rack cables and wiring must be properly routed, and where available, run in cable trays. Overhead cables must be easily removed or reworked within the cable trays. Proper care must be taken to ensure that new cables added to the trays are not stressed or intertwined with existing cables. Overhead cables may not cross perpendiculars or be suspended in mid-air without supports. No supports may be installed without prior approval from Owner. All long cable runs must be properly identified at each end and every 100 feet indicating the carried frequency and communication room of origin. All cabling within the building must be cut to proper length.

- H. The Contractor shall obtain written permission from Owner before proceeding with any work which requires cutting into or through any part of the building structures such as, but not limited to, girders, beams, concrete, carpeted or tiled floors, partitions or ceilings. The Contractor shall also consult with the General Contractor before cutting into or through any part of the building structures where fireproofing or moisture proofing could be impaired.

### 3.2 INSTALLATION

- A. System equipment shall not be installed until the environment is free of dust. A dust-free environment shall be considered one in which all construction work has been completed and the air handling system for the area has been operated continuously for at least two weeks with a filter change after one week. During and following installation of the system equipment, relay assemblies and equipment cabinets, the air handling system shall be kept operational continuously and shall be adjusted to maintain a positive pressure relative to building spaces outside the areas of installation. Openings into the installation spaces shall be kept closed, filters shall be changed at frequent intervals, equipment enclosures shall be kept closed, covers shall be installed and any other provisions for keeping the equipment, assemblies, and cabinets clean and free of dust and deliver shall be employed.
- B. Verify exact location and sizes of all conduit runs and back boxes prior to rough-in.
- C. All switches, connectors, outlets, etc. shall be clearly, logically, and permanently labeled during installation.
- D. All items of equipment related to the AV system shall be installed in the designated positions as defined on the drawings.
- E. All wiring terminations shall be trimmed to the required length for proper system operation and neatly dressed. No excess wire loops shall remain in the final system unless required for maintenance access. Each system wire and cable shall be clearly marked at each end.
- F. All audio and video interconnections shall use the highest quality signal path available.

### 3.3 WIRING

- A. Wiring within equipment enclosures shall be neatly grouped or tied or run in plastic snapcover wireway sections. All connections to panel mounted devices shall employ compression attached full 360° ring type or 'push-on' type terminators securely fastened to the device terminals. Wiring shall run behind the panel in a manner that is not visible from the operator's position. A 3" termination loop shall be formed immediately adjacent to each terminal.
- B. Terminal strips shall be fully insulated but allow insertion of test equipment probes. Each terminal segment shall be numbered to correspond with the drawings and conductor identification numbers.

- C. All wire and cable shall extend to each outlet location with complete electrical continuity and without any shorts or grounds. Cables shall run uninterrupted and un-spliced to each remote device.
- D. Cables shall be routed so as to maintain a separation of at least 2 feet from all heat sources and from ballasts, transformers, dimmers and all other sources of electromagnetic interference.
- E. Care shall be exercised during installation not to damage the cable insulation. Damaged cables shall be removed and replaced.
- F. Each cable termination shall be tagged and labeled.
- G. Wire color coding for all AV cabling shall be at the option of the Contractor, but each individual conductor shall be the same color throughout its entire length.
- H. After testing is complete, audio levels on all systems shall be set to levels satisfactory to Owner.

### 3.4 SYSTEM CONFIGURATION

- A. Contractor shall provide for configuration of all devices and software into a complete and fully operational AV System.
  - 1. All configuration files shall be provided to Owner as part of the close-out package
    - a. Contractor shall maintain Ownership of any custom software files.
    - b. Contractor shall extend to Owner a perpetual license for use and modification of any custom software files when used with systems provided as part of this scope of work.
- B. During the installation phase of the project, the Contractor shall work with Owner to establish the baseline configuration requirements for the different AV elements.

### 3.5 CONFIGURATION REQUIREMENTS

- A. An IP Addressing Plan shall be coordinated, developed, and finalized with Owner and submitted for approval prior to implementation.
- B. VLAN(s) shall be configured to support the LAN and as identified during Owner network coordination efforts.
- C. Configure AV devices for centralized management via an Owner provided workstation connected to the network. Configuration and management software for the various network components shall be installed on the workstation. Training shall include management of the AV devices via the management workstation.

### 3.6 TESTING

- A. Project Testing: The overall Audio Visual Systems shall not be considered complete until On-Site Testing is completed. The purpose is to test the complete system and demonstrate that all specified features and performance criteria are met. All requirements of the specification shall be tested.

- B. Contractor shall follow the Avixa/ANSI 10:2013 *Audiovisual Systems Performance Verification* testing and documentation process and submit a completed testing plan prior to final Owner and Design Professional testing.
  - 1. Design Professional may elect to request retesting of individual rooms following the Avixa/ANSI 10:2013 standard until satisfied that systems are properly installed and configured.
- C. For any system or equipment types not covered in the Avixa/ANSI 10:2013 standard, Contractor shall provide the proposed test plan/procedures for each testing phase for review by Owner or Design Professional. The test plan for each phase of testing shall detail the objectives of all tests. The tests shall clearly demonstrate that the system and its components fully comply with the requirements specified herein. The submission of Test Plans shall adhere to the following:
  - 1. A draft test plan shall be presented to Owner at least forty-five (45) days prior to the scheduled start of each test.
  - 2. A workshop for reviewing comments shall be conducted with Owner at least thirty (30) days prior to the scheduled start of each test.
  - 3. A final test plan shall be submitted to Owner at least fourteen (14) days prior to the scheduled start of each test.
  - 4. Test plans shall contain at a minimum:
    - a. Functional procedures including use of any test or sample data.
    - b. Test equipment is to be identified by manufacturer and model.
    - c. Interconnection of test equipment and steps of operation shall be defined.
    - d. Expected results required to comply with specifications.
    - e. Testing matrix referencing Specification requirements with specific test procedures.
    - f. Record of test results with witness initials or signature and date performed.
    - g. Pass or fail evaluation with comments.
- D. The test procedures shall provide conformity to all Specification requirements. Satisfactory completion of the test procedure is necessary as a condition of system acceptance.
- E. All Test plans must be reviewed by Owner. To successfully complete a test, the test document must be signed and dated by both the Contractor and Owner.
- F. Owner will review, witness and validate the execution of all formal test procedures prepared by the Contractor and deliverable under the contract to assure the tests cover all requirements and that there is a conformity between the conducted test, the test results and Specification requirements.
- G. Documentation verification both interconnects and operationally, shall be part of the test. Where documentation is not in accordance with the installed system interconnect and operating procedures, the system shall not be considered accepted until the system and documentation correlate.
- H. The Contractor shall provide Owner or Owner representative the opportunity to participate in any or all of tests.
- I. Test Reports: The Contractor shall prepare, for each test, a test report document that shall certify successful completion of that test. Submit to Owner's representative for review and acceptance within seven (7) days following each test. The test report shall contain, at a minimum:
  - 1. System power measurement results and settings

2. Commentary on test results
3. A listing and discussion of all discrepancies between expected and actual results and of all failures encountered during the test and their resolution.
4. Complete copy of test procedures and test data sheets with annotations showing dates, times, initials, and any other annotations entered during execution of the test.
5. Signatures of persons who performed and witnessed the test
6. Test Resolution: Any discrepancies or problems discovered during these tests shall be corrected by the Contractor at no cost to Owner. The problems identified shall be corrected and the percentage of the entire system re-tested determined by Owner before any subsequent testing is performed.

### 3.7 CLEANING

- A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where work has been completed unless designated for storage.

### 3.8 TRAINING

- A. The Contractor shall provide a minimum of two hours of onsite training per space type with Owner specified trainees. Training may be broken into two categories with dedicated sessions for each; technical and operational.
  1. Technical training includes Owner's technical or administrative staff and is intended to cover overall space functionality, infrastructure, individual equipment operation, preventative maintenance and troubleshooting.
  2. Operational training includes Owner's users or day-to-day administrative staff and is intended to cover overall space functionality, a walkthrough of typical use cases and troubleshooting.
- B. The Contractor shall provide the trainees with detailed as-built information. The training shall provide trainees with a working knowledge of the system design and layout, ability to configure and monitor the system, and troubleshooting methods and techniques. In addition, the training shall cover testing, maintenance, and repair procedures for all equipment and applications, which are provided under this Specification.
- C. Course materials shall be delivered to Owner. Final delivery of the course materials shall include a master hard copy of all materials and an electronic copy in a format reviewed in advance by Owner. The Contractor shall supply a video recording of each training course.
- D. All training shall be completed a minimum of two weeks prior to the system becoming operational and utilized by Owner. Training schedule subject to Owner's review.

### 3.9 ACCEPTANCE

- A. Acceptance will be withheld until the following have been completed successfully:
  1. Acceptance of all submittals
  2. Delivery of final documentation
  3. Successful testing
  4. Completion of training
  5. Demonstrate system to designated Owner personnel as required by applicable sections of these specifications. Use submitted operation and maintenance manual as reference



during demonstration and training. Demonstrate as-built records are in format required and can lead troubleshooting technicians to port level of detail in field.

END OF SECTION

**SECTION 27 52 23  
NURSE CALL/CODE BLUE SYSTEMS**

**PART 1 - GENERAL**

**1.1 STIPULATIONS**

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.
- B. Related Sections:
  - 1. Division 07 – Through-Penetration Firestop Systems
  - 2. Division 26 – Common Work Results for Electrical
  - 3. Division 26 – Low-Voltage Electrical Power Conductors and Cables
  - 4. Division 26 – Grounding and Bonding for Electrical Systems
  - 5. Division 26 – Hangers and Supports for Electrical Systems
  - 6. Division 26 – Box and Covers for Electrical Systems
  - 7. Division 26 – Surface Raceways for Electrical Systems
  - 8. Division 26 – Identification for Electrical Systems
  - 9. Division 27 – General Requirements for Telecommunications
  - 10. Division 27 – Common Work Elements for Communications Systems
  - 11. Division 27 – Network Communications Systems
  - 12. Division 27 – Two-Way Communications System
  - 13. Division 27 – Audiovisual Systems
  - 14. Division 27 – Nurse Call/Code Blue
  - 15. Division 28 – Common Work Elements for Electronic Safety and Security
  - 16. Division 28 – Physical Electronic Safety and Security
  - 17. Division 28 – Video Surveillance System
- C. Section includes visual/tone nurse-call system.

**1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Equipment cabinets.
  - 2. Cabling diagrams.
  - 3. Station installation details.

**1.3 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.
- B. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Compatibility: System shall be capable of integration with any brand of phone system (wired or wireless), staff locating system, CCTV, and fire-alarm system.
- C. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for 2 years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within 2 years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
- C. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

**PART 2 - PRODUCTS**

2.1 NURSE-CALL SYSTEM GENERAL REQUIREMENTS

- A. Station Zones: Able to program 256 station zones for each master station in the network with a minimum of 8 priority levels and addressable visual and audible annunciation of audible devices such as smoke detectors and door contacts.
- B. System shall provide integrated and centralized "Code Blue" and "Staff Emergency" calls.
- C. Expansion Capability: Equipment ratings, housing volume, spare keys, switches, relays, annunciator modules, terminals, and cable conductor quantities adequate to increase the number of stations in the future by 25 percent above those indicated without adding internal or external components or main trunk cable conductors.
- D. Resistance to Electrostatic Discharge: System, components, and cabling, and the selection, arrangement, and connection of materials and circuits, shall be protected against damage or diminished performance when subjected to electrostatic discharges of up to 25,000 V in an environment with a relative humidity of 20 percent or less.

- E. Equipment: Microprocessor, electronic, modular.
- F. Master Nurse-Call Station: Programmed via a PC.
- G. Wall-Mounted Component Connection Method: Components connect to system wiring in back boxes with factory-wired plug connectors.
- H. Telephone Interface: Permit use of wired and wireless telephones to execute nurse-call master station functions.
- I. Third-Party Pager Interface: Programmable to send tone, numeric, and alphanumeric message to pocket pagers or personal digital assistants and to use industry standard-protocol, RS-485 interface.

## 2.2 VISUAL/TONE NURSE-CALL SYSTEM

### A. Operational Requirements:

1. Patient Station Call: Lights a steady call-placed lamp on the station, steady lamps in the zone light and corridor dome light associated with the patient's room, and steady lamps at the central annunciator and other system display devices and displays message on master and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the respective annunciator and master and staff/duty stations. Legends at the central annunciator and master station identify the calling station.
2. Pull-Cord-Call Station Call: Flashes a call-placed lamp on the station and distinctive-color lamps in the zone light and corridor dome light and at the central annunciator and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the central annunciator and master and staff/duty stations. A legend at the master station identifies the calling station, priority as programmed, and bed identification.
3. Emergency-Call Station Call: Produces the same responses as pull-cord-call station calls except rapidly flashing red emergency digital display and tone repetition rates are more frequent, tone frequency is higher, and lamps in the zone light and corridor dome light are a different color. Indicator lamps may be turned off and the system reset only at the calling station. Displays message on pocket pagers, sounds programmed tone on phones, and displays message on display equipped phones.
4. System Reset: Operating reset button at the originating station cancels signals associated with the call. Illuminates a green digital display on the patient station and log presence on the master station.
5. Cord-Set Removal: Initiates a patient station call when the cord set is removed from the jack in the patient station faceplate. Displays location and "cord removed" message on master station, pocket pagers, and display equipped phones. Inserting a cord-set plug or a dummy plug into the jack and operating the station reset button resets the call.
6. Patient Control Unit: Controls entertainment volume and channel selection. Nurse button on the unit initiates a patient station call. Integral speaker reproduces entertainment sound.
7. Emergency Bath Station Call: Illuminates the digital display on the emergency bath station; rapidly flashes white dome lamp; displays location, priority, and bath on master station; and sounds programmed tone on master station display equipped phones and pocket pagers.

8. Staff/Duty Station Operation: Operation shall be identified to patient station except the message staff shall display on all devices when the staff call button is activated.
9. Privacy Key Activation: When privacy key is activated on patient station, the system shall disconnect the patient station microphone and slowly flash yellow privacy digital display on the patient station. Displays "privacy" on master station when selecting this room/bed.

**B. Central Annunciator:**

1. Lamp type.
2. Lamp Legends: Machine lettered and legible from a distance of at least 48 inches when a call is present. Legend shall identify initiating station and priority of call.
3. Power-on Indicator: Digital, or push-to-test switch.
4. Audible Signal: Electronic tone.

**C. Central Equipment Cabinet:**

1. Lockable metal.
2. Houses power supplies, controls, terminal strips, and other components.
3. Power-on indicator lamp.

**D. Single-Patient Station: Call-placed lamp, reset push button, and polarized receptacle matching cord-set plug; mounted in a single faceplate.**

**E. Staff/Duty Stations: A minimum of two call lamps, one for routine calls and one for emergency calls; and an audible tone signal device.**

**2.3 SYSTEM COMPONENTS**

**A. Emergency-Call Station: Locking-type push button, labeled "Push to Call Help"; reset trigger to release push button and cancel call; and call-placed lamp, mounted in a single faceplate.**

**B. Emergency-Bath Station:**

1. Consists of a sliding, chemical-resistant, ABS red fascia marked with the word "URGENT" in bold letters.
2. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
3. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
4. Water resistant and able to withstand routine cleaning and chemical disinfectants.
5. Uses magnetic reed switch technology for reliability and corrosion resistance.
6. Mounts on a single-gang electrical box wire to the respective patient station or input controller.

**C. Staff, Emergency Station:**

1. Consists of a sliding, chemical-resistant, ABS red fascia marked with the word "EMERGENCY" in bold letters.

2. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
  3. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
  4. Mounts on a single-gang electrical box wire to the input controller.
- D. Pull-Cord-Call Station:
1. Pull-Down Switch: Lever-locking type, labeled "Pull Down to Call Help."
  2. Reset trigger.
  3. Call-placed lamp.
  4. Water-resistant construction.
- E. Patient Control Unit:
1. Equipped with plug and 96-inch long white cord.
  2. Ethylene oxide, sterilizable.
- F. Pillow Speakers:
1. Eight-conductor, DIN, flexible PVC jacketed cable.
  2. Contain nurse-call button, volume control, speaker, and channel control in molded flame-retardant ABS housing.
  3. Cord: 96 inches long with sheet clip.
- G. Call-Button Plug:
1. Designed to plug into patient station cord-set receptacle.
  2. Button switches call circuit.
  3. Two plugs for every 10 patient beds.
- H. Dummy Plugs:
1. Designed to plug into patient station cord-set receptacle when call-button plug or patient cord set is not used.
  2. Three plugs for every 10 patient beds.
- I. Indicator Lamps: Digital type with rated life of 20 years unless otherwise indicated.
- J. Station Faceplates:
1. Stainless steel, a minimum of 0.0375 inch thick.
  2. Finish: Brushed.
  3. Machine-engraved labeling identifies indicator lamps and controls.
- K. Corridor Dome Lights and Zone Lights:
1. Three-lamp signal lights.
  2. Lamps: Front replaceable without tools, low voltage with rated life of 7500 hours. Barriers are such that only one color is displayed at a time.

3. Lenses: Heat-resistant, shatterproof, translucent polymer that will not deform, discolor, or craze when exposed to hospital cleaning agents.

L. Cable:

1. Conductors: Jacketed single and multiple, twisted-pair copper cables.
2. Sizes and Types: As recommended by equipment manufacturer.
3. Cable UL-Listed and labeled for plenum installation.

M. Grounding Components: Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

## 2.4 SOFTWARE REQUIREMENTS

A. Telephone System Interface:

1. Permits use of wired and/or wireless telephones to execute nurse-call master station.
2. Two-way communication with patient and staff stations.
3. Two-way communication with the master nurse station.
4. "All Call," group call, and staff call paging.
5. Capable of being programmed to forward calls destined for a master nurse station to any connected telephone.
6. Telephones connected to the telephone interface shall have the same call tone ring patterns as those generated at the master nurse station.
7. Telephones having a display shall indicate the call type, priority code, and the calling station number of incoming calls.
8. Telephones shall be capable of initiating a service request for a particular patient station, logging calls on the master station's reminder list, and activating door lock mechanisms associated with a call station.
9. Capable of routine setup and configuration changes using the keypads on display telephone and/or the master station.

B. Display Telephones:

1. Digital telephones for use as mini-master nurse-call stations.
2. Digital display shall indicate the call type, priority code, and calling station number of incoming calls.
3. Ring patterns shall be identical to those generated at the master station.
4. Capable of two-way communication with patient and staff stations and the master station, and other telephones interfaced with the system.
5. Capable of placing or answering outside calls when interfaced with the facility telephone system.
6. Capable of "All Call," group call, and staff call paging and of initiating service requests, logging calls to the reminder list, and activating optional door controls.

C. Third-Party Pocket Pager Interface:

1. Equipped with a standalone pocket pager interface.
2. Connects with the facility paging system and transmit alphanumeric messages to the pocket pagers as preprogrammed in the system.

D. Statistical Software:

1. Includes a data statistical software package that stores, sorts, and analyzes activities occurring on the nurse-call system network.
2. Windows based and operated on a PC that is connected to the nurse-call system network.
3. Stores events on the PC's hard disk. Accumulation of these stored events shall make up the database that is used to generate reports and statistics.
4. Events stored by the software shall include date, day of week, time, ward, priority, and room number.
5. Capable of assigning a patient name to bed number.
6. Stored events shall include, but not be limited to, calls placed, call priority, calls cancelled at the nurse station, calls cancelled at the point of origin, regenerated calls, calls answered, calls sent to pager interface, staff presence registration, staff presence cancellation, service request, service cancellation, and system and network error messages.

E. Data Analysis Software:

1. Capable of analyzing the stored information and generating computed analysis.
2. Analysis of the database can be conducted by specifying one, many, or all of the following parameters of the database: date, day of week, time, wards, priority, and room number.
3. Analysis shall include, but not be limited to, total number of calls placed, average call response time (from call placed to call cancellation), total number of presence registrations, average presence time in a room, total number of service requests, average response time (from audio answer to call cancellation), and average ring time (from call placed to audio answer).

F. Statistical Software Package:

1. Capable of displaying multiple calls/events on a PC monitor or on a RS-485 data-bus-driven digital display panel.
2. Calls from patient or staff stations and associated devices shall be displayed by priority. Display shall be customizable as follows:
  - a. Choice of color by type of call.
  - b. Choice of display size (character size).
  - c. Choice of priority levels, type of events, points of origin.
  - d. Identification of facility.
  - e. Identification of ward.
  - f. Identification of patient with specific patient information.

2.5 CONDUCTORS AND CABLES

A. Audio Cables:

1. Conductors: Jacketed, twisted-pair and twisted-multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
2. Insulation: Thermoplastic, not less than 1/32 inch thick.
3. Minimum Shielding Coverage on Conductors: 60 percent.



- 4. Plenum Cable: Listed and labeled for plenum installation.
- B. Data Cable and Hardware: Category 6 balanced twisted-pair cabling and hardware. Comply with requirements in Section 271100.
- C. Power Conductors and Cables: Copper, solid, No. 20 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Grounding Conductors and Cables: Copper, stranded, No. 16 AWG. Comply with requirements in Section 260526 "Low-Voltage Electrical Power Conductors and Cables."

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Wiring Method:
  - 1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used.
    - a. Install plenum cable in environmental air spaces, including plenum ceilings.
    - b. Conceal raceway and cables except in unfinished spaces.
  - 2. Conduit and Boxes: Comply with requirements in Section 270528 "Pathways for Communications Systems."
- B. Install cables without damaging conductors, shield, or jacket.
- C. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.
- D. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
  - 1. Pull cables simultaneously if more than one is being installed in same raceway.
  - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
  - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
- E. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.
- F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

- G. Separation of Wires: Separate speaker/microphone, line-level, speaker-level, and power-wiring runs. Run in separate raceways or, if exposed or in same enclosure, provide 12-inch minimum separation between conductors to speaker/microphones and adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors.
- H. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Install terminal cabinets where there are splices, taps, or terminations for eight or more conductors.
- I. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks if required.
- J. Identification of Conductors and Cables: Comply with requirements in Section 270553 "Identification for Communications Systems" for cable administration, cable schedule, and cable and wire identification.
- K. Equipment Identification:
  - 1. Comply with requirements in Section 270553 "Identification for Communications Systems" for equipment labels and signs and labeling installation requirements.
  - 2. Label stations, controls, and indications using approved consistent nomenclature.

### 3.2 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other signal impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding except at connection to main building ground bus.
- C. Grounding Provisions: Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Schedule tests a minimum of seven days in advance.
  - 2. Report: Submit a written record of test results.

3. Operational Test: Perform an operational system test and demonstrate proper operations, adjustment, and sensitivity of each station. Perform tests that include originating station-to-station and "All Call" messages and pages at each nurse-call station. Verify proper routing, volume levels, and freedom from noise and distortion. Test each available message path from each station on the system. Meet the following criteria:
    - a. Speaker Output: 90 dB plus or minus 3 dB, 300 to 3000 Hz, reference level threshold of audibility 0 dB at 0.02 mPa of sound pressure.
    - b. Gain from patient's bedside station to nurse station, with distortion less than 65 dB (plus or minus 3 dB, 300 to 3000 Hz).
    - c. Signal-to-Noise Ratio: Hum and noise level at least 45 dB below full output.
  4. Test Procedure:
    - a. Frequency Response: Determine frequency response of two transmission paths by transmitting and recording audio tones.
    - b. Signal-to-Noise Ratio: Measure the ratio of signal to noise of the complete system at normal gain settings using the following procedure: Disconnect a speaker/microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure the ratio of signal to noise and repeat the test for four speaker microphones.
    - c. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 300, 400, 1000, and 3000 Hz into each nurse-call equipment amplifier and measure the distortion in the amplifier output.
  - D. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify, by the system test, that the total system meets these Specifications and complies with applicable standards. Report results in writing.
  - E. Inspection: Verify that units and controls are properly labeled, and interconnecting wires and terminals are identified.
  - F. Prepare test and inspection reports.
- 3.4 ADJUSTING
- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sound levels and controls to suit actual occupied conditions. Provide up to 3 visits to Project during other-than-normal operating hours for this purpose.
- 3.5 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse-call equipment.

**END OF SECTION 275223**

**SECTION 28 05 00**

**COMMON WORK ELEMENTS FOR ELECTRONIC SAFETY AND SECURITY**

**PART 1 - GENERAL**

**1.1 STIPULATIONS**

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.
- B. Related Specification Sections:
  - 1. Division 07 – Through-penetration Firestop Systems
  - 2. Division 26 – Common Work Results for Electrical
  - 3. Division 26 – Low Voltage Electrical Power Conductors and Cables
  - 4. Division 26 – Grounding and Bonding for Electrical Systems
  - 5. Division 26 – Hangers and Supports for Electrical Systems
  - 6. Division 26 – Raceways and Boxes for Electrical Systems
  - 7. Division 26 – Identification for Electrical Systems
  - 8. Division 27 – General Requirements for Telecommunications
  - 9. Division 27 – Common Work Elements for Communications Systems
  - 10. Division 27 – Network Communications Systems
  - 11. Division 27 – Two-Way Communications System
  - 12. Division 27 – Audiovisual Systems
  - 13. Division 28 – Common Work Elements for Electronic Safety and Security
  - 14. Division 28 – Physical Electronic Safety and Security
  - 15. Division 28 – Video Surveillance System
- C. Reference Symbols:
  - 1. All device symbols are defined by the appropriate symbol schedule on the symbols and abbreviations sheet in the communications system drawing package. Not all device symbols as indicated may be required for the project.
    - a. Because of the scale of the drawings, symbols are shown on the drawings as close as possible to the mounting location. Contractor shall coordinate exact locations with architectural drawings and all affected trades prior to submittal of shop drawings.
- D. Abbreviations:
  - 1. ASIS: American Society Industrial Security (International)
  - 2. AP: Wireless Access Point
  - 3. A/V: Audio Visual Systems – For purposes of this specification section A/V systems shall include all Media Management, Video Broadcasting, Intercommunications (Paging/Public Address, Clock, Auxiliary Sound), Video Intercom, Emergency Communications, Mass Notification, Master Antenna (MATV) and Distance Learning Systems.
  - 4. AVI Audio Visual Systems Integrator: Shall be a qualified Contractor experienced in the installation and certification of A/V systems. The

AVI Contractor shall be responsible for the design, testing and certification of all audio/visual systems including but not limited to Intercommunications, TV Distribution, Audio/Visual, Master Antenna and Bi-Directional Antenna systems as well as all structured cabling systems supporting these technologies. The AVI shall be RCDD registered certified for the installation and commissioning of all structured cabling networks and communications systems.

5. BACnet: A communications protocol for building automation and control networks as outlined in ISO 16484-5 and ASHRAE/ANSI Standard 135.
6. BAS: Building Automation System
7. BICSI: Building Industry Consultant Services International- International organization whose primary objective is to enhance the reputation and skills of companies and individuals employed in the telecommunications and security industries by ensuring that current and developing standards are maintained.
8. CATV: Community Antenna Television System – Cable TV Network
9. CCD: Charge-coupled device.
10. CCTV: Closed Circuit Television Surveillance System.
11. CMOS: Complementary metal–oxide–semiconductor
12. CP: Consolidation Point - Local Interconnection Point between horizontal cables from the building IDF/MDF rooms and horizontal cables for the furniture drops.
13. CPU: Central Processing Unit
14. DP: Demarcation Point - The point of interface between the Communications Networks, MATV, any Auxiliary Systems, and the associated Service Providers or Public Utilities. Also known as Entrance Facility. Shall also serve as the primary termination point for all incoming OSP cabling as well as the primary main grounding bus-bar for all communications systems. Refer to project documents for exact location and termination requirements.
15. DVR: Digital Video Recorder.
16. DTS: Digital Termination Service: A microwave-based, line-of-sight communications provided directly to the end user.
17. DVT: Remote digital viewing terminal which shall serve as the video surveillance systems' operator HMI terminal remote from the primary rack mounted HMI.
18. EMI: Electromagnetic interference.
19. EMT: Electric Metallic Tubing.
20. ESS: Electronic Security Systems – Including but not limited to; intrusion detection, physical access control, CCTV video surveillance, electronic perimeter detection, duress alarm, programmable logic controllers (PLC), supervisory control and data acquisition (SCADA), integrated security management platforms and electronic screening systems.
21. ESSI: Electronic Security Systems Integrator– Shall be a qualified Contractor experienced in the design, programming, installation, testing and certification of all Intrusion Alarm, Access Control, CCTV Surveillance and Security Management Systems. The ESSI shall have a registered RCDD professional review and seal the designs, installations and certifications of all structured cabling networks related to the installation of any IP based electronic security system.
22. EVAC: UL Listed Emergency Voice Evacuation System. Not to be confused with the building; Public Address/Intercom, Intercommunications and/or Mass Notification systems.
23. FAS: Fire Alarm System
24. FASI: Fire Alarm System Integrator – Shall be a NICET Level III certified

- Contractor experienced in the installation, programming, testing and certification of Rescue Assistance, Protected Premises and Central Station Signaling Fire Alarm Systems as defined by NFPA 72.
25. GAP: Graphic Annunciator Panel – A custom fabricated fixed display panel providing operational control and visual display of all alarm and system functions related to the operation of the FAS and/or ESSM as described in related specification sections.
26. GFI: Ground fault interrupter.
27. GUI: Graphic User Interface – A specialized program employing graphical display maps of a facility and/or site which, also provides a manual user interface for all system functions and operations by utilizing control and annunciation ICON's from dedicated human machine interface terminals.
28. HMI: Human Machine Interface – A Computer-operated, video control terminal complying with FCC Part 15 CFR Title 47, Subparts A and B, and shall utilize multiple dynamic GUI based displays for annunciation and control LCD flat panel computer monitor or display screen as defined by related specification sections.
29. ICS: Intercommunications system – Shall include but not limited to all intercoms, public address, clock, program, and auxiliary sound or emergency communications systems as defined by related specification sections.
30. IDF: Intermediate Distribution Frame – The room/space that shall serve as the local termination point for all horizontal and backbone cabling. Also shall be known as Equipment Room (ER), Horizontal Cross-Connect (HC) or Floor Distribution (FD).
31. IDS: Intrusion Detection System.
32. I/O: Input/Out – Commonly associated with dry/contact relay based digital integration.
33. ITS: Information Transport Systems – For purposes of this specification section ITS shall include all data and telecommunications communications systems including but not limited to all Data, Telephone, Intercommunications (Paging/Public Address), TV Distribution Systems (MATV) and Audio Visual Systems (A/V) and IP based CCTV Surveillance Systems.
34. ITSI: Information Technology System Integrator – Shall be a qualified Contractor experienced in the installation and certification of all data, telecommunications and A/V systems. The ITSI shall be responsible for the design, testing and certification of Data, Telephone communications systems and all structured cabling systems supporting these technologies.
35. LAN: Local Area Network
36. LCD: Liquid-crystal display.
37. LED: Light Emitting Diode.
38. LV: Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
39. MATV: Master Antenna System – Shall include all TV and media management distribution cabling, termination jacks, head-end components, control, equipment racks, amplifiers, projection equipment and video monitoring devices as defined by the project drawings and related specification sections.
40. MDF: The Main Distribution Frame – The room/space that shall serve as the primary termination point for all backbone cabling to each IDF locations and horizontal connection point for local communication drops. May also serve as a local IDF location as well as the cross-connection and interconnection of all entrance cables from the DP for all PSTN and WAN connections. Also shall be known as Main Cross Connect (MC), Telecommunications Room (TR) and/or Campus Distributor (CD)

- 41. M-JPEG: Motion – Joint Photographic Experts Group.
- 42. MPEG: Moving picture experts group.
- 43. NEC: National Electric Code
- 44. NEMA: National Electrical Manufacturers Association
- 45. NFPA: National Fire Protection Association
- 46. NTSC: National Television System Committee.
- 47. NRTL: Nationally Recognized Testing Laboratory.
- 48. NVR: Network Video Recorder
- 49. NVS: Network Video Server
- 50. OTDR: Optical Time Domain Reflectometer
- 51. OSP: Outside Plant – All cabling associated with building services supporting the incoming service connections to Service Providers, Public Utilities and Wide Area Networks.
- 52. PA: Public Address or Building Intercommunications System.
- 53. PBB: Telecommunications Primary Bonding Busbar
- 54. PACS: Physical Access Control System.
- 55. PIDS: Perimeter Intrusion Detection System
- 56. PIR: Passive Infrared
- 57. POTS: Plain Old Telephone Service – Analog Telephone Circuit used for the connection of FAX machines, BAS and FAS communications devices and shall be wired upstream of the facility's telephone switch.
- 58. PSP: Physical Security Professional as registered by the American Society of Industrial Security-International (ASIS)
- 59. PSTN: Public Switched Telephone Network – Connection to local telephone utility providing local telephony communications service.
- 60. RCDD: BICSI accredited Registered Communications Distribution Designer
- 61. RFI: Radio-frequency interference.
- 62. RIGID: Rigid conduit is galvanized steel tubing, with a tubing wall that is thick enough to allow it to be threaded.
- 63. RS-232: A TIA standard for asynchronous serial data communications protocol between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.
- 64. RS-485: A TIA standard for multipoint communications protocol.
- 65. SBB: Telecommunications Secondary Bonding Busbar
- 66. SCADA: Supervisory Control and Data Acquisition – A system used in to monitor and control plant status of facilities scattered over wide geographic areas.
- 67. SMS: Security Management System – A system incorporating security alarms, door controls, emergency intercoms/paging, duress alarms and surveillance systems all integrated through a single operating platform, providing centralized command and control capability for the various systems via dedicated human machine interface terminals.
- 68. TCP/IP: The standard communications protocol that implement protocol stack on which the Internet and data communications networks operate
- 69. TP: Transition Point – A location in the horizontal cabling where flat under-carpet cable transitions to a horizontal cabling consolidation point (CP).
- 70. TVSS: Transient voltage surge suppressor
- 71. VLAN: Virtual LAN – A technique made possible by switching technologies that permits the logical grouping of any number of network devices into one or more sub- networks.
- 72. UPS: Uninterruptible Power Supply
- 73. UTP: Unshielded Twisted Pair
- 74. VMS: Video Management Software which shall software that incorporates multiple security subsystems (e.g., physical access control, intrusion detection, closed circuit television, intercom) into a single platform and

- graphical user interface.
- 75. VoIP: Voice Over IP telephone Network
  - 76. WAN: Wide Area Network
  - 77. WLAN: Wireless Local Area Network

E. Definitions:

1. Contract Documents: The documents consisting of the Form of Agreement between Owner and Contractor, Conditions of the Contract, (General, Supplementary, and other Conditions), Drawings, Specifications and all Addenda issued prior to the execution of the Contract.
2. Contract Drawings: The drawings that form a part of the Contract Documents that provides the graphical representation of the project requirements intended design and/or performance criteria to be delivered by the Contractor.
3. Reference Drawings: A drawing and/or set of drawings produced by a proprietary supplier, manufacturer, subContractor, or fabricator included in the Contract Documents for informational purposes, providing specific information related to the installation of related appurtenances, components, devices, hardware, products and/or systems. Reference Drawings shall also include any Contract Drawings from prior bid packages that may have pertinent information or require coordination of trades related to this contract.
4. Shop Drawings: A drawing and/or set of drawings produced by the Contractor, supplier, manufacturer, subContractor, or fabricator as a detailed representation of the proper installation of the related, appurtenance, component, device, hardware, product and/or system to be delivered in conformance to the requirements of the Contract Documents.

1.2 SUMMARY

- A. This Section contains the overall requirements associated with all Division 28 Specification Sections and includes the project design intent for all electronic security systems (ESS) as well as requirements for submittals, quality assurance, product handling, record documents, project conditions, installation, system performance, demonstrations, testing, training and certifications for all scopes of work related to these systems. Refer to related specification sections and contract drawings for additional information.
- B. The ESSI shall have overall responsibility for all designs, equipment and all technical support related to all Division 28 scopes of work and shall ensure full coordination of all work with relationship to the Division 26 Contractor as required to provide fully operational security systems as herein specified and in accordance with all requirements of the related specification sections and contract drawings.
- C. It shall be the responsibility of the Contractor to furnish and install all necessary cabling, conduits/raceways, cable terminations, controls, systems, equipment, materials, devices, components, electrical power, equipment racks/cabinets and software as well as all appurtenances, programming, commissioning and testing necessary to deliver complete and fully operational systems as indicated by all division 28 specification sections and related contract drawings.
  1. The installation, performance, features, functions, software and programming criteria as specified herein as well as all related Division 28 specification sections have been



designed to offer the maximum system efficiency, ease of operation, occupant safety and the protection of equipment as recommended by the Owner and Design Professional.

2. Any deviations from the specified criteria shall be documented, reviewed and agreed to in writing by Owner and Design Professional prior to submission of bids. Refer to Division 1, and all related Division 28 specification sections for any substitutions and/or project deviation requests.
    - 1) The required information shall include but not limited to: reason for deviation, all differences in performance, operation and function from the herein specified requirements, all benefits and added features to Owner as a result of the deviations and any additional incurred costs to Owner for maintenance and long term Ownership.
    - 2) Failure to provide the Owner and Design Professional with the required information shall result in any shop drawing submissions being returned for non-conformance with the contract requirements.
  3. The Contractor and all sub-Contractors for this work shall have read all of the General Conditions, Special Requirements, General Requirements, Division 1 and all related specification sections and in the execution of all work shall be bound by all of the conditions and requirements therein.
  4. Prior to the submission of the Bid any discrepancies or inconsistencies noted within these specifications and/or the project drawings shall be brought to the immediate attention of the Owner and Design Professional.
  5. All device symbols are defined by the appropriate symbol schedules as indicated by the symbol and abbreviation drawing sheets for each discipline. The Contractor shall coordinate exact locations with all architectural, mechanical, electrical, reflected ceiling, furniture drawings and door hardware specifications as well as all affected trades prior to submittal of shop drawings.
  6. All symbols are shown on the contract drawings as close as possible to their intended location. Contractor shall coordinate the installation of all equipment, devices, controls, components, cabling conduits/raceways and integration of other systems with all affected trades and specified system integrators. The Contractor shall document all coordination requirements at the time of shop drawing submission.
- D. Drawings for this work are diagrammatic and intended to convey the extent, general arrangement and locations of the work. Because of the scale of the drawings, certain basic items such as access panels, conduits, cabinet sizes, penetration sleeves, pull boxes, back-boxes and junction boxes may or may not be shown on the contract drawings. Include all items where required by code and related specification sections for proper installation of all work.
- E. Where ambiguity exists between the project specifications and the contract drawings, the superior in system performance regardless of cost shall prevail and shall be delivered by the Contractor at no additional expense to the project.
1. Project specifications and drawings may not deal individually with every part, control, device, component, or appurtenance which may be required to produce the equipment performance for the specified system and/or as required for compliance with all specified systems integration.
    - 1) Include such items and components, as required, for complete operational

systems as defined by the project documents, whether or not specifically indicated. The Contractor shall be responsible for providing conduits/raceways, cable terminations, controls, systems, equipment, materials, devices, components, electrical power, equipment racks/cabinets, software, programming, commissioning, testing and all appurtenances as well as the integration of any ancillary systems or Owner provided equipment/components/systems.

- 2) Coordinate with other applicable trades in submittal of shop drawings and the installation of all systems. All shop drawings shall detail space conditions in order to accommodate other concerned trades, all equipment locations are subject to final review by the Owner and Design Professional.

### 1.3 REFERENCES

- A. References to industry and trade association standards as well as all building codes are minimum installation requirements. The codes, standards and agencies listed below shall form a part of this specification section and all work shall comply with the latest adopted standards.
- B. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this and all related division 28 specification sections to the extent referenced. The publications are referenced in the text by the basic designation only.
- C. Where the contract drawings and specifications mandate a greater requirement or performance than those specified by any of the below referenced codes and standards, the Contract Documents shall then be the governing requirements for this project. The minimum codes and standards to be applied for this project shall be the following:

1. American National Standards Institute (ANSI)/ International Code Council (ICC):
  - a. A117.1 - Standard on Accessible and Usable Buildings and Facilities
2. American National Standards Institute (ANSI)/ Security Industry Association (SIA):
  - a. AC-03 - Access Control: Access Control Guideline Dye Sublimation Printing Practices for PVC Access Control Cards
  - b. CP-01-00 - Control Panel Standard-Features for False Alarm Reduction
  - c. PIR-01-00 - Passive Infrared Motion Detector Standard - Features for Enhancing False Alarm Immunity
  - d. TVAC-01 - CCTV to Access Control Standard - Message Set for System Integration
3. American National Standards Institute (ANSI):
  - a. 330-09 - Electrical Performance Standards for CCTV Cameras
  - b. 375A-76 - Electrical Performance Standards for CCTV Monitors
4. American National Standards Institute (ANSI):
  - a. ANSI S3.2-99 - Method for measuring the Intelligibility of Speech over Communications Systems

5. American Society for Testing and Materials (ASTM)
  - a. B1-07 - Standard Specification for Hard-Drawn Copper Wire
  - b. B3-07 - Standard Specification for Soft or Annealed Copper Wire
  - c. B8-04 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
  - d. C1238-97 (R03) - Standard Guide for Installation of Walk-Through Metal Detectors
  - e. D2301-04 - Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape
6. Department of Justice: American Disability Act (ADA)
  - a. 28 CFR Part 36-2010 - ADA Standards for Accessible Design
7. Federal Communications Commission (FCC):
  - a. (47 CFR 15) Part 15 - Limitations on the Use of Wireless Equipment/Systems
8. Federal Information Processing Standards (FIPS):
  - a. FIPS-201-1 - Personal Identity Verification (PIV) of Federal Employees and Contractors
9. Federal Specifications (Fed. Spec.):
  - a. A-A-59544-08 - Cable and Wire, Electrical (Power, Fixed Installation)
10. Owner Accountability Office (GAO):
  - a. GAO-03-8-02 - Security Responsibilities for Federally Owned and Leased Facilities
11. Homeland Security Presidential Directive (HSPD):
  - a. HSPD-12 - Policy for a Common Identification Standard for Federal Employees and Contractors
12. Institute of Electrical and Electronics Engineers (IEEE):
  - a. 81-1983 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
  - b. 802.3af-08 - Power over Ethernet Standard
  - c. 802.3at-09 - Power over Ethernet (PoE) Plus Standard
  - d. C2-07 - National Electrical Safety Code
  - e. C62.41-02 - IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
  - f. C95.1-05 - Standards for Safety Levels with Respect to Human Exposure in Radio Frequency Electromagnetic Fields
13. International Building Code (IBC)
14. International Organization for Standardization (ISO):
  - a. 7810 – Identification cards – Physical characteristics
  - b. 7811 – Physical Characteristics for Magnetic Stripe Cards

- c. 7816-1 – Identification cards - Integrated circuit(s) cards with contacts - Part 1: Physical characteristics
  - d. 7816-2 – Identification cards - Integrated circuit cards - Part 2: Cards with contacts - Dimensions and location of the contacts
  - e. 7816-3 – Identification cards - Integrated circuit cards - Part 3: Cards with contacts - Electrical interface and transmission protocols
  - f. 7816-4 – Identification cards - Integrated circuit cards - Part 11: Personal verification through biometric methods
  - g. 7816-10 – Identification cards - Integrated circuit cards - Part 4: Organization, security and commands for interchange
  - h. 14443 – Identification cards - Contactless integrated circuit cards; Contactless Proximity Cards Operating at 13.56 MHz in up to 5 inches distance
  - i. 15693 – Identification cards -- Contactless integrated circuit cards - Vicinity cards; Contactless Vicinity Cards Operating at 13.56 MHz in up to 50 inches distance
  - j. 19794 – Information technology - Biometric data interchange formats
15. The Joint Commission (TJC) formally - Joint Commission on Accreditation of Healthcare Organizations (JCAHO)
16. National Electrical Contractors Association
- a. 303-2005 – Installing Closed Circuit Television (CCTV) Systems
17. National Electrical Manufacturers Association (NEMA):
- a. 250-08 – Enclosures for Electrical Equipment (1000 Volts Maximum)
  - b. TC-3-04 – PVC Fittings for Use with Rigid PVC Conduit and Tubing
  - c. FB1-07 – Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
18. National Fire Protection Association (NFPA):
- a. 70-2011 – National Electrical Code (NEC)
  - b. 72-2010 – National Fire Alarm and Signaling Code
  - c. 90A 2009 – Installation of Air Conditioning and Ventilating Systems
  - d. 101-2009 – Life Safety Code
  - e. 731-2008 – Standards for the Installation of Electric Premises Security Systems
  - f. 99-2005 – Health Care Facilities

#### 1.4 SUBMITTALS

- A. In addition, to all submittal requirements as stipulated by Division 01 specifications sections, the Contractor shall provide all shop drawing submittals in accordance with the following:
- 1. The Owner and Design Professional approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage, or installation of equipment or material which has not had prior approval will not be permitted at the job site.
  - 2. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for Owner to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be

- legible and clearly identify equipment being submitted.
3. Submittals shall be provided as a complete submission, no partial submissions will be accepted. Failure to provide a complete submission shall result in all submittals being returned for resubmission.
4. No substituted equipment shall be reviewed without prior approval in accordance with the requirements of "substitutions" under Division 1 specification section.
5. Mark the submittals, "SUBMITTED UNDER SECTION \_\_\_\_\_".
  - a. Submittals shall be marked to show specification reference including the section and paragraph numbers.
6. The Contractor shall schedule submittals in order to maintain the project schedule. For coordination requirements refer to Division 01 Specification Sections, which outline basic submittal requirements and coordination. All Division 01 Specification Sections requirements shall be used in conjunction with this specification section.
7. Prior to any submission the Contractor shall be responsible for performing the following quality control items to ensure compliance with all project requirements:
  - a. Review all Shop Drawings and Product Data
  - b. Review all field measurement criteria.
  - c. Review all field construction criteria and methodologies.
  - d. Review all catalog numbers and similar data.
  - e. Review all coordination requirements of affected trades.
  - f. Review conformance to all appropriate specification sections.
8. All drawings shall be prepared using computer aided design software. The Contractor shall not reproduce the Contract Documents or copy standard information as the basis of the technical data, hand drawn mark-ups of the original project drawings shall not be acceptable. Failure to provide a complete set of "Contractor prepared" installation drawings at the time of submittal shall result in all submittals being returned for resubmission.
9. The ESSI shall have a registered RCDD professional review and seal all system designs, installations and testing certification for all electronic security systems and associated structured cabling. Failure to provide RCDD sealed shop drawings shall result in all shop drawings being returned for resubmission without any reviews taking place.
10. The Design Professional's review of shop drawings and/or samples does not relieve the Contractor from compliance with all requirements of the project documents. No deviations from the project requirements shall be accepted unless the Contractor has informed Owner and Design Professional in writing of any such deviations prior to the submission of shop drawings, has noted all deviations on the shop drawing submission, and Owner and Design Professional has given written approval for the specific deviations to the project documents, otherwise all project requirements shall stand. Owner and Design Professional's review does not relieve the Contractor from any responsibility for delivering all criteria as stipulated by the contract documents because of errors, lack of clarity or omissions on the part of the Contractor in the review of shop drawings and/or samples by the Design Professional.
11. Submit all system testing and startup procedures to be employed. Include all estimated times for performance of all tests, all test equipment and manpower necessary for testing.
12. Submit all integrator qualifications, certifications and licenses in accordance with the requirements as specified elsewhere in this specification section.
13. Submit project schedule outlining the time frames for all equipment with long lead times for equipment deliveries; include all system commissioning, testing and training time expectations. Project schedule shall be submitted as CPM schedule and shall utilize a

software based project management program.

**B. Shop Drawings:**

1. All shop drawings shall include sufficient information, clearly presented, to determine full compliance with all project drawings and specifications. Include the following information for review, failure to provide all information listed below shall result in all shop drawing submittals being returned for resubmission:
  - a. All Building Floor and Site Plans
  - b. All equipment with manufacturer's name(s), model numbers,
  - c. All equipment /device electrical ratings and power requirements
  - d. All equipment /device performance ratings.
  - e. All standby battery and wiring voltage drop calculations
  - f. All surge and/or transient protection devices and device locations
  - g. All equipment rack, panels and cabinet layouts, rack/cabinet sizes.
  - h. All equipment and device-mounting elevations.
  - i. All device wiring details.
  - j. Complete point-to-point-wiring diagrams for all systems.  
Include all equipment and wiring termination schedules and programming matrixes.
2. Provide a complete set of "Contractor prepared" installation drawings. All drawings at the minimum shall consist of floor plans indicating all device locations, device identifications, control panels, auxiliary control panels, power supplies, annunciation panels, conduit and cabling requirements as well as all 120 volt electrical circuit locations and designations.
  - a. Drawings shall include at the minimum the following:
    - 1) Detailed equipment layouts for all equipment rooms. Coordinate all room layouts with affected trades.
    - 2) Floor plan drawings showing locations of all control panels, sub-panels, ancillary controls, equipment cabinets and/or racks, annunciator panels, HMI terminals, auxiliary power supplies, devices and sensors, electrical power and grounding terminations as well as all device\sensor identifications
    - 3) Conduit routing of all conduits 2 inches in diameter or greater.
    - 4) System riser diagrams and single line drawings representing interconnections of all system control panels, sub- panels, ancillary controls, equipment cabinets and/or racks, annunciator panels, HMI terminals, auxiliary power supplies, devices, sensors and components, include all cable types and sizes, electrical power connections and circuits, grounding connections, surge and/or transient protection devices and all field device\sensor identifications.
    - 5) Block diagrams and Logic flow charts representing all systems architecture and interconnection of the security management systems (SMS) and fire management systems (FMS) all related integrated subsystems. Include detailed information on all system component integrations, data transmission and media conversions as well as logical functional data and performance criteria.
    - 6) Equipment wattage for all equipment room locations and estimated BTU production.
    - 7) Detailed equipment layouts for all equipment consoles. Indicate all equipment

- locations, power connections and installation details. All equipment mounting hardware/brackets and installation details, Identify type size, load capacities of all mounting hardware/brackets; include all mounting and installation details, all space requirements, any special architectural modifications required.
- 8) Outline drawings of all equipment cabinets/racks showing the relative position of all major components, all-wiring and grounding terminations. Include all panel, cabinet and/or rack dimensions.
- 9) Door Schedules for each door equipped with electronic security components. At a minimum, the door schedules shall be coordinated with Division 08 work and include the following information:
- a) Door Number (Extracted from Architectural Drawings)
  - b) Door location on security floor plan drawing
  - c) Installation Details
  - d) Door Description (Extracted from alarm programming matrixes)
  - e) Data Gathering Panel Input Number
  - f) Door Position or Monitoring Device Type & Model Number
  - g) Lock Type, Model Number & Power Input/Draw (standby/active)
  - h) Card Reader Type & Model Number
  - i) Shunting Device Type & Model Number
  - j) Sounder Type & Model Number
  - k) Delayed Egress Type & Model Number
  - l) Intercom (video or standard)
  - m) Camera ID# associated with camera call-up (Extracted from alarm programming matrixes)
  - n) Type of Electric Transfer Hinge
  - o) Electric Pass-through device
  - p) Remarks Column for Camera
- 10) Camera Schedules for all interior and exterior cameras.  
Note: camera schedule shall be coordinated with the Owner and Design Professional for determination of camera numbers and naming conventions. At a minimum, the camera schedules shall include the following information:
- a) Camera Number
  - b) Camera Naming Convention
  - c) Description of Camera Coverage
  - d) Camera Location description
  - e) Camera location on Floor Plan drawings (include sheet and grid number)
  - f) Camera Type & Model Number
  - g) Mounting Type & Model Number
  - h) Installation Details
  - i) Cable Sizes, Types, Conductors, and Color
  - j) Power Input & Current Draw
  - k) Power Supply Location and electrical circuit number
  - l) Automatic Camera Call input (Extracted from alarm programming matrixes)
  - m) Remarks Column for Camera

3. All shop drawing submissions shall have a registered RCDD professional review and seal all

shop drawings confirming that the proposed cabling infrastructures and terminations are in conformance with all stipulated standards and requirements as herein specified or in related specification sections.

4. Failure to provide all required documentation in accordance will ALL related specification requirements at the time of shop drawing submission shall result in all submittals to be returned for non- compliance to the contract requirements.

**C. Equipment Submittals and Data Sheets:**

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - a. Include all equipment data sheets pertinent to equipment provided. All data sheets shall be highlighted indicating specific equipment supplied. Failure to provide the proper annotation of all equipment shall result in submittals being returned for resubmission.
2. Submit complete technical data necessary to evaluate the material and equipment. Include a complete technical specification for the submitted equipment, noting differences and adherence to this Section. Failure to provide the required data will result in all submittals being returned for resubmission.
3. Submit performance data, equipment ratings, cable requirements, control sequences, GUI based control panels, programming matrixes, logic diagrams and all other descriptive data necessary to describe the installation and operations of the system being provided. Failure to provide the required data will result in all submittals being returned for resubmission.
4. Provide a complete termination schedule of all system devices, sensors, components, equipment and controls, identify all locations as indicated on the installation drawings, include all unique identification numbers which correspond with shop drawing floor plans.
  - a. Include point to point wiring terminations and programming matrixes for all readers and devices
5. Provide a clear and concise sequence of operation that gives, in detail, all information required to properly operate all equipment and systems. Include detailed programming matrixes, indicating at the minimum all manual and automatic functions for all system, components and devices comprising the system being provided.
6. Provide copies of all preliminary graphic screens for all HMI configurations for this project. Graphic maps shall indicate all site plans, floor plan maps, utility screens, camera/monitor interface screens all door control functions, intercom activation's, alarm indications, door interlock functions and ancillary controls.
7. Provide a listing of all recommended time zone and alarm shunting functions.
8. Provide a preliminary list of all on screen emergency response instructions and help menus.
9. Provide system parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
10. Failure to provide all required documentation in accordance will ALL related specification requirements at the time of shop drawing submission shall result in all submittals to be returned for non- compliance to the contract requirements.

**D. Maintenance and Operation Manuals: Submit in accordance with all requirements of**



Division 01 specification sections and as herein specified.

1. Maintenance and Operation Manuals shall be submitted for all systems and equipment specified in the technical sections. Furnish the number of copies as specified by Division 1, all manuals shall be bound in hardback binders, (manufacturer's standard binders) or an approved equivalent prior to the commissioning, testing and final acceptance of each system.
  - a. The Contractor shall also furnish one complete set of manuals as specified herein at the time of shop drawing submission for Design Professional s' use in the review of all submittals.
2. Inscribe the following identification on the cover: "Maintenance and Operational Manual" include the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subContractor installing the system or equipment and the local representatives for the system or equipment.
  - a. The Maintenance and Operation Manuals at the minimum shall include:
    - 1) Copy of approved shop drawing and equipment submittals
    - 2) Internal and interconnecting wiring and control diagrams
    - 3) with data to explain detailed operation and control of all equipment, components, devices and servers.
    - 4) A complete control sequence describing start-up, operation, and shutdown of all equipment, components, devices and servers.
    - 5) Description of the function of each principal item of equipment.
    - 6) Installation and maintenance instructions
      - a) Safety precautions
      - b) Diagrams and illustrations.
      - c) Testing methods.
      - d) Performance data.
      - e) Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
      - f) Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
  - b. Failure to provide all required documentation in accordance with ALL related specification requirements at the time of shop drawing submission shall result in all submittals to be returned for non-compliance to the contract requirements.

#### 1.5 QUALITY ASSURANCE

- A. In addition to all general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections include the following project requirements:
  1. Integrator Qualifications: The projects' Electronic Security System Integrator (ESSI) shall

be an accredited and authorized distributor of the appropriate equipment manufacturer and shall be fully certified in the installation, testing and programming of all equipment being provided. The ESSI shall be a licensed security Contractor with a minimum of five (5) years' experience installing and servicing systems of similar scope and complexity.

- a. The ESS integrator shall be capable of providing documented successful work experience of at least three (3) facilities of equivalent size and technical requirements utilizing the proposed equipment being provided. The system integrator shall have on staff a minimum of one full time individual that holds a current RCDD registration.
  - 1) All electronic security systems and related work shall be certified in writing to the Owner and Design Professional by a RCDD professional asserting that all electronic security system shop drawings and all associated structured cabling is in conformance with all appropriate NEC requirements, EIA/TIA standards; NFPA 731 recommended practices, BICSI recognized installation practices and all related specification sections.
2. Cable Installer Qualifications: The cable installation Contractor shall demonstrate not less than three (3) years' experience in the installation of structured cabling systems and shall have on staff a minimum of one full time member that holds a current BICSI level II installer credential.
  - a. NOTE: The installation of all cabling shall be under the direct supervision of a current BICSI level II installer who shall be knowledgeable in the following technical applications:
    - 1) The Routing and installation of shielded, unshielded, twisted pair, coaxial and fiber optic cables.
    - 2) Generally accepted industry standards, as well as manufacturers written installation instructions, will be used for in-process quality control and final acceptance of the work installation.
  - b. Provide registration number and expiration date of BICSI level II installer assigned to the project.
3. The Owner and Design Professional reserve the right to require the Contractor to submit a list of installations where the products have been in operation before approval of shop drawings.
  - a. Experience shall be defined as the completion of the specific system being provided, with that system being successfully operated by Owner for its intended purpose for at least three (3) years.
  - b. In addition to the above "Experience" shall also be defined as the completion of modifications and renovations to any associated system being provided in any existing occupied facility of this size and magnitude.
  - c. For each facility submit the following:
    - 1) Name and location of facility.
    - 2) Date of Occupancy or beneficial use by Owner.
    - 3) Owner's representative to contact and telephone number.
    - 4) Construction Manager or General Contractor.
    - 5) Project Architect or Engineer.

- 6) Provide detailed information on the installed locations with operational equipment.
4. Service Qualifications: The ESSI shall be a permanent service organization maintained and/or trained by the product manufacturer on the products being provided for this project.
  - a. The integrator shall be properly licensed by the governing municipality (where required) certified to provide the services and work of the specific system being provided.
  - b. In addition, all integrators shall be capable of providing full service for the entire warranty period within an 8-hour response time upon notification of a service emergency.
  - c. Provide registration number and expiration date of RCDD professional.
5. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and materials specified for this project, and shall have manufactured the items for at least three years.
  - a. Product Qualification: The Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  - b. The equipment manufacturer shall submit the appropriate documentation certifying that the project integrator is a qualified service provider and certified in the installation and programming of all manufacturers' products being provided for this project.

#### 1.6 RECORD DOCUMENTS

- A. In addition to all general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections include the following project requirements.
  1. Provide complete set of finalized copies of record documents prior to final acceptance of the project by Owner and Design Professional in accordance with all requirements of Division 01 specification sections. At the minimum the record documents shall contain all information, data and drawings as described in Chapter 1.4 "Submittals" of this specification section.
    - a. As-built documents shall be submitted in both paper and electronic media formats in the quantities as specified by Division 1 specification requirements.
      - 1) All electronic data sheets, control sequences, programming matrixes and other descriptive data shall be provided in PDF format.
      - 2) Copies of all current system programming and associated software shall be provided on downloadable media formatted for the use in restoration all system operations and functionality in the event of a catastrophic failure.

#### 1.7 SOFTWARE AGREEMENT

- A. Included as part of the scope of work for this project Owner shall retain Ownership and access rights of ALL system programs and software associated with all systems installed and/or modified as part of this project.

1. The Contractor shall provide to Owner complete copies of all current software programming and software licenses related to the operation of each system prior to final acceptance of the related Contract scopes of work.
    - a. All programming shall include but not be limited to all device identifications, device descriptions, Programming Logic Matrixes, all program access level passwords as well as all function and sub-function routines.
  2. Programming and software copies shall be provided to Owner on CD or DVD digital formatted media. In addition, the Contractor shall provide a complete hard copy printout of all system programming and shall be included as part of closeout documentation for review by Owner and Design Professional.
- B. Software and firmware upgrade provisions shall be included as part of this specification requirement and shall include the automatic upgrades as required to maintain all software and firmware to the manufacturers most current revision on all system components installed and or modified as part of this project for duration of the warranty period. This upgrade policy shall require the Contractor to install, test and certify all software and firmware upgrades that become available from manufacturer for a period of one year from date of final acceptance to the expiration of the warranty.
1. Upgrading of software shall include all revised/new software, labor, testing certification as well as all licenses, software and all programming copies as described in Chapter 1.6 of this section associated with the installation of all revised software.
  2. These updates shall be accomplished in a timely manner, fully coordinated with the system operators, and incorporated into the operations\maintenance and software documentation manuals.
    - a. One (1) scheduled final update shall be provided near the end of the warranty period, at which time the Contractor shall install and validate the latest released version of the Manufacturer's software and firmware for all systems installed and\or modified for this project.
    - b. All software changes shall be recorded in a log maintained in the unit control. An electronic copy of the most current software update shall be maintained within the log.
      - 1) At a minimum, the Contractor shall provide a description of the modification, when the modification occurred, and name and contact information of the individual performing the modification. The log shall be maintained in a white 3 ring binder and the cover marked "Software Change Log".
  3. Provide not less than thirty days' notice to the Owner and Design Professional to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

#### 1.8 EXTRA MATERIAL

- A. In addition to all general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections refer to related specification sections "Extra Material" for specific requirements.

- B. All Extra materials shall be provided at the time of final acceptance of the project and a signed packing list shall be obtained at the time of delivery. At no time is the Contractor to use the extra materials provided for this project to replace malfunctioning or damaged equipment and or components.
- C. Provide 5% of all material as “ Extra Material.”

## **PART 2 – PRODUCTS**

### **2.1 MANUFACTURED PRODUCTS**

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, that meet and/or exceed the specified performance and features of the equipment and/or systems and for which replacement parts shall be readily available to the system integrator and/or using agency.
  - 1. When more than one unit, device or component of the same class of equipment is required, such units, devices or components shall be the product of a single manufacturer.
  - 2. Acceptable manufacturers for each system shall be as specified and shall be provided in full compliance with the requirements of this and all related specification sections and contract drawings.
    - a. Manufacturers listed as acceptable shall not negate the Contractors’ responsibility for providing all equipment, devices, components and/or systems, in accordance with all functions and performance requirements of the Contract Documents.
    - b. Where manufacturer and/or manufacturer model numbers reference specific system components in the related specification sections, it is to establish the performance requirements and quality of the systems and components only.
      - 1) It is in no way an inference that the referenced model numbers are the manufacturer’s current product and are the only acceptable components for this project unless specifically referenced as “no substitutions”.
    - c. The Contractor shall provide the manufacturers’ most current product that shall meet and/or exceed the specified performance and features of the equipment and/or systems.
    - d. Equivalent UL- listed equipment may be substituted for the approved manufacturers unless stipulated by other specification sections as “No Substitutions”. All substitutions shall be submitted for approval by Owner and Design Professional in accordance with all requirements of Division 01 specification sections and Chapter 1.4 “Submittals” of this specification section.
      - 1) Where systems and/or components are referenced as “no substitutions” the specific system and/or components shall be provided.
      - 2) All substitutions shall comply with all requirements as specified above and all system performance standards shall be maintained.
      - 3) The Contractor shall stipulate the following information impacted by such a substitution.

- a) Any and all extensions in time impacted by the substitution.
    - b) Any changes to the architectural or structural elements to the project
    - c) Differences in operation and/or performance from intended system criteria.
  - 4) Failure to provide the required substitution information shall result in “without consideration” the immediate rejection of the substituted equipment and/or systems.
- B. Equipment Assemblies and Components:
- 1. Components of an assembled unit need not be products of the same manufacturer.
    - a. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
    - b. Components shall be compatible with each other and with the total assembly for the intended service.
    - c. Constituent parts which are similar shall be the product of a single manufacturer.
    - d. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- C. Where Factory or Off-Premises Testing of any equipment, product or assembly is recommended by the product manufacturer or where specified as part of this section and/or any related specification section:
- 1. Owner and/or Owner representatives shall have the option of witnessing all factory tests. The Contractor shall notify the Design Professional at a minimum of thirty (30) working days prior to the performance of any factory or off-premises tests.
    - a. Where the factory or assembly point for all off-premises testing is not within two (2) hours driving time from the project location, the ESSI shall include as part of this project all per diem costs (travel, meals and lodging) for a minimum of two representatives of the using agency and the project Design Professional to witness all testing.
  - 2. Provide four (4) copies of certified test reports containing all preliminary test data and testing procedures shall be furnished to the Owner and Design Professional prior to any final testing and not more than ninety (90) days after completion of any tests.
  - 3. When equipment, product or assembly fails to meet any factory or off-premises tests, retesting of equipment, product or assembly shall be mandated, the Contractor shall be liable for all additional expenses, including all expenses incurred by the Owner and Design Professional for witnessing the retesting of any equipment, product or assembly.

## **PART 3 – EXECUTION**

### **3.1 EQUIPMENT PROTECTION**

- A. Protect all materials, equipment, devices or components permanently installed and/or stored on the job site. Protect all materials, equipment, cabling, devices or components during construction

and after installation, provide appropriate protection of all materials, equipment, components and/or devices until time of substantial completion. All materials, equipment, components and/or devices shall be protected during shipment and storage against any physical damage, dirt, moisture, cold, snow or rain:

1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of any foreign matter; and shall be vacuum cleaned both inside and outside before testing and operating and repainting if required.
  2. Any materials, equipment, components and/or devices, stored on site which have been deemed by the Design Professional to exhibit any indications of damage or exposure dust or moisture shall not be installed and shall returned to the source of supply for immediate replacement.
    - a. The use of spare parts or the return of defective equipment for repair to mitigate the damage of defective materials, equipment, components and/or devices shall not be acceptable. All materials, equipment, components and/or devices shall be new and unused until final acceptance by the Design Professional.
  3. Provide and apply protective material immediately upon receiving the products and maintain throughout the construction process.
    - a. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
    - b. Any damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas is not obvious or detectable.
  4. Failure to properly protect all materials, equipment, components and/or devices prior to final acceptance shall constitute sufficient cause for rejection of materials, equipment, components and/or devices should any defects, damage or degradation in performance is observed.
- B. Immediately replace all malfunctioning materials, equipment, components and/or devices with new unused products up until the time the Design Professional issues final acceptance of the system. The returning of any malfunctioning equipment, devices and/or components to the manufacturer for repair and then reinstallation at the project site shall not be acceptable.
1. All replacement materials, equipment, components and/or devices shall be factory new and not scavenged from the Project's spare parts inventory or factory recycled products unless expressly identified by Contractor prior to replacement and approved beforehand by the Design Professional.

### **3.2 WORK PERFORMANCE**

- A. Installation, final termination, testing, start-up and commissioning of all systems, system components and cabling infrastructures shall be under the direct supervision of the appropriate system integrator. The integrator shall be an accredited and authorized distributor of the appropriate equipment manufacturer and shall be fully certified in the installation, testing, commissioning and programming of all equipment, devices, components and/or systems being provided as part of this project.
- B. Job site safety and worker safety is the responsibility of the Contractor. Ensure that safe access

and egress from all work areas is maintained during movement and installation of materials. Clean up all debris generated by installation activities. Keep all security electronic equipment rooms free of debris at all times.

- C. Pre-installation Conferences: Include provisions to attend all pre- installation conferences at Project site in compliance with all requirements in Division 01 specification section and as herein specified. Review methods and procedures related to installation and operations of all safety and security systems, including, but not limited to, the following:
  - 1. Inspect and discuss electrical and control system roughing-in related to all safety and security systems as well as other preparatory work required to be performed by other trades.
  - 2. Review sequence of operations for each type of system, controls and/or integration to any systems and/or equipment provided by other trades
  - 3. Review and finalize construction schedule and verify availability of materials, installation personnel, equipment, and any preparatory work by other trades needed to make progress and avoid delays.
  - 4. Review required start-up, testing, commissioning and certifying procedures to be employed for each system and any impacts to other trades.
- D. For work on existing facilities, arrange, phase and perform work to assure the operation of all security systems for other buildings and contiguous spaces at all times. Refer to Division 1 specification section for additional information.
- E. All new work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Division 1 specification sections.
- F. Coordinate the installation of all cabling, conduits/raceways and cable trays and equipment with applicable trades to ensure proper operation and function of all integrated systems in accordance with all related specification sections. Refer to Division 1 specification section for additional project coordination requirements.
  - 1. Coordinate with all trades at the time of shop drawing submission detailing all space and/or room conditions. The Contractor shall coordinate with the appropriate trade all conditions impacting the installation of any system including but not limited to all equipment locations, ceilings, lighting fixtures, fire protection piping and ductwork layouts to the satisfaction of all concerned trades, subject to final review by the Design Professional.
    - a. Coordinate exact location of all desktop/counter/wall mounted equipment with the Owner and Design Professional and affected trades prior to the installation of any equipment and/or cabling.
    - b. Coordinate exact location(s) of all ceiling mounted cable, conduits, equipment and/or devices with all architectural plans, reflected ceiling plans and affected trades prior to installation.
    - c. Equipment installations requiring coordination with other trades the Contractor shall provide all templates, back-boxes and equipment anchor bolts for mounting or flush mounting preparation, (e.g. pedestals or other devices requiring mounting on walls, concrete pads or other materials). Coordinate delivery of templates and equipment anchor bolts to preclude any delay in the construction schedule or the work of the affected trade.



- d. If installation of equipment, devices, cabling, raceways, cable trays and/or conduit is performed prior to coordination with other trades, which interferes with work of other trades or operation and maintenance of the facility, make necessary changes to correct the condition at no additional cost to Owner.
  - e. Prior to the final programming of any systems review with Owner and Design Professional all system features, functions, system operations, network mapping, system integrated responses and all related programming as required for the proper operation of the respective security systems.
- G. The Contractor shall maintain a complete set of current and up to date set of shop drawings and equipment submissions at the job site at all times. The Shop drawings and all other submissions shall be marked up to reflect all as-built conditions and shall be made available for review by the Design Professional at request.

### **3.3 EQUIPMENT/CABLE INSTALLATION AND REQUIREMENTS**

- A. All system wiring and equipment installation shall be in accordance with good engineering practices and by all IEEE, TIA, NEC and manufacturer's requirements. Wiring shall comply with all state and local electrical codes. All wiring shall test free from all grounds, shorts, stray voltages and EMI.
- B. Follow manufacturers' instructions for installing, components and adjusting all equipment and cabling. Submit two (2) copies of such instructions to the Design Professional before installing any equipment. Provide a copy of such instructions at the equipment during any work on the equipment. Where no instructions are included with the equipment, follow accepted industry practices and workmanlike installation standards.
- C. Ensure that all security and video, systems cabling supports (conduits, support grips, cable tray and J-hooks) are fully installed before proceeding with cable installation. At no times shall any cables be installed and left unsupported. At no times shall cables be tie-wrapped to any other supporting structure in lieu of specified cable supports. Do not bundle or tie-wrap the cables even within the approved cable supports.
- 1. Do not leave any system cabling unprotected on the floor at any time. If cables must be left on any floor, protect the cables so that they may not be walked on or have any material or equipment placed or rolled on top. Replace all damaged cables from demarcation to termination point; no splicing of damaged cables shall be permitted.
  - 2. Maintain manufacturers recommended minimum bend radiuses of all cabling. Do not stretch, stress, tightly coil, bend or crimp the backbone, horizontal, patch or workstation cables. The Contractor shall keep all cabling out of the way of other trades during staging of any work. The Contractor at the Contractor's expense will replace all severely stressed or damaged cables, equipment and materials as determined by the Design Professional.
- D. Equipment location shall be as close as practical to locations as indicated on the contract drawings.
- 1. Provide all equipment clearances in accordance with NEC requirements. Arrange equipment to facilitate unrestricted access for maintenance and service around all equipment, components and/or cable terminations.

**E. Inaccessible Equipment:**

1. Where the Design Professional determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the project.
  - a. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

**F. Cabling Requirements**

1. Contractors shall have the option to combine all home runs and conductors of same type and voltage "class" in accordance with NEC requirements unless specified elsewhere. Size all conduits and install all conductors in accordance with NEC requirements and manufacturers recommendations.
  - a. All TCP/IP based security system cabling is to be Category-6 and concealed above suspended ceilings, bundled and supported to the building structure. All cabling bundles shall be plenum rated and shall not contain any AC carrying conductors or non-associated security network cables. All TCP/IP based security cabling located above accessible suspended ceilings may be installed without conduit and shall be supported by "J" hooks.
    - 1) Cabling installed above inaccessible ceiling spaces shall be installed in dedicated conduits.
    - 2) No exposed cabling will be acceptable in finished or occupied spaces of the facility without approval by the Owner and Design Professional.
    - 3) Any CCTV, intercom or PACS system cabling installed exterior to the building and/or all cabling being routed from the facility to any remote location external to the project location shall be installed in fiber optic cable.
    - 4) Refer to related specification sections for additional information for additional information related to cabling types, sizes and testing requirements.

**G. Environmental Conditions**

1. Systems, components, devices materials and equipment shall be capable of withstanding the environmental conditions of the space without mechanical or electrical damage or degradation of operating capabilities or performance.
  - a. Interior, Controlled Environment: System components, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 2 to 50 deg C (36 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing and shall utilize NEMA 250, Type 1 enclosures.
  - b. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of -18 to 50 deg C (0 to 122 deg F) dry bulb and 20 to 90 percent relative humidity,

non-condensing and shall utilize NEMA 250, Type 4X enclosures.

- c. Exterior Environment: System components, conduits and back-boxes installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of -34 to 50 deg C (-30 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, condensing. Rated for continuous operation where exposed to rain as specified in NEMA 250, winds up to 137 km/h (85 mph) and snow cover up to 610 mm (24 in) thick shall utilize NEMA 250, Type 4X enclosures.
- d. Hazardous Environment: System components, conduits and back-boxes located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
- e. Corrosive Environment: System components, conduits and back-boxes subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, shall utilize NEMA 250, Type 4X enclosures.
- f. Submersible Environment: System components, conduits and back-boxes subjected to prolonged submersion in water, shall utilize NEMA 250, Type 6P enclosures.
- g. Areas where equipment and devices may be subject to damage by the general population shall be installed in vandal resistant enclosures, all fire alarm devices shall be provided with wire guards.
- h. Console: All console equipment shall, unless noted otherwise, be rated for continuous operation under ambient environmental conditions of 15.6 to 29.4 deg C (60 to 85 deg F) and a relative humidity of 20 to 80 percent.

**H. Conduits/raceway/Cable Trays:**

- 1. All conduits/raceways shall be concealed and shall be installed above accessible finished ceilings and/or in walls. Any conduits/raceways installed in areas requiring installation to be exposed, shall be installed tight to ceilings at right angles to walls and shall not obstruct any access hatches, equipment service panels, lighting or other equipment and/or devices. No exposed conduits/raceways shall be installed without prior approval of the Design Professional prior to installation.
  - a. All raceways shall be supported in accordance with NEC requirements and shall be affixed in such a manner that tampering and/or removal by the general population without the use of specialized tools shall be prevented.
  - b. Outlet Boxes: shall be 4 x4 x 2-1/8 inches deep for all data jack locations and single gang for wall mounted telephone locations.
    - 1) All outlet boxes shall be provided with single or dual gang device mud-rings flush to finished wall as required based on type and configuration of outlet and type of wall construction.
    - 2) Use deep masonry boxes at masonry construction. T-Bar hangers or other appropriate mounting hardware shall be utilized to support boxes mounted in the ceiling.

**I. Penetrations of Walls and Floors**

- 1. All wall/floor penetrations are to be sleeved and fire stopped with approved fire stopping material. Coordinate all cable and conduit penetrations of the structure with all trades.
  - a. All penetrations of walls and floors shall be fire stopped in accordance with the

- ASTM and NFPA standards. Refer to related specification sections for additional information.
- b. Floor penetrations shall be sleeved with a minimum sleeve diameter of 4 inches. An additional penetration shall be provided for future use, sleeved and capped and fire stopped as required.
  - c. Coordinate size of wall penetration with conduit size, number of conductors. Comply with all NEC requirements.
  - d. The fire rating of all penetrated walls, floors, and ceiling structures shall be strictly maintained. All penetrations shall be fire-stopped and sealed by the Contractor.
  - e. Install fire-stopping in open penetrations and in the annular space of penetrations for fire rated barriers.
  - f. Installation of fire-stops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
  - g. Installation of all fire-stopping shall be in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and shall be installed in a manner acceptable to the authority having jurisdiction.
- J. Transient Voltage Surge Suppression: All cables and conductors extending beyond building façade, except fiber optic cables, which serve as communications, control, or signal lines shall be protected against Transient Voltage surges and have Transient Voltage Surge Suppression (TVSS) protection.
1. The TVSS device shall be UL listed in accordance with Standard TIA 497B installed at each end. Lighting and surge suppression shall be a multi-strike variety and include a fault indicator.
  2. Protection shall be furnished at the equipment and additional triple solid state surge protectors rated for the application on each wire line circuit shall be installed within 914.4 mm (3 ft) of the building cable entrance. Fuses shall not be acceptable for surge protection applications. All inputs and outputs shall be tested in both normal mode and common mode to verify there is no interference at the minimum surge suppression test shall meet the following criteria.
    - a. All system power supplies serving exterior system components or devices shall be provided with the appropriate transient surge suppression protection on both the line side as well as the load side.
      - 1) A 10-microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes shall be the minimum performance requirements. Provide surge suppression in accordance with all manufacturers requirements.
      - 2) An 8-microsecond rise time by 20-microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes shall be the minimum performance requirements. Provide surge suppression in accordance with all manufacturers requirements.
      - 3) Maximum series current: 2 AMPS. Provide units manufactured by Advanced Protection Technologies, model #TE/FA 10B or TE/FA 20B or approved equal.
      - 4) Operating Temperature and Humidity: -40 to 85 deg C (-40 to 185 deg) shall be the minimum performance requirements. Provide surge

suppression in accordance with all manufacturers requirements.

### 3.4 GROUNDING AND BONDING

- A. All electronic equipment, conduits, cable trays, racks/cabinets and cable shields shall be properly grounded and bonded in accordance with all requirements of TIA 607-D, NEC 250 and IEEE 1100.
  - 1. All grounding connections shall provide the equalization of all grounding potentials between the building power system and the grounding terminations at the security equipment in order to provide the diversion of electrical transients as well as providing the necessary coupling in order to cancel and/or reduce any voltage transients.
    - a. Equipment Grounding: Metallic structures, equipment racks, cabinets and enclosures as well as all raceways, cable trays, junction boxes, outlet boxes, machine frames, and other conductive items shall be bonded and grounded.
  - 2. All connections of grounding conductors to ground rods, bus bars, rebar, structural members, pipes and fences, as well as splices of any ground conductors, shall be made by exothermic welds except where otherwise noted. All connections to bar lugs shall be exothermic weld or compression type connections. Bolted type connection of ground conductors may only be made where terminal lugs or blocks have been furnished and installed in equipment by the manufacturer.
    - a. Equipment grounding conductors shall be insulated stranded copper, except for sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be permitted to be identified per the NEC.
      - 1) At the minimum bonding connection shall be a #6 AWG copper conductor. All grounding shall provide an effective bonding connection between the protected equipment to the nearest approved building grounding electrode (structural steel) as well as to the local power distribution panel grounding system (e.g., ac branch circuit panel board's equipment grounding busbar). All bonding and grounding connections shall be NEMA type compression or exothermic welded connections.
  - 3. Refer to related specification sections for any additional grounding and bonding requirements.

### 3.5 EQUIPMENT IDENTIFICATION

- A. Identify all system controls, components and equipment cabinets using plastic laminate engraved labels, or approved equal. Firmly affix to the panel, device and/or component.
  - 1. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item or where other method of identification is herein specified. Dymo or Kroy tap adhesive backed lettering shall not be acceptable.
  - 2. Color-code all junction boxes and enclosures per NEC recommendations. At the minimum

provide all security junction boxes as follows:

- a. Color for Security circuits - Orange.
  - b. Color for CCTV circuits - Green
  - c. Color for Fire - Red.
  - d. Letter all pull boxes and junction boxes located in service area tunnels, above accessible ceilings and pipe chases with laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws.
    - 1) Example: Security system "SS," Circuit Number SS-126.  
Engraved laminated plastic tags shall be used for identification and securely fastened in accordance with the project requirements.
3. Permanently label all wiring at both ends with self-adhering plastic labels.
  4. Provide typewritten circuit directories installed in 3-ring binders with transparent page protectors in each control and sub control cabinet and/or equipment rack.

### 3.6 MAINTENANCE & SERVICE

#### A. General Requirements

1. The Contractor shall provide all services required and equipment necessary to maintain the electronic security systems in an operational state as specified after formal written acceptance of the system.
  - a. Provide all necessary material required for performing scheduled adjustments or other non-scheduled work. Impacts on facility operations shall be minimized when performing scheduled adjustments or other non-scheduled work. Refer to Division 1 specification section for additional information.
  - b. The adjustment and repair of the security systems shall include all software and firmware up-dates on all computers, CPU's, HMI terminals, devices, communications and data transmission medias' (DTM), facility interface processors, signal transmission equipment, video surveillance and security management software and processors.
  - c. Test, inspect and service each system on a quarterly basis at three month intervals during the warranty period from the time of final acceptance. The Contractor shall compare each three month test results with the test results at the time of final acceptance.
    - 1) The Contractor shall include as part of the quarterly test the calibration and/or adjustment of any device, component and/or system that has deviated from the original test results at the time of final acceptance.
  - d. For each quarterly maintenance period, provide written notification to Owner of the systems condition before and after service, the exact components that were tested and serviced, and overall status of the system.

#### B. Personnel

1. Service personnel shall be manufacturer certified in the maintenance, testing and repair

of the type of system and equipment provided for the project. Provide the Owner and Design Professional the name of the designated service representative, and of any change in personnel. Owner and Design Professional shall be provided copies of system manufacturer certification for the designated service representative.

- a. Schedule of work to be performed during regular working hours, Monday through Friday, excluding federal holidays.

**C. Emergency Service**

1. Owner shall initiate service calls whenever the system is not functioning properly. The Contractor shall provide the Owner with an emergency service center telephone number. The emergency service center shall be staffed 24 hours a day 365 days a year. Owner shall have sole authority for determining catastrophic and non-catastrophic system failures.

- a. For catastrophic system failures, the Contractor shall provide same day eight (8) hour service response with a defect correction time not to exceed sixteen (16) hours from [notification] [arrival on site]. Catastrophic system failures are defined as any system failure that Owner determines will place the facility(s) at increased risk.
- b. For non-catastrophic failures, the Contractor within 1 business day with a defect correction time not to exceed 48 hours from time of notification.

**D. Records & Logs**

1. The Contractor shall maintain records and logs of each task and organize cumulative records for each component and for the complete system chronologically. A continuous log shall be submitted for all devices. The log shall contain all initial settings, calibration, repair, and programming data. Complete logs shall be maintained and available for inspection on site, demonstrating planned and systematic adjustments and repairs have been accomplished for the system.

**E. Work Request**

1. The Contractor shall separately record each service call request, as received. The record shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing the action taken, the amount and nature of the materials used, and the date and time of commencement and completion. The Contractor shall deliver a record of the work performed within five (5) working days after the work was completed.

**F. System Modifications**

1. The Contractor shall make any recommendations for system modification in writing to the Design Professional. No system modifications, including operating parameters and control settings, shall be made without prior written approval from the Design Professional. Any modifications made to the system shall be incorporated into the operation and maintenance manuals and all related documentation.

**3.7 WARRANTY**

- A. Warrant material and workmanship for a period as specified in Division 1 of the contract documents and all related specification sections. The warranty period shall commence from the date the Contractor received written notification of final acceptance from the Design Professional. At the minimum the Contractor shall provide warranty provisions:
1. Warrant the replacement of defective components/materials and/or correct defective work when given notice by Owner during the warranty period.
  2. Warranty excludes liability for consequential incidental, or special damages due to vandalism, misuse, or acts of God.
  3. Onsite warranty response time by qualified technician shall be within 8 hours upon receipt of request from Owner.
  4. Warranty repairs shall be provided to Owner at no cost. This shall include but not limited to all repairs and/or replacement of defective components/materials, all labor charges, all travel costs and all vehicle charges.
  5. Response time shall be 7 days a week / 24 hours a day / 365 days a year.
  6. Provide test, inspection and service of each system on a quarterly basis at three month intervals.
  7. Contractor must provide verification that they maintain their principal base of operation along with the personnel that will be responsible for providing service within 3 hours driving time to the project site. This tenet of the warranty shall remain in effect for the life of the warranty.
  8. All TCP/IP based security communications cabling and related appurtenances shall be provided with the manufacturers 25 year extended warranty in addition to all requirements above.
- B. The Contractor shall, as a condition of final payment, execute a written warranty certifying all contract requirements have been completed according to all requirements of the Contract Documents.
1. All system testing, commissioning, demonstration and training shall be performed prior to final system acceptance. All defects or damages due to faulty materials or workmanship shall be repaired or replaced without delay, to the satisfaction of the Owner and Design Professional, at the Contractor's expense.
    - a. The Contractor shall provide written documentation of test results and stating what was done to correct any deficiencies. The first inspection shall occur 90 calendar days after the acceptance date. The last inspection shall occur 30 calendar days prior to the end of the warranty.
    - b. The warranty period shall be extended until the last inspection and associated corrective actions are complete. When equipment and labor covered by the Contractor's warranty, or by a manufacturer's warranty, have been replaced or restored because of its failure during the warranty period, the warranty period for any replaced or repaired equipment or restored work shall be reinstated for a period equal to the original warranty period, and commencing with the date of completion of the replacement or restoration work.
  2. In the event any manufacturer customarily provides a warranty period greater than one (1) year, the Contractor's warranty shall be for the same duration for that component.



### 3.8 FIELD SERVICES

- A. Notify Owner and Design Professional in writing, ten days advance of testing of all system cabling to prevent delays in construction schedules.
1. Test all cabling to confirm that no grounds, shorts, sneak currents, RFI and EMI conditions exist prior to start-up and commissioning of all, components, devices, equipment and/or systems.
    - a. Before requesting a final inspection, the Contractor shall perform a series of end to end installation performance tests. The Contractor shall submit for approval by Design Professional all test procedures to be employed, test result forms, and timetable for testing all fiber optic and copper plant wiring.
    - b. Acceptance of the simple test procedures discussed below is predicated on the Contractor's use of the recommended products including but not limited to twisted pair cable, cross-connect blocks, and outlet devices specified and adherence to the inspection requirements and practices set forth. Acceptance of the completed installation will be evaluated in the context of each of these factors.
  2. Perform all tests, as required, by authorities having jurisdiction throughout the facility.
  3. Testing of all electronic security systems shall be in the presence of the Owner and Design Professional as well as all appropriate representatives of the authorities having jurisdiction.
    - a. All completed the security systems shall be fully tested in accordance with all requirements of NFPA 731. Upon completion of a successful testing, the Contractor shall so certify in writing to Owner and Design Professional that all testing was completed, certified and left in first class operational condition, include all completed NFPA 731 certification and test reports.
    - b. The service of a competent, factory-trained engineer or technician authorized by the equipment manufacturer shall be provided to technically supervise installation and participate during initial system programming, start-up, final testing, assist in the final acceptance testing and Owner demonstrations.
    - c. At the minimum all acceptance testing, demonstrations and training shall include, but not be limited to the following:
      - 1) Security Monitoring/Control Systems
      - 2) CCTV Surveillance System Performance and Functions
      - 3) Remote Security Monitoring/Control Systems
      - 4) CCTV Surveillance System programming and configurations
      - 5) UPS and Battery Back-up Functions.
      - 6) Integration of all Auxiliary Systems
  4. In addition, provide all testing, commissioning and certifications as specified by Division 1 specification sections and any manufacturer's recommendations or requirements.
- B. Training
1. In addition to all demonstration and training as specified by Division 1 specification section and all related Division 28 specification sections, system demonstrations and training shall be provided in accordance with all requirements of this section.

2. Prior to acceptance of the work, the System Integrator shall demonstrate to the Owner and Design Professional, all systems and sub-systems all features and functions of each system and shall instruct Owner Representatives in the proper operation, event sequences, programming and maintenance of all systems and sub-systems.
  3. The System Integrator shall furnish the necessary trained personnel to perform all demonstrations and instructions and arrange to have the manufacturer's representatives present to assist with the demonstrations.
  4. Training time shall include, as a minimum, the total time determined by the sum of the times per system as specified in this and related specification sections, for performing the prescribed demonstrations/training. Refer to related specification sections for additional training requirements.
    - a. Allow a minimum of 16 hours' time for each system provided for performing the prescribed demonstrations/training.
      - 1) Provide a minimum of (4) four 4-hour training classes performed at the project location and spaced over a three week interval. Training classes shall be scheduled not less than 48 hours apart to allow Owner User\Operators to familiarize themselves with all system operations.
  5. Provide operation, parts and maintenance manuals defining operation and troubleshooting methods of all systems and review with Owner User\Operators as part of training demonstrations.
  6. Provide detailed video recordings in high quality digitally formatted media of all demonstration and training of all systems and system operations.
    - a. Utilize remote microphones as may be required to ensure high quality audio of the recorded demonstrations.
    - b. Permanently and professionally label all recorded materials and provide self-sealing plastic cases.
- C. Inspections
1. At the completion of the project and prior to final acceptance of the Work, provide evidence of final inspections and approvals to the Owner and Design Professional, as required by the authorities having jurisdiction as well as all requirements of Division 01 specification sections.

**END OF SECTION 28 05 00**

**SECTION 28 13 00**

**ACCESS CONTROL**

**PART 1 - GENERAL**

**1.1 STIPULATIONS**

- A. Project drawings and general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections and all stipulated Specification Sections shall apply to this and all related Division 27 specification sections.

B. Related Sections:

1. Division 07 – Through-penetration Firestop Systems
2. Division 26 – Common Work Results for Electrical
3. Division 26 – Low Voltage Electrical Power Conductors and Cables
4. Division 26 – Grounding and Bonding for Electrical Systems
5. Division 26 – Hangers and Supports for Electrical Systems
6. Division 26 – Raceways and Boxes for Electrical Systems
7. Division 26 – Identification for Electrical Systems
8. Division 27 – Common Work Elements for Communications Systems
9. Division 27 – Audiovisual Systems
10. Division 28 – Common Work Elements for Electronic Safety and Security
11. Division 28 – Access Control
12. Division 28 – Video Surveillance System

C. Reference Symbols:

1. All device symbols are defined by the appropriate symbol schedules. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location.
  - a. Contractor shall coordinate exact locations with all architectural drawings, site plans, reflected ceiling plans, furniture plans, mechanical and electrical drawings as well as all affected trades prior to submittal of any shop drawings.

D. Abbreviations:

1. Refer to Specification Section 28 05 00 for additional information.

E. Definitions:

1. Refer to Specification Section 28 05 00 for additional information.

**1.2 SUMMARY**

A. Section Includes:

1. The Contractor shall include in the bid all labor, materials, tools, plant, transportation, storage costs, software/licenses, installation, programming, configuration, testing,

- commissioning, training, equipment, insurance, temporary protection, permits, fire stopping, inspections, taxes and all necessary and related items required to provide complete and operational equipment / systems shown and described in this section and matching the scope of responsibilities schedule indicated in the security drawing package.
2. This section is intended to define and describe minimum security system performance, required vendors and equipment, and installation standards and criteria.
  3. All equipment and materials provided shall be new and unused and of the most current model or revision. All components of this system shall be installed in a workmanlike manner, following security industry "best practices" and in strict adherence to the manufacturer's specifications and applicable codes.
  4. All Security System design guides, schematic designs, design development documents, device location maps, system records, record documents, operating instructions, and emergency response procedures are extremely confidential. Access to these documents shall be restricted to authorized personnel, the Security System Contractor(s), and approved vendors providing associated services. Parties receiving these documents shall take every reasonable precaution to protect these documents from unauthorized access.
  5. Failure to follow manufacturer guidelines or the substitution of non-approved equipment or materials shall result in the rejection of the installation and shall require remediation efforts.
  6. The Security Contractor shall furnish and install all equipment, accessories and materials in accordance with these specifications and drawings to provide a complete and operating security access and surveillance system.
  7. Any material and/or equipment necessary for the proper operation of the surveillance system not specified or described herein shall be deemed part of this specification.
  8. Final approval and acceptance of the installed systems rests solely with Owner's Facility and Security personnel.

### 1.3 DESCRIPTION OF WORK

- A. Provide all labor, materials, equipment, services and accessories necessary to furnish and install the work of this Section, complete and functional, as indicated in the contract documents and as specified herein.
- B. The following standards, requirements, and equipment access control and video management systems shall be installed:
  1. Networked nodes and panels, configured with the appropriate access, alarm input, and temperature probe application blades.
  2. Lock power supplies, 24VDC, with fused protected outputs.
  3. Systems controller with partitioning feature.
  4. Integration with the building's fire alarm system to release fail-safe locks upon activation of the fire detection system.
  5. Doors identified on the drawings as an access control portal shall include at least one P o E card reader with integral electric door hardware, and door status switch. Additional components, including external request-to-exit devices and push-to-exit emergency buttons, may also be required for specific applications.
  6. The access control system is a network device and will be terminated in dedicated patch panels in the MDF/IDF.

7. Security Contractor shall provide and install individual patch cables between the Data Outlet and the Network Node. Coordinate with Telecommunications Contractor. Data outlet shall be installed inside Network Node panel enclosure.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Submittals shall include information that confirms compliance with contract requirements. Include the manufacturer's name, model numbers, technical data sheets, and shop drawings as required.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for Owner and Engineer to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  1. Wiring Diagrams
  2. System labeling schedules.
  3. Cable administration drawings.
  4. Battery and charger calculations for central station, workstations, and controllers.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section "Operation and Maintenance Data," include the following:
  1. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware supplied under this contract, and PDF files of the hard-copy submittal.
  2. System installation and setup guides with data forms to plan and record options and setup decisions. Submit manufacturer's operation and maintenance data, customized to the specified systems installed. Include system and operator manuals. Training of staff on hardware and software functions.
  3. Maintenance Service Agreement: Submit a sample copy of the manufacturer's maintenance service agreement, including cost and services for a one-year period for Owner's review.
- B. Record Drawings: During construction maintain record drawings indicating location of equipment and wiring. Submit an electronic version of record drawings for the specified systems no later than Substantial Completion of the project. Project record drawings shall accurately show the physical placement of the following:
  1. Equipment and devices.

2. Interfaces to fire alarm system and other external systems.

#### 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70, National Electrical Code; SIA CP-01, and SIA CP-07.
- C. The Contractor shall be responsible for providing, installing, and configuring the access control and video surveillance systems as shown. The Contractor shall also provide certification as required.
- D. The access control and video surveillance systems will be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems.
- E. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- F. Product Qualifications:
  1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  2. Owner reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- G. Contractor Qualifications:
  1. The Security Contractor shall be a licensed Security Contractor with a minimum of five (5) years' experience installing and servicing systems of similar scope and complexity.
  2. The Contractor shall be an authorized regional representative of the system approved for installation. The Contractor shall provide four (4) current references from clients with systems of similar scope and complexity which became operational in the past three (3) years. At least three (3) of the references shall be utilizing the same system components, in a similar configuration as the proposed system. The references must include a current point of contact, company or agency name, address, telephone number, complete system description, date of completion, and approximate cost of the project.
  3. Owner reserves the option to visit the reference sites, with the site Owner's permission and representative, to verify the quality of installation and the references' level of satisfaction with the system.
  4. The Contractor shall only utilize factory-trained technicians to install, program, and service the specified systems. The Contractor shall only utilize factory-trained technicians to install, terminate and service controller/field panels and reader modules.
  5. The technicians shall have a minimum of five (5) continuous years of technical experience in electronic security systems. The Contractor shall have a local service facility.

- H. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed.

- I. Pre-installation Conference: Conduct conference at project site.

## 1.8 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  - 1. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122-degree F dry bulb and 20 to 90 percent relative humidity, non-condensing.
  - 2. Indoor, Uncontrolled Environment: NEMA 250, enclosures. System components installed in non-temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122-degree F dry bulb and 20 to 90 percent relative humidity, non-condensing.

## 1.9 WARRANTY

- A. Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- B. Warranty Period: One year from date of completion.

## **PART 2 - PRODUCTS**

### 2.1 DESCRIPTION:

- A. Security Access System: Subject to compliance with requirements, provide product indicated on Drawings. The access control system for this location shall be an extension of the existing campus platform. Refer to SC series drawings for furnish and installation responsibilities for cabling and access control active equipment.

### 2.2 ACCESS CONTROL AND INTERCOM EQUIPMENT

- A. All access control and intercom active equipment to be Owner furnished and Contractor installed using Contractor provided access control cabling where required on the SC series drawings.

### 2.3 PUSH-BUTTON SWITCHES

- A. Push-Button Switches:
  - 1. Momentary-contact mushroom-type push buttons with stainless-steel switch enclosures.
  - 2. Single gang, with "PUSH TO EXIT" knob, Green in color.
  - 3. Push-button switches shall be powered from their associated controller, using DC power.

4. Push-button switches shall be equipped with an adjustable 1 to 45 second pneumatic time delay.

**B. Mounts**

1. Flush or surface mounting.
2. Push buttons shall be suitable for flush mounting in the switch enclosures.
3. Enclosures shall additionally be suitable for installation in a controlled and uncontrolled indoor environment.

**C. Manufacturer: Dortronics 5236 Series or approved equal.**

**2.4 DOOR HARDWARE INTERFACES**

- A. All hardware interfaces shall be integral to the PoE access control device unless otherwise indicated on the SC series drawing set.

**2.5 FIRE ALARM INTERFACE:**

- A. The Fire Alarm Contractor shall provide fire alarm relays at all doors. The relay shall be mounted on the secure side of the door, above the ceiling.
- B. The Security Contactor shall provide an interconnection between the fire alarm relay and each door controller. The purpose of the interconnection is to drop power to all fail-safe locks upon activation of the fire detection system.

**2.6 CABLES**

- A. General Cable Requirements: Comply with requirements in Division 28 Section "Conductors and Cables for Electronic Safety and Security" and as recommended by system manufacturer for integration requirement.

**B. Plenum-Type, TIA 485-A Cables:**

1. Two pairs, No. 22 AWG, stranded tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.
4. Manufacturer: Belden or approved equal.

**C. Multi-Conductor Reader Cable:**

1. Cable shall be Siamese type composite cable, with multiple sheaths under a common jacket:
  - a. Elem1: 22/1P Conductor Shielded, Lo-Cap, Tinned Copper, RS-485, 120 Ohms;+ 18-02 Conductor Non-Shielded, Bare Copper White Jacket with no Stripe
  - b. Elem2: 18-04 Conductor Non-Shielded, Bare Copper White Jacket with Orange Stripe;
  - c. Elem3: 22-04 Conductor Non-Shielded, Bare Copper White Jacket with Red Stripe;



- d. Elem4: 22-02 Conductor Non-Shielded, Bare Copper White Jacket with Green Stripe NFPA 70, Type CMP.
- 2. Windy City Wire Part No. 4461030-OSDP or approved equal.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for conduits and pathways for access control cabling and conduit at PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Comply with recommendations in SIA CP-01 and CP-07.
- B. Comply with ANSI/TIA 606-C, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Obtain detailed project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.
  - 1. Record setup data for control station and workstations.
  - 2. For each Location, record setup of controller features and access requirements.
  - 3. Propose start and stop times for time zones and holidays and match up access levels for doors.
  - 4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
  - 5. Assign action message names and compose messages.
  - 6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
  - 7. Prepare and install alarm graphic maps.
  - 8. Develop user-defined fields.
  - 9. Develop screen layout formats.
  - 10. Propose setups for guard tours and key control.
  - 11. Discuss badge layout options; design badges.
  - 12. Complete system diagnostics and operation verification.
  - 13. Prepare a specific plan for system testing, startup, and demonstration.
  - 14. Develop acceptance test concept and, on approval, develop specifics of the test.
- D. In meetings with Architect and Owner, present project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

### 3.3 INSTALLATION REQUIREMENTS

- A. Security Systems Contractor shall execute their work in a neat and skillful manner.
- B. The Security Systems Contractor shall provide all wiring, connectors, power supplies, interfaces, and other hardware as necessary to affect an operating system unless specified as being provided by others in the contract drawings and documents.
- C. Wiring and cabling shall be in conduit where exposed to physical damage or tampering. Method and routing of any exposed raceways and/or wiring shall be approved by Owner prior to installation.
  - 1. Cable that is concealed within building structure or above suspended ceilings shall not require conduit.
  - 2. Cable that is not accessible due to location or which is installed at or below the roof deck must be attached to the building structure or structural steel using approved hangers, straps, or other suitable methods. Cables shall not rest directly upon structural steel members or suspended ceiling assemblies.
- D. System components and control devices shall be wired to the appropriate power supply, Network Node, and PoE switch as homeruns. Terminations shall be made in a manner consistent with the equipment manufacturer's written installation instructions.
- E. Conductors and cables shall be specified and sized to reduce voltage drop and ensure proper system operation.
  - 1. Data communications wiring to each door shall be Plenum-rated Category 6, as installed by Division 27 Contractor.
- F. All cable shall be labeled at origin and termination, referencing to a master legend schedule shown on submittal drawings. Labeling and any splice locations shall be noted on Record Drawings.
- G. Security Contractor shall provide trim plates, adapters or back boxes for card readers as needed to mount to electrical back boxes. The color and finish of all trim plates, adapters or back boxes used shall closely match that of the card reader.
- H. Completely seal all exterior openings of outdoor mounted devices and back boxes to make weather-tight.
- I. Miscellaneous hardware required for installation shall be suitable for the purpose for which it is used. Hardware includes nuts, bolts, screws, washers, miscellaneous fasteners, terminals, terminal strips, tie wraps, and related parts. Where the equipment manufacturer specifies hardware for use in the installation, the hardware specified shall be used. The finish on all hardware and fasteners shall be suitable for the environment in which it will be used and shall be selected to minimize corrosion or deterioration due to moisture, sunlight, or temperature extremes.
- J. All electrical power work and conduit work shall be by licensed electricians.

- K. The Security Systems Contractor will be required to install and test local equipment, programming it with an IP address specified by Owner. In all circumstances, the Security Systems Contractor's work shall not be considered complete until the equipment has been programmed and tested to the satisfaction of Owner.

### 3.4 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- B. Furnish and install cables and wiring in accordance with these specifications and the requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum-rated cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
- E. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible.
- F. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- G. Furnish and install end-of-line resistors at the field device location, not at the controller or panel location.

### 3.5 CABLE INSTALLATION

- A. Comply with ANSI/TIA-569-E, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 232-F Cabling: Cabling between devices shall not exceed 50 feet, or distance allowed by equipment manufacturer.

### 3.6 GROUNDING

- A. Comply with Division 26 "Grounding and Bonding for Electronic Safety and Security."
- B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

- C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- D. Bond shields and drain conductors to ground at only one point in each circuit.
- E. Signal Ground:
  - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
  - 2. Bus: Mount on wall of main equipment room with standoff insulators.
  - 3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

### 3.7 INSTALLATION

- A. Furnish and install card readers, keypads, magnetic locks, push buttons, door contacts, and request-to-exit devices. Provide connectivity to these devices if these devices have been furnished as part of the door hardware.

### 3.8 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 260553 "Identification for Electrical Systems" and with ANSI/TIA-606C.
- B. Develop and provide as-built device and cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
  - 1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
  - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
- D. At completion, as-built drawings and information provided by the Contractor shall reflect as-built conditions.

### 3.9 SYSTEM SOFTWARE AND HARDWARE

- A. Configure and test software and hardware and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

### 3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

B. Devices and circuits will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

### 3.11 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checklists according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

B. Train Owner's maintenance personnel on equipment operation, startup and shutdown, troubleshooting, servicing and preventative maintenance procedures. Review the data contained in the Operating and Maintenance Manuals with Owner's personnel. Training shall occur separate from startup activities. Provide 4 hours of training minimum.

### 3.12 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control stations and workstations that have been powered up shall be locked and secured with an activated security system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units", during periods when a qualified operator in the employ of Contractor is not present.

### 3.13 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system.

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.

3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

**3.14 FINAL ACCEPTANCE**

- A. After work is completed, and prior to requesting the Final Acceptance Test, Security Contractor shall conduct a final inspection and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.
- B. Contractor shall notify Owner and Engineer to schedule a Final Acceptance Test. The request for Acceptance Test shall constitute a certification from the Security Contractor that all work is complete and in compliance with the Contractor Documents, all systems have been tested, and all corrections have been made.
- C. Technicians performing the acceptance test shall have been involved in the installation of the system and shall be thoroughly familiar with all aspects of the work.
- D. Security Contractor shall provide all ladders, tools, test equipment as needed to accomplish the Final Acceptance Test.
- E. Any portions of the work found to be deficient or not in compliance with the Contract Documents will be rejected.

**END OF SECTION 28 13 00**

**SECTION 28 23 00**

**VIDEO SURVEILLANCE SYSTEM**

**PART 1 - GENERAL**

**1.1 STIPULATIONS**

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.
- B. Related Sections:
  - 1. Division 07 – Through-penetration Firestop Systems
  - 2. Division 26 – Common Work Results for Electrical
  - 3. Division 26 – Low Voltage Electrical Power Conductors and Cables
  - 4. Division 26 – Grounding and Bonding for Electrical Systems
  - 5. Division 26 – Hangers and Supports for Electrical Systems
  - 6. Division 26 – Raceways and Boxes for Electrical Systems
  - 7. Division 26 – Identification for Electrical Systems
  - 8. Division 27 – General Requirements for Telecommunications
  - 9. Division 27 – Common Work Elements for Communications Systems
  - 10. Division 27 – Network Communications Systems
  - 11. Division 27 – Two-Way Communications System
  - 12. Division 27 – Audiovisual Systems
  - 13. Division 28 – Common Work Elements for Electronic Safety and Security
  - 14. Division 28 – Physical Electronic Safety and Security
  - 15. Division 28 – Video Surveillance System
- C. Reference Symbols:
  - 1. All device symbols are defined by the appropriate symbol schedules. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location.
    - a. Contractor shall coordinate exact locations with all architectural drawings, site plans, reflected ceiling plans, furniture plans, mechanical and electrical drawings as well as all affected trades prior to submittal of any shop drawings.
- D. Abbreviations:
  - 1. Refer to Specification Section 28 05 00 for additional information.
- E. Definitions:
  - 1. Refer to Specification Section 28 05 00 for additional information.

**1.2 SUMMARY**

- A. The intent of this specification is to establish a standard of quality, overall system configuration and equipment requirements for the installation of a new TCP/IP-based Video Surveillance System (CCTV). The Contractor shall be responsible for providing all design, installation, programming, commissioning, testing and certifications as necessary to provide a complete, fully integrated and operating TCP/IP-based Video Surveillance System in accordance with the Contract Drawings and/or as herein specified.
- B. The installation, performance, features, functions, software and programming criteria as specified herein as well as all related specification sections have been designed to offer the maximum system efficiency ease of operation, occupant safety and the protection of equipment as recommended.
  - 1. The scope of work for this project shall include but not limited to providing all necessary conduits, cabling, equipment, components, devices, network video recorders, materials, active network electronics, integration of existing surveillance cameras and ancillary systems in order to provide a seamless and fully integrated video management system.
  - 2. In addition, the video management system platform shall also be fully integrated in a seamless manner with the Stations' new Physical Access Control System (PACS) providing a secondary platform with full operational control and monitoring of all video surveillance system cameras, network recorders and all system functions accessible from the PACS client workstations.
  - 3. The integration to the PACS shall permit system operators to monitor/control and trigger specific surveillance cameras, video monitors and video recordings as well as all related events and alarms annunciated by the physical access control, intrusion detection and emergency call systems.
  - 4. The PACS workstation shall provide a graphical display of all events, controls and functions for all video surveillance system functions and features. Surveillance systems which Do Not conform to the performance criteria or Do Not provide for all functional and operational capabilities in a seamless manner through the PACS platform shall not be acceptable. Refer to all related specification sections for additional information.

### 1.3 REFERENCES

- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) shall form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
  - 1. Closed Circuit Television Manufacturers Association (CCTMA).
  - 2. Open Network Video Interface Forum (ONVIF)
- B. All references to industry and trade association standards as well as all building codes are minimum installation requirements for this system. The codes, standards and agencies listed in specification section 28 05 00 shall form a part of this specification section and all work shall comply with the latest adopted standards.
  - 1. The publications listed in specification section 28 05 00 (including all amendments, addenda, revisions, supplement, and errata) shall form a part of this specification section to the extent referenced. The publications are referenced in the aforementioned



specification section by the basic designation only.

2. Where the contract drawings and/or specification sections mandate a greater requirement or performance than those specified by the aforementioned referenced codes and standards in section 28 05 00, shall then be the governing requirements for this project. Refer to specification section 28 05 00 for all minimum codes and standards to be applied for this project.

#### 1.4 SUBMITTALS

- A. In addition to all requirements as specified by Specification Section 28 05 00 the video surveillance system shall also be provided in accordance with the following requirements:
  1. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
  2. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
  3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  4. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
  5. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
  6. UPS: Sizing calculations.
  7. Wiring Diagrams: For power, signal, and control wiring.
- B. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation.

#### 1.2 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data

#### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NECA 1.
- C. Comply with NFPA 70.
- D. Electronic data exchange between the video surveillance system and access-control system shall comply with SIA TVAC.

#### 1.4 WARRANTY

- A. Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- B. Warranty Period: One year from date of completion for all Contractor provided parts and labor.

## **PART 2 - PRODUCTS**

### **2.1 SYSTEM REQUIREMENTS**

#### **A. Description:**

1. The Video Surveillance system for this project shall be an extension of the existing campus system with storage and licensing provided by Owner.
2. Camera system units shall be furnished by Owner and installed by Contractor.
3. Surge Protection:
  - a. Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
  - b. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements as recommended by manufacturer for type of line being protected.
4. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

### **2.2 NETWORK VIDEO RECORDERS**

- a. Exiting Genetec campus platform.

### **2.3 IP CAMERA SYSTEMS**

- A. Color Dome Camera: Assembled and tested as a manufactured unit, containing fixed color camera, varifocal lens, and vandal resistant dome assembly.
- B. Provide all wall and ceiling mounting hardware and brackets as indicated on drawing details. Coordinate color of mounting hardware with Owner and architect before installation.
- C. PTZ Camera: Assembled and tested as a manufactured unit, containing color camera, varifocal lens, vandal resistant dome assembly, Pan Tilt, Zoom capability and controls.
- D. Approved list of Camera Manufacturers:
  1. Axis or approved equal to be furnished by Owner and installed by Contractor.

### **2.4 POWER SUPPLIES**

- A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera.
- B. Annunciation: Indicate change in system condition and switching of system or component to backup power.

### **PART 3 - EXECUTION**

#### **3.1 VIDEO SURVEILLANCE SYSTEM INSTALLATION**

- A. Install cameras so that each is level and plumb.
- B. Install cameras with 84-inch-minimum clear space below cameras and their mountings. Maximum outdoor camera height shall not exceed 13ft above ground. Change type of mounting to achieve required clearance. Keep camera views free from all obstructions.
- C. Install power supplies and other auxiliary components at control stations unless otherwise indicated.
- D. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.
- E. Identify system components, wiring, cabling, and terminals according to Section "Identification for Electrical Systems."
- F. Miscellaneous hardware required for installation shall be suitable for the purpose for which it is used. Hardware includes nuts, bolts, screws, washers, miscellaneous fasteners, terminals, terminal strips, tie wraps, and related parts. Where the equipment manufacturer specifies hardware for use in the installation, the hardware specified shall be used. The finish on all hardware and fasteners shall be suitable for the environment in which it will be used and shall be selected to minimize corrosion or deterioration due to moisture, sunlight, or temperature extremes.
- G. All electrical power work and conduit work shall be by licensed electricians.
- H. The Security Systems Contractor will be required to install and test local equipment, programming it with an IP address specified by Owner. This support shall include the coordination of dates and times for programming and the testing of individual devices following programming. In all circumstances, the Security Systems Contractor's work shall not be considered complete until the equipment has been programmed and tested to the satisfaction of Owner.

#### **3.2 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
  - 2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

- a. Prepare equipment list described in "Informational Submittals" Article.
    - b. Verify operation of auto-iris lenses.
    - c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
    - d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
    - e. Set and name all preset positions; consult Owner's personnel.
    - f. Set sensitivity of motion detection.
    - g. Connect and verify responses to alarms.
    - h. Verify operation of control-station equipment.
  3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
  4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- C. Video surveillance system will be considered defective if it does not pass tests and inspections.
- D. Prepare and issue test and inspection reports.
- E. After work is completed, and prior to requesting the Final Acceptance Test, the Security Contractor shall conduct a final inspection and pre-test all equipment and system features. The Security Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.
- F. The Security Contractor shall notify Owner and Engineer to request a Final Acceptance Test. The request for Acceptance Test shall constitute a certification from the Security Contractor that:
1. All work is complete and in compliance with the Contract Documents.
  2. All systems have been tested.
  3. All corrections have been made.
- G. Technicians performing the acceptance test shall have been involved in the installation of the system and shall be thoroughly familiar with all aspects of the work.
- H. The Security Contractor shall provide all ladders, tools, test equipment as needed to accomplish the Final Acceptance Test.
- I. Any portions of the work found to be deficient or not in compliance with the Contract Documents will be rejected.

**3.3 ADJUSTING**

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

**3.4 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's Security personnel to adjust, operate, and maintain video-surveillance equipment.
- B. Train Owner's maintenance personnel on equipment operation, startup and shutdown, troubleshooting, servicing, and preventative maintenance procedures. Review the data contained in the Operating and Maintenance Manuals with Owner's personnel. Training shall occur separate from startup activities. Provide 8 hours of training minimum.

**END OF SECTION 28 23 00**

## SECTION 283105 - FIRE ALARM CABLES AND PATHWAYS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fire alarm cables.
  - 2. Fire-resistive fire alarm cables.
  - 3. Fire-resistive data cables.
  - 4. Fiber-optic cables and hardware.
  - 5. Fire alarm terminal cabinets.
  - 6. Fire alarm raceway and boxes.

#### 1.3 DEFINITIONS

- A. Dedicated Continuous Metal Raceway: Enclosed metal pathway dedicated to power-limited fire alarm cable; comprised of and limited to: EMT, IMC, RGS, FMC, and / or LFMC as specified.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each fire alarm cable application, including cable type, wire size, shielding, **circuit integrity**, and electrical characteristics.
  - 1. Include statement endorsed by the manufacturer's authorized representative that the electrical characteristics of the submitted fire alarm cables are within all operating parameters of the fire alarm system as designed and represented by the detailed fire alarm system Shop Drawings.
- B. Product Data: For fire alarm terminal cabinets, including furnished options and accessories.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Record of Inspection and Testing: For field wiring inspection and testing; for each circuit indicate measured values and corresponding acceptance criteria for circuit continuity, resistance, stray voltage, ground-faults, short-circuit-faults, and any other manufacturer recommended conductor field testing parameters.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 FIRE ALARM CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Belden Inc.
  - 2. Southwire Co.
  - 3. West Penn Wire.
  - 4. Windy City Wire.
  - 5. Or approved equal.
- B. Fire Alarm Cable: UL 1424, Type FPL, FPLR, and FPLP, power-limited fire alarm cable; red-jacketed, twisted-pair and parallel-pair insulated solid copper conductors; unshielded and shielded.
- C. Fire Alarm Water Resistant Cables: UL 444 & UL 13 and TIA455-82B Water Infiltration Test, power-limited fire alarm cable, twisted-pair insulated stranded copper conductors; unshielded and shielded.
- D. Fire Alarm Metal-clad Cable: UL 1424, Type MC-FPLP, power-limited fire alarm cable; jacketed, twisted-pair solid copper conductors with red aluminum interlocking outer armor jacket; unshielded and shielded.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Red Alert MC-FPLP cable, manufactured by Southwire Co.
- E. Minimum Fire Alarm Cable Conductor Size:
  - 1. Auxiliary (24 Vdc) Power: 14 AWG / 2C.
  - 2. Data Communications Network: 16 AWG / 2C.
  - 3. Digital Voice Riser: 16 AWG / 2C.
  - 4. Notification Appliance Circuits: 14 AWG / 2C.
  - 5. Relay Circuits: 14 AWG / 2C.
  - 6. RS Serial Data Communications: 18 AWG / 2C.
  - 7. Signaling Line Circuits: 16 AWG / 2C.
  - 8. Speaker Circuits: 16 AWG / 2C.
  - 9. Supervision Circuits: 16 AWG / 2C.
- F. Data and Voice Circuits:

1. Fire alarm cable for Data Communications Network, Digital Voice Riser, Signaling Line Circuits, Speaker Circuits, RS Serial Data Communications, and other manufacturer-specific data and voice circuits shall be shielded, twisted-pair unless fire alarm manufacturer's installation guidelines recommend or require unshielded twisted-pair cable.
2. Fire alarm cable electrical characteristics for Data Communications Network, Signaling Line Circuits, RS Serial Data Communications, and other manufacturer-specific data circuits shall comply with the fire alarm manufacturer limitations for linear-unit and total-circuit capacitance and resistance.

## 2.2 FIRE-RESISTIVE FIRE ALARM CABLES

- A. Multi-conductor Fire-resistive Cable: UL 2196 fire resistive, Type FPL, power-limited fire alarm cable; ceramifiable silicon insulation; jacketed, solid copper conductors; unshielded and shielded.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Duralife FPL fire resistive alarm cable, manufactured by Radix Wire Co.

## 2.3 FIRE-RESISTIVE DATA CABLES

- A. Multi-conductor Fire-resistive Cable: UL 2196 fire resistive, Type FPL, Category 3 channel, capable of transmitting signals at a speed of 10 Mbps, power-limited data cable; low smoke, zero halogen insulation; jacketed, solid copper conductors; unshielded and shielded.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide FPL fire resistive data cable, manufactured by RATH Communications.

## 2.4 FIBER OPTIC CABLES FOR FIRE ALARM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Belden Inc.
  2. CommScope, Inc.
  3. Corning Cable Systems.
  4. General Cable Technologies Corporation.
  5. Optical Cable Corporation.
  6. 3M Communication Markets Division.
  7. Tyco Electronics Corporation; AMP Products.
  8. Or approved equal.
- B. Description: Single-mode, 9/125-micrometer, 6-strand minimum, tight buffer, fiber optic cable; with performance characteristics to satisfy fire alarm system manufacturer requirements for digital network and voice applications.
  1. Multi-mode fiber permitted where required by fire alarm system manufacturer.
  2. Comply with ICEA S-83-596 for mechanical properties.
  3. Comply with TIA/EIA-568-B.3 for performance specifications.



4. Comply with TIA-492-CAAA for detailed specifications.
5. Maximum Attenuation (Premises): 1.0 dB/km at 1310 nm; 1.0 dB/km at 1550 nm.
6. Maximum Attenuation (Outside Plant): 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.

C. Jacket:

1. Jacket Color: Yellow for 9/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

**2.5 OPTICAL FIBER CABLE HARDWARE**

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden Inc.
2. Corning Cable Systems.
3. Optical Cable Corporation.
4. 3M Communication Markets Division
5. Tyco Electronics Corporation; AMP Products.
6. Or approved equal.

B. Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each cable of fibers assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type SC or Type LC connectors. Insertion loss not more than 0.75 dB.
3. Type SFF connectors may be used in termination racks, patch panels, and equipment enclosures.

**2.6 FIRE ALARM TERMINAL CABINETS**

- A. Enclosure: 16-gauge steel; factory applied red enamel finish; removable hinged door with keyed locking latch; with embedded 1/2 inch, 3/4 inch, 1 inch, 1-1/2 inch and 2 inch knockout clusters.
- B. Terminals: Each terminal pole with quick-connect wire termination points and integral test port; sized to accept 20 - 12 AWG and rated for 20 amp at 250V (Class B/UL) 300V (CSA).
- C. Identification: Marked "FIRE ALARM TERMINAL CABINET" in 2-inch white factory applied indelible screened lettering; field identification labels on the inside cover corresponding to the terminal strip's labeling inside the back box.

- D. Basis-of-Design Product: Subject to compliance with requirements, provide IF-Series fire alarm terminal cabinets, manufactured by Space Age Electronics Inc.

## **2.7 FIRE ALARM RACEWAY AND BOXES**

- A. Comply with Division 26.
  - 1. Finish: Factory applied red finish for cover plates and connectors.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Comply with NFPA 70 and NFPA 72.
- B. Unless more restrictive requirements are noted in Division 28, comply with applicable Division 26 sections for the installation of low voltage electrical systems.
- C. Comply with Division for NFPA 72 pathway Class and Survivability Level requirements.
- D. Install fire alarm system pathways and cables in accordance with the reviewed fire alarm system Shop Drawings. Where field modifications of layout are necessary, obtain prior approval from the fire alarm system vendor's qualified fire alarm system designer.

### **3.2 FIRE ALARM PATHWAY INSTALLATION**

- A. Pathways for Fire Alarm: The pathway system for fire alarm shall be dedicated continuous metal raceway throughout.
  - 1. Comply with Division 26 for application and installation of EMT, IMC, RGS, FMC, and LFMC with respect to environmental conditions and resistance to physical damage.
  - 2. Plenum rated cable shall be permitted in place of Continuous Metal Raceway for the following applications:
- B. Pathways beneath Slab, Within Slab, and Buried: Comply with Division 26 for applicable RNC installation requirements.
- C. Class A and X Pathways: Unless greater distances are indicated on the Drawings or Specifications, install Class A and X pathways in compliance with NFPA 72 recommendations for minimum horizontal and vertical separation between supply and return pathways.

### **3.3 FIRE RESISTIVE PATHWAY INSTALLATION**

- A. Where NFPA 72 Survivability Level 2 or 3 pathways (2-hr fire resistance rated) are indicated or required, provide one of the following:
  - 1. UL 1424 fire alarm cable installed within 2-hr fire resistance rated shaft construction or similar 2-hr rated building construction.
  - 2. UL 2196 fire resistive fire alarm cable (Category FHJR) installed within metal raceway in accordance with the corresponding UL "Circuit Integrity System" (Category FHIT).
  - 3. UL 1424 fire alarm cable installed within metal raceway protected by an endothermic wrap assembly installed in accordance with the corresponding UL "Circuit Integrity System" (Category FHIT).

- a. Basis-of-Design Product: Interam Endothermic Mat, manufactured by 3M.

### 3.4 FIRE ALARM CABLE INSTALLATION

- A. Install fire alarm cables within dedicated continuous metal raceway throughout. Wiring shall be continuous between equipment, device, and appliance terminals without splices.
- B. T-tapping: Not permitted for any fire alarm circuit.
- C. Do not install fire alarm system wiring within conduits, junction boxes, or outlet boxes containing conductors of lighting or power systems.
- D. Separate power-limited and non-power-limited conductors within enclosures as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess.
- E. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams.
- F. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal.

### 3.5 FIBER OPTIC CABLE FOR FIRE ALARM INSTALLATION

- A. Comply with TIA/EIA-568-B.3.
- B. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

### 3.6 GROUNDING

- A. Comply with Division 26.

### 3.7 FIELD QUALITY CONTROL

- A. Field inspections and testing shall be performed by fire alarm system manufacturer's factory-authorized service technicians.
- B. End-to-end cabling shall be considered defective if it does not pass tests and inspections.
- C. Perform visual wiring inspections in accordance with fire alarm system manufacturer recommendations. Correct deficiencies.
- D. Test wiring in accordance with fire alarm system manufacturer requirements and NFPA 72 for Initial Acceptance Testing of conductors. Correct deficiencies.
- E. Document inspections and tests via formal inspection test and report(s).

END OF SECTION

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## **SECTION 283111 - DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:

1. Fire alarm control units.
2. Emergency voice messaging components.
3. Remote annunciators with microphone.
4. Power supplies.
5. Network communications.
6. Digital alarm communicator transmitters.
7. Internet protocol (IP) communicators.
8. Cellular communicators.
9. Digital alarm radio transmitters.
10. Municipal fire alarm boxes.
11. Manual fire alarm boxes.
12. System detectors.
13. Notification appliances.
14. Addressable interface modules.
15. Fault isolation modules.
16. Magnetic door holders.
17. Maintenance bypass switches.
18. System printers.
19. Emergency two-way communication systems.
20. Guards and shields.
21. Record document box.
22. Fire department key box.

#### **1.3 DEFINITIONS**

- A. ADS: Acoustically Distinguishable Space.

- B. AHJ: Authority Having Jurisdiction.
- C. BMS: Building Management System.
- D. EVACS: Emergency Voice Alarm Communication System.
- E. FACU: Fire Alarm Control Unit.
- F. FATC: Fire Alarm Terminal Cabinet.
- G. IDC: Initiating Device Circuit.
- H. NAC: Notification Appliance Circuit.
- I. NICET: National Institute for Certification in Engineering Technologies.
- J. PSTN: Publically Switched Telephone Network.
- K. SLC: Signaling Line Circuit.

#### 1.4 SUBMITTALS

- A. Comply with Division 20 for common mechanical/electrical requirements.
- B. Comply with Division 28 specifications and drawings; state/local regulations; and NFPA 72 - Chapter "Documentation". For purposes of applying NFPA 72, all identified documentation requirements are a mandatory part of the Work, including those that "apply only where required by other governing laws, codes, or standards, by other parts of the Code; or by project specifications or drawings".
- C. Submit Action Submittals prior to applying for authority having jurisdiction installation permits (where required) and system installation.
- D. Submit Informational Submittals after successful initial system testing and prior to scheduling authority having jurisdiction final approval demonstration testing.
- E. Submit Closeout Submittals as part of project closeout procedure.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
  - 1. Include approvals and listings, construction details, material descriptions, dimensions, profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, and electrical characteristics.
  - 3. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements of this Specification and of NFPA 72.
- B. Shop Drawings: For fire alarm system and fire safety control interfaces.
  - 1. Floor Plans. Include floor plans to indicate final equipment, cabinet, device and appliance locations. Indicate address of each addressable device. Show all interface modules. Show candela setting for each strobe appliance. Show complete point-to-point routing of all circuits and pathways; indicate Class and Survivability Level. Show size and type of all conduits, cable, wire, and conductors. Indicate panel circuit designation for each normal power supply branch circuit.
  - 2. Riser Diagram. Include complete device/appliance accurate riser diagram. Indicate address of each addressable device. Show all interface modules. Show candela setting of

each strobe appliance. Show each circuit and pathway; indicate Class and Survivability Level. Show size and type of all conduits, cable, wire, and conductors. Indicate panel circuit designation for each normal power supply branch circuit.

3. Equipment Wiring Diagrams. Include wiring diagrams for each system component/node including control unit cabinets, remote power supply cabinets, terminal cabinets, remote annunciators, supervising station transmitters, and PC workstations.
4. Component Wiring Diagrams. Include typical wiring diagrams for fire detector bases, pull stations, conventional devices, interface modules including wiring connections to supervised/controlled equipment, notification appliances, and component modules and cards.
5. Ductwork Smoke Detector Plans. Include installation details for typical ductwork detector condition. Show plan and section view for each condition. Show requirements for ductwork attachments, penetrations, and access panels.
6. Calculations - Voltage Drop. Include voltage drop calculations inclusive of safety/spare capacity factor(s) for notification-appliance circuits. Calculations shall assume alarm operation using the minimum standby power available at the conclusion of quiescent and alarm phases of operation.
7. Calculations - Power Supply and Battery Capacity. Include power capacity calculations inclusive of safety/spare capacity factor(s) for each system power supply and connected battery set.
8. Calculations - Conduit Fill. Include conduit fill calculations prepared in accordance with the National Electric Code.
9. Sequence of Operation. Include complete and detailed input/output sequence of operation matrix. Supplement matrix with narrative descriptions for complex specialty sequences.
10. Emergency Voice/Alarm Communication Systems; additionally:
  - a. Floor Plans. Indicate amplifier equipment cabinets, primary and remote paging locations, and associated circuits and pathways. Show wattage tap and corresponding ADS for each speaker. Indicate circuit pathway Class and Survivability Level.
  - b. Equipment Wiring Diagrams and Component Wiring Diagrams. For amplifier racks, remote microphone stations, and speaker appliances.
  - c. Amplifier Loading. For each speaker circuit, identify quantity of speakers at each wattage tap setting and total connected wattage per circuit and per amplifier. Demonstrate calculated loading inclusive of safety/spare capacity factor(s) is accommodated by amplifier nominal power (watts) capacity.
  - d. Audio dB Loss Calculations. For each speaker circuit.
  - e. Power Supply Battery Capacity Calculations. For each amplifier array power supply and connected battery set, inclusive of safety/spare capacity factor(s).

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and Certified Engineering Technician.

- B. Seismic Qualification Certificates: For fire alarm control unit, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Record of Inspection and Testing. Detailed documentation of completed 100 percent fire alarm and signaling system initial acceptance testing. Use NFPA 72 "System Record of Inspection and Testing" forms.
- D. Statement of Completion: Written statement that system has been installed in accordance with approved plans and tested in accordance with the manufacturer's published instructions and appropriate NFPA 72 requirements.
- E. Sample Warranty: For special warranty.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Record of Completion. Provide detailed description of installed, tested, and approved fire alarm and signaling system; including description of protected premises, fire alarm system and component sub-systems, fire safety function interfaces, monitoring service, and all other information required by NFPA 72. Use NFPA 72 "System Record of Completion" forms.
- B. Record Drawings. Provide complete Shop Drawing re-submittal updated to reflect actual final system installation and sequence of operation of all components.
- C. Device address list. Provide complete device address list organized by SLC loop and system node.
- D. System type detectors shall be tested for their sensitivity compensation head room range (% dirty). Detectors shall not be greater than 20% dirty for their compensation range. Detectors over 20% shall be clean or replaced per the manufacturer's requirements.
- E. Operation and Maintenance Data: For fire alarm systems and components to include in emergency, operation, and maintenance manuals.
  - 1. Provide manufacturer's Owner's Operation and Maintenance Manuals with required related system warranty requirements.
  - 2. Provide NFPA 72 "Inspection, Testing, and Maintenance" tables indicating required component inspection and testing activities and frequencies.
  - 3. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
- F. Software and Firmware Operational Documentation:
  - 1. Provide software operating and upgrade manuals.
  - 2. Site-specific Software Backup: Provide on compact solid state USB storage device or compact disk; complete with data files.

**1.8 QUALITY ASSURANCE**

- A. **Installer Qualifications:** Personnel licensed by the governing licensing authority for the installation of fire alarm systems. Successfully installed, tested, obtained approvals for, and put into service no less than three (3) fire alarm systems similar in type, size, and complexity to that of the Work of this Section.
- B. **Certified Engineering Technician Qualifications:** Personnel trained and certified by the fire alarm system manufacturer as an approved technician.
  - 1. **Shop Drawings and Calculations** prepared by personnel certified by NICET as fire alarm Level III or IV technician, or licensed as a Professional Fire Protection Engineer by the governing licensing authority.
- C. **Source Limitations for Fire Alarm System and Components:** Single vendor source to provide fire alarm system components and connected non-system components as a single listed addressable fire alarm and signaling system.
  - 1. **Modifications to Existing Systems:** Components compatible with, and operate as an extension of, existing system.
- D. **Product Standards:** UL's "Fire Protection Equipment Directory" listing and "Approval Guide," published by FM Global.
  - 1. Subject to compliance with requirements, indication of a UL product requirement within Part 2 shall be construed to require a UL listed and FM approved product.
- E. **Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 1. **Explosion-Proof:** Listed and labeled for use in "Hazardous (Classified) Locations"; Class and Division listing appropriate to intended location and application.

**1.9 COORDINATION**

- A. **Definition, "Coordinate":** Where Sections of the Work interact, the Contractor responsible for this Section of the Work initiates verbal and/ or written communication with one or more different Contractors responsible for other interacting Sections of the Work for the purposes of establishing a coordinated approach of product selections and installation sequencing that satisfies the individual requirements of the interacting Sections of the Work as well as the requirements of the Work as a whole.
- B. **Coordinate construction operations** with those of other Sections of the Work and other entities to ensure efficient and orderly installation of each part of the Work.
- C. **Coordinate operations and product selections** of this Section with operations and product selections included in different Sections that depend on each other for proper installation, connection, and operation.
- D. **Schedule construction operations** in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
- E. **Coordinate installation** of different components with other Sections of the Work to ensure maximum performance and accessibility for required maintenance, service, and repair.
- F. **Make adequate provisions** to accommodate items scheduled for later installation.



- G. Coordination Drawings: Contribute to preparation of Coordination Drawings in the sequence established under Division 1 and Division 20; indicate water-based fire suppression system Work coordinated with other Sections of the Work.

#### 1.10 MAINTENANCE MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Smoke Detectors and Heat Detectors: Five (5) of each type installed.
  - 2. Detector Bases: Five (5) of each type installed.
  - 3. Audible and Visual Notification Appliances: Five (5) of each type installed.
  - 4. Keys and Tools: One extra set for access to locked or tamper-proof components.
  - 5. Fuses: Two (2) of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

#### 1.11 UNIT-COST ALLOWANCES

- A. Definition: Unit-cost allowance is a quantity of work established in lieu of additional requirements, used to defer the installation of materials and equipment to a later date when direction may be provided to Contractor by the Architect or Authorities Having Jurisdiction (AHJ) to provide labor and materials pursuant to final field coordination or AHJ final inspections.
- B. Unit-cost allowance shall include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- C. Include the following Unit-cost Allowances:
  - 1. System spot-type smoke detector: Total quantity equal to five (5) installed.
  - 2. System spot-type heat detector: Total quantity equal to five (5) installed.
  - 3. System in-duct smoke detector: Total quantity equal to five (5) installed.
  - 4. System sampling tube duct smoke detector: Total quantity equal to five (5) installed.
  - 5. System carbon monoxide detector: Total quantity equal to five (5) installed.
  - 6. Monitor interface module: Total quantity equal to ten (10) installed.
  - 7. Relay / control interface module: Total quantity equal to ten (10) installed.
  - 8. Remote alarm indicator: Total quantity equal to five (5) installed.
  - 9. Audible / intelligible notification appliance: Total quantity equal to five (5) installed.
  - 10. Visible notification appliance: Total quantity equal to five (5) installed.
  - 11. Combination audible / intelligible and visible notification appliance: Total quantity equal to five (5) installed.
- D. Unused Materials: After installation has been completed and accepted by authorities having jurisdiction return unused materials to manufacturer or supplier and credit Owner for materials and labor.

1.12 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire alarm system equipment and components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
  - 2. Warranty Period: One years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products listed as a component of a single addressable fire alarm and signaling system technology platform by one of the following:
  - 1. Simplex, (Johnson Controls).
    - a. System must conform to campus wide system manufacturer, no substitutions.
    - b. Existing system agency:
      - 1) Johnson Controls Fire Protection  
930 Riverview Dr. Suite 800  
Totowa NJ 07512
- B. Where additional manufacturer listings or basis of design products are indicated, provide products listed and duty-rated as compatible with the selected fire alarm and signaling technology platform.

2.2 SYSTEM DESCRIPTION

- A. UL 864; non-coded, microprocessor-based addressable protected premises fire alarm and signaling system, with multiplexed signal transmission and audible/visual evacuation signaling. All components provided listed for use and compatible with fire alarm system head-end FACU.
- B. Protected premises backbone architecture comprised of multiple fire alarm control units and system components networked via peer-to-peer communications node network.
- C. Control units, system components, and power supplies inclusive of boards, drivers, and expansion modules necessary to support the specified system performance criteria, minimum quantity of circuits, and NFPA 72 circuit pathway class designations.
- D. System circuiting and component power loading to provide minimum specified spare capacities, safety factors, and redundancies.
- E. Special Alarm Signal Processing – RESERVED.
- F. NFPA 72 Pathway Class (Performance During Fault) and Survivability Level (Fire Resistance):
  - 1. Addressable signaling loops.
    - a. Circuit Type: SLC.
    - b. Pathway Class: B.
    - c. Class A Short-circuit Fault Isolation Modules or Bases Located as Follows:

- 1) At each SLC exit/entry point of from/to a control unit or terminal cabinet.
  - 2) No more than twenty (20) addressable devices between isolation modules at any point on SLC.
- d. Pathway Survivability Level: 1.
2. Audible and intelligible public mode signaling (occupant evacuation).
  - a. Circuit Type: NAC.
  - b. Pathway Class: B.
  - c. Pathway Survivability Level: 1.
3. Visible public mode signaling (occupant evacuation).
  - a. Circuit Type: NAC.
  - b. Pathway Class: B.
  - c. Pathway Survivability Level: 1.
4. Audible and visible private mode signaling.
  - a. Circuit Type: NAC.
  - b. Pathway Class: B.
  - c. Pathway Survivability Level: 1.
5. Supervision of conventional devices.
  - a. Circuit Type: IDC.
  - b. Pathway Class: B.
  - c. Pathway Survivability Level: 1.
6. Fail-safe operation, magnetic door holders and similar.
  - a. Circuit Type: Fail safe.
  - b. Pathway Class: D.
  - c. Pathway Survivability Level: 1.
7. Partial evacuation or relocation EVACS; critical circuits that effect the operation of more than one (1) evacuation zone, and circuits located outside of the evacuation zone they serve.
  - a. Circuit Type: NAC, and SLC.
  - b. Pathway Class: A.
  - c. Pathway Survivability Level: 3.
- G. All addressable circuits designed and installed without T-taps.
- H. Maximum 100 addressable alarm-initiating devices on each SLC.
- I. No fewer than two (2) visible and two (2) audible NAC's serving each protected premises fire area or evacuation zone. Unless noted otherwise, notification appliances circuited such that no two adjacent appliances are connected to the same NAC.
- J. Component Primary Power: 24-V dc obtained from premises AC power supply.

1. Capacity: Alarm current draw of components connected to each power-supply module no greater than 80 percent of the power-supply module rating.
- K. Component Standby Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
  1. Base Capacity: System operation for twenty-four (24) hours under quiescent load plus fifteen (15) minutes operating all alarm notification appliances.
  2. Spare Capacity: 20 percent.
- L. Remote power supplies used as distributed power sources only and not as in-line circuit power “boosters”.
- M. Fire alarm system listed for protected premises in-building Emergency Voice Alarm Communications System (EVACS) service utilizing digital multi-channel technology:
  1. Fire Emergency Voice Alarm Communications Systems (EVACS); comply with UL 864, 1480, and 1711.
  2. Amplifier loading no greater than 80 percent of rated power capacity (Watts).
  3. Complete functional integration (common audio circuits and speakers) of protected premises fire alarm in-building EVACS and premises Public Address System (PAS).
- N. Fire alarm system interfaces with other premises building systems including Fire Suppression, HVAC, Vertical Transportation, Audio/Visual, Public Address, Access Control, Fire Protection Opening Protectives, Emergency Power, and similar for all code-required and project-specified fire safety supervision and functional control.
- O. Fire alarm system control and supervision of building smoke control system(s) including automatic operation, manual operation, and indication of smoke control system component status. Comply with UL 864 UUKL.
- P. Dedicated manual and automatic initiating devices and notification appliances for indication of non-fire emergency conditions.
- Q. Retransmission of protected premises alarm, supervisory, and trouble status signals (Contact ID format) to an AHJ approved alarm supervising station.
- R. Wide-area Campus/Site Integration.
  1. Complete functional integration of protected premises in-building fire alarm network nodes with wide-area campus/site fire alarm node network to form a global peer-to-peer fire alarm network.
  2. Complete functional integration of protected premises in-building fire alarm network nodes with wide-area campus/site fire alarm node network via contact-id signal transmission to proprietary supervising station alarm receiver.
  3. Complete functional integration of protected premises in-building EVACS and campus/site Wide Area Mass Notification System (WAMNS).

## 2.3 PERFORMANCE REQUIREMENTS

- A. Operational Performance: Fire alarm system shall process alarm, supervisory, and trouble status signals and perform associated output functions in compliance with NFPA 72, Division 28 and Drawings “Input/Output Matrix”.

- B. Circuit Integrity and Fault Performance: Fire alarm system circuit integrity and functional performance capability under fault conditions shall comply with the NFPA 72 circuit Class designations as indicated within the "System Description" Article and as indicated on the Drawings.
- C. Survivability Performance: Fire alarm system fire resistive performance capability shall comply with the NFPA 72 circuit Level designations as indicated within the "System Description" Article and as indicated on the Drawings.
- D. Design and Installation Standard(s):
  - 1. Fire Alarm Systems: Comply with NFPA 72.
  - 2. FM Global: Comply with FM Global Datasheets for the design, installation, and testing of digital fire alarm systems.
- E. Seismic Performance: Fire alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

#### 2.4 FIRE ALARM CONTROL UNITS

- A. General: UL 864; power-limited, field-programmable, microprocessor-based, modular design. Interconnected power supplies, circuit board modules, displays, and associated electronics mounted to standard mounting chassis within common control unit cabinet enclosure. Control unit cabinet assemblies configured as control units with integral display and controls or as transponder units with solid door and no local display/controls.
- B. Central Processors and System Software:
  - 1. Central Processing Unit (CPU): Solid-state processor for processing and storage of system status and event signal data and execution of control-by-event and logic software functions; with real-time clock for time annotation of events accurate to second time-increments.
  - 2. Memory: System software, event history logs, and programs held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
  - 3. Software Programming: Programmable via local FACU display and controls and also via externally connected laptop/PC programming application. Passwords required to access software program, one (1) "Master" password for highest level of permissions for use by authorized technicians and multiple "User" passwords for lower level permissions for use by general facilities personnel.
  - 4. Alarm Signal Processing:
    - a. General: General alarm actuation of notification appliances, emergency control function interface devices, and annunciation at the protected premises within 10 seconds of initiating device alarm activation.
    - b. Smoke Detector Verification: Capability to password-enable individual addressable smoke detectors to include a maximum 60 second verification phase.

- c. Pre-signal Alarm Sequence: Capability to password-enable system such that protected premises general alarm functions are delayed for more than 60 seconds after receipt of initial alarm signal; general alarm functions may be initiated automatically or by human action after delay.
  - d. Positive Alarm Sequence: Capability to password-enable system such that protected premises general alarm functions are delayed for no more than 15 seconds to permit manual acknowledgement of signal. If signal is not acknowledged within 15 seconds general alarm operation automatically initiates. If signal is acknowledged within 15 seconds, general alarm is delayed for up to 180 seconds to permit investigation. If fire alarm control unit is not reset within the investigation time-delay general alarm operation automatically initiates. If a second initiating device is activated during the investigation time-delay, general alarm operation automatically initiates.
- 5. Remote Smoke Detector Sensitivity Adjustment: Controls capable of selecting specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.
- 6. Software Zones: General alarm zone, releasing zone, and special logic zones used to map system inputs from assigned addressable device(s) to corresponding system output(s).
- 7. Time-Function Control: Capability to assign 24-hr clock time-dependent logic to event functions for time delay feature and/or automatic function scheduling to specific day of the week or year.
- 8. Non-Fire Events: Capability to assign "Non-Fire" ID category to module addresses such that assigned event functions are executed without indication at the FACU display.
- 9. Walk test: Test modes to permit system testing under bypass mode.
- C. Display and Controls:
  - 1. General: Display and controls arranged for interface between human operator and fire alarm system including system status indication, event status indication, manual query inputs, manual programming inputs, and manual output functions.
  - 2. Event Display: LCD; minimum 16 lines, 640 characters.
  - 3. Status Indicators: LED indicators for indication of system status; with corresponding membrane switch buttons to acknowledge incoming alarm, supervisory and trouble event signals.
  - 4. Audible Indicator: Piezo sounder for audible indication of system status and incoming event signals; silenced upon signal acknowledge.
  - 5. Keypad: Alpha-numeric entry and LCD navigation keys for display scrolling, item selection, system programming, and similar manual user operations.
  - 6. Function-key Modules: Membrane switch buttons used to initiate assigned software function, each with corresponding LED indicators for indication of function status.
- D. Signaling Line Circuit Controllers:
  - 1. SLC Loop Capacity: Minimum 125 addressable initiating devices and 125 addressable modules (250 addressable devices total) per loop.

2. Degrade Mode: Upon CPU communication failure, controllers capable of stand-alone function mode permitting alarm operation during communication fault condition.
3. Configuration: Capable of supporting Class A or Class B SLC configuration.
- E. Serial Interfaces: RS 232, RS 485 or equivalent for communication with system annunciators, printers, graphics displays, digital controllers, and similar distributed system components; USB ports for laptop configuration of system and file download to USB data storage devices.
- F. Cabinet Enclosures: Steel back-box with top, bottom, and side knockouts for 1/2-inch through 2-inch metal raceway; manufacturer's chassis rails for electronics mounting; key-lock latching, left or right swing hinged, removable steel front door panel with and without view panel(s); with trim accessories for flush mount where indicated in Part 3 "Equipment Installation" and Drawings; steel box and door surfaces in factory-finish red enamel.

## 2.5 EMERGENCY VOICE ALARM COMMUNICATION SYSTEMS

- A. General: NFPA 72 compliant, digital, multi-channel, one-way emergency voice alarm communication system for automatic and manual voice broadcast of fire or other emergency instructions and signals; distributed system architecture with central master audio controller and distributed amplifier arrays connected via digital voice audio riser.
- B. Master Audio Controller: Solid-state digital multi-channel audio controller with digitized alarm tones and digitally recorded voice messages stored in on-board memory.
- C. Tones and Messages: Selectable evacuation tones (Temporal-3, Slow/Fast Whoop, GSA), standard digitally pre-recorded voice messages and digitally recorded custom voice messages. Module on-board memory capacity sufficient for minimum of 32 minutes total message duration at standard resolution.
- D. Amplifiers: UL 1711, digital, multi-channel, power-limited 25 or 70 VRMS, with on-board test switches and indicators.
  1. Self-Backup Mode: Automatically re-route NAC's connected to a disabled amplifier channel to remaining active amplifier channel(s).
  2. Degrade Mode: On-board temporal pattern horn tone for default backup signaling over connected NAC's.
- E. Amplifier Supervision: Digital communication between amplifiers and controller for supervision and indication of amplifier status and operating power and voltage values.
- F. Microphone Module: Push-to-talk integral corded microphone for manual voice messaging; with local speaker, volume controls, and LED status indicators.
- G. Controls and Status Indicators:
  1. Indicators: LED indicators for indication of system status and operation of user selected functions.
  2. Function-keys: Membrane switch buttons with corresponding LED indicators for selective user initiation of voice messaging and evacuation functions on a premises-wide or per- zone basis.
- H. Auxiliary Audio Inputs: Audio controller capable of accepting line-level auxiliary audio source input for re-broadcast over emergency voice speaker circuits.

- I. Auxiliary Audio Outputs: Audio controller capable of transmitting line-level auxiliary audio source output for re-broadcast over another system's emergency or non-emergency voice speaker circuits.
- J. Cabinet Enclosures: Comply with Article "Fire Alarm Control Units" for cabinet enclosures. Modules and amplifiers mounted within cabinet enclosures common to FACU and within dedicated solid-door remote amplifier array cabinet enclosures.

## 2.6 REMOTE ANNUNCIATORS

- A. General: Display and controls remote from Fire Alarm Control Unit arranged for interface between human operator and fire alarm system including system status indication, event status indication, manual query inputs, manual programming inputs, and manual output functions.
- B. Event Display: LCD; minimum 2 lines, 40 characters.
- C. Status Indicators: LED indicators for indication of system status; with corresponding membrane switch buttons to acknowledge incoming alarm, supervisory and trouble event signals.
- D. Audible Indicator: Piezo sounder for audible indication of system status and incoming event signals; silenced upon signal acknowledge.
- E. Keypad: Alpha-numeric entry and LCD navigation keys for display scrolling, item selection, system programming, and similar manual user operations.
- F. Function-key Modules: A minimum of 8 membrane switch buttons used to initiate assigned software function, each with corresponding LED indicators for indication of function status.
- G. Enclosure: Comply with Article "Fire Alarm Control Units" for enclosures; steel box and door surfaces in factory-finish red enamel.

## 2.7 REMOTE ANNUNCIATORS WITH MICROPHONE

- A. General: Display and controls remote from Emergency Voice Messaging Control Unit arranged for interface between human operator and emergency voice system for manual voice messaging via push-to-talk microphone or selective keyed operation of emergency evacuation functions.
- B. Event Display: LCD; minimum 2 lines, 40 characters.
- C. Status Indicators: LED indicators for indication of system status; with corresponding membrane switch buttons to acknowledge incoming alarm, supervisory and trouble event signals.
- D. Audible Indicator: Piezo sounder for audible indication of system status and incoming event signals; silenced upon signal acknowledge.
- E. Keypad: Alpha-numeric entry and LCD navigation keys for display scrolling, item selection, system programming, and similar manual user operations.
- F. Function-keys: A minimum of 8 membrane switch buttons used to initiate assigned evacuation function, each with corresponding LED indicators for indication of function status.
- G. Enclosure: Comply with Article "Fire Alarm Control Units" for enclosures; steel box and door surfaces in factory-finish red enamel



## 2.8 POWER SUPPLIES

- A. General: Switched-mode supervised power supply base and expansion modules supplying regulated and filtered 24-V dc power to system components, notification appliances, and auxiliary power loads.
- B. FACU Applications: Power supply modules and batteries mounted within Fire Alarm Control Unit (FACU) equipment cabinets to provide integral system power to chassis-mounted components, connected notification appliance circuits, and connected auxiliary power circuits; batteries located within stand-alone battery cabinet for high-capacity applications.
- C. RPS Applications: Power supply modules and batteries mounted within distributed Remote Power Supply (RPS) equipment cabinets to provide supplemental power to connected notification appliance circuits and connected auxiliary power circuits.
- D. Primary Power Supply: 120-V ac.
- E. Secondary Power Supply: 24-V dc supply system including sealed lead acid batteries, automatic float-charge battery charger, and automatic transfer switch.
- F. Voltage Drop Calculations: Circuit loading no greater than 80 percent of rated nominal power voltage drop (Volts).
- G. Outputs: Programmable for operation as Notification Appliance or Auxiliary Power circuits; NAC outputs capable of operation as sync-generator or sync-follower; capable of supporting Class A or Class B circuit configuration.
- H. Supervision: Loss of primary power, low battery power, battery charger failure, and output circuit fault conditions supervised by fire alarm system via serial communication or system SLC supervision of trouble contacts.
- I. Cabinet Enclosures: Comply with Article "Fire Alarm Control Units" for cabinet enclosures.

## 2.9 NETWORK COMMUNICATIONS

- A. Provide network communications for fire-alarm system nodes and peripherals according to fire-alarm manufacturer's written requirements.

## 2.10 DIGITAL ALARM COMMUNICATION TRANSMITTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Same manufacturer as the selected manufacturer of the fire alarm and signaling system technology platform.
  - 2. Simplex, (Johnson Controls)
  - 3. .
- B. General: UL 864 digital alarm communicator transmitter (DACT) compatible with supervising station receiving equipment; module mounted within FACU cabinet or within stand-alone enclosure; with onboard status LED indicators for component and signal transmission status.
- C. Signal Input Connections: Serial connection to host FACU.

- D. Signal Transmission Connections: Primary and secondary loop-start telephone lines; programmable such that both phone lines report to the same telephone number, or such that each phone line reports to a different telephone number.
- E. Transmission Format: Selectable for Contact ID, SIA, or 4/2 Pulse formats.
- F. Supervision: DACT system trouble status supervised by host FACU via serial interface or DACT auxiliary contacts.
- G. Self-Test: Conducted automatically every 24 hours with report transmitted to supervising stations.
- H. Programming: Remotely via serial interface or integral programming keypad with LED display.
- I. Power Supply: Primary 24-V dc obtained from premises AC power supply or host FACU power supply module. Standby 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch provided with DACT unit or as part of host FACU standby power supply system.

## 2.11 IP COMMUNICATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Same manufacturer as the selected manufacturer of the fire alarm and signaling system technology platform.
  - 2. Simplex, (Johnson Controls)
- B. General: UL 864 IP communicator (native-IP module or IP-dialer-capture module) compatible with supervising station receiving equipment; module mounted within FACU cabinet or within stand-alone enclosure; with onboard status LED indicators for component and signal transmission status.
- C. Signal Input Connections: Serial connection to host FACU or telephone line connections to host FACU-DACT.
- D. Signal Transmission Connections: 10/100 Base network ethernet reporting to primary and secondary IP addresses; dynamic DCPH or static IP supported.
- E. Transmission Format: Selectable for Contact ID, SIA, or 4/2 Pulse formats converted to encrypted UDP protocol data transmission.
- F. Supervision: IP Communicator system trouble status supervised by host FACU via serial interface, FACU-DACT telephone line interface, or IP Communicator auxiliary contacts.
- G. Self-Test: Supervisory heartbeat signal of no less than once every 90 seconds to supervising station to ensure multiplexed level line supervision.
- H. Programming: Remotely via serial interface or integral programming keypad with LED display.

## 2.12 CELLULAR COMMUNICATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Same manufacturer as the selected manufacturer of the fire alarm and signaling system technology platform.
2. Simplex, (Johnson Controls)
- B. General: UL 864 cellular communicator compatible with supervising station receiving equipment; module mounted within stand-alone enclosure; with onboard status LED indicators for component and signal transmission status and remote antenna.
- C. Signal Input Connections: Serial connection to host FACU or telephone line connections to host FACU-DACT.
- D. Signal Transmission Connections: CDMA, GSM, or LTE cellular network pathway.
- E. Transmission Format: Selectable for Contact ID, SIA, or 4/2 Pulse formats converted to encrypted UDP protocol data transmission.
- F. Supervision: Cellular communicator system trouble status supervised by host FACU via serial interface, FACU-DACT telephone line interface, or communicator auxiliary contacts.
- G. Self-Test: Supervisory heartbeat signal of no less than once every 90 seconds to supervising station to ensure multiplexed level line supervision.
- H. Programming: Remotely via serial interface or integral programming keypad with LED display.
- I. Power Supply: Primary 24-V dc obtained from premises AC power supply or host FACU power supply module. Standby 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch provided with DACT unit or as part of host FACU standby power supply system.

#### 2.13 MUNICIPAL FIRE ALARM BOXES

- A. Manufacturers: Subject to compliance with requirements and municipality equipment standards, provide products by the following:
  1. Simplex, (Johnson Controls)
- B. Approved local energy-type, solid state, coded signal, master box for connection to municipal auxiliary fire alarm system; surface-mount for installation on pedestal.
- C. Operation methods:
  1. Integral manual pull.
  2. Alarm input signal from protected premises fire alarm system.
- D. Power supply: 24vdc from protected premises fire alarm system.
- E. Local supervision: Trouble conditions supervised by the protected premises fire alarm system.
- F. Enclosure: NEMA 4X steel enclosure, red finish, hinged door, lock assembly with keys; with 1/2-inch threaded conduit connections for installation of exterior flashing beacon.
- G. Pedestal Base: Subject to compliance with requirements and municipality equipment standards, provide Alloy Castings Co model ATC-1 pedestal with sub-base.
  1. Pedestal shall include factory fabricated custom mounting holes and conduit connections for installation of surface-mount electric waterflow bell.

**2.14 MANUAL FIRE ALARM BOXES**

- A. General: UL 38; die-cast metal housing, red finish, with molded, raised-letter operating instructions and “FIRE” identification in contrasting color; device shall show visible indication of operation.
- B. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral or attached addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire alarm control unit.
- C. Station Reset: Key- or wrench-operated switch.
- D. Indoor Protective Cover: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible sounder intended to discourage false-alarm operation.
- E. Weatherproof Protective Cover: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

**2.15 SYSTEM FIRE DETECTORS**

- A. General: Analog addressable system smoke, system heat, or other system detectors for sensing products of combustion; listed as compatible with fire alarm system control unit and with integral addressable module capable of two-way analog communication with fire alarm control unit permitting remote sensitivity control, identification of device address, alarm status, trouble status, and trending of maintenance data.
- B. Detector Housing: Low profile, white-polycarbonate thermoplastic, impact resistant, and flame retardant detector housing for mounting into twist-lock base; with LED indicator for indication of detector status-polling (flashing) or in operation (constant).
- C. Detector Bases: Ceiling- and wall-mount, low profile, white-polycarbonate thermoplastic, impact resistant, and flame retardant plastic twist-lock fixed base; with terminals for SLC conductor terminations.
  - 1. Auxiliary Detector Bases: Optional bases furnished to perform supplemental detector-local functions.
    - a. Sounder bases to provide local audible alarm at detector; 24-V dc.
    - b. Relay bases for output control of associated equipment.
    - c. Isolation bases to isolate short circuit faults on SLC.
    - d. UL 2075 carbon monoxide sensor and associated distinct audible alarm and visual indicator.
- D. Remote Alarm Indicators (RAI): LED visual indicator in flush-mount plate, connected to corresponding detector base terminals for remote indication of detector alarm.
- E. Remote Test Station (RTS): RAI with key operated test switch for remote detector testing.
- F. Operating Voltage: 24-V dc nominal for detectors and auxiliary bases; 120-V ac rated contacts for relay bases as per application.
- G. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

**2.16 SYSTEM SMOKE DETECTORS**

- A. Comply with “System Fire Detectors” Article.
- B. UL 268, photoelectric spot-type with insect-screen protected sensing chamber; for installation in twist-lock system bases.
- C. Operating Temperature Range: 32 – 100 deg F (0 – 38deg C).
- D. Operating Humidity Range: 10 - 95 percent RH.
- E. Sensitivity Range: 1.5 - 5.0 percent obs/ft.
- F. Air Velocity Rating: 0 - 4,000 fpm (0 - 1220 mpm).

**2.17 SYSTEM IN-DUCT SMOKE DETECTORS**

- A. Comply with “System Fire Detectors” Article.
- B. UL 268A, photoelectric spot-type system smoke detector listed for installation directly within air distribution ductwork, with and without integral output relays.
- C. Mounting: For square and round ducts via factory furnished mounting kit or standard electrical raceway and boxes as per detector manufacturer requirements.
- D. Air Velocity Range: 0 - 4,000 fpm (0 - 1,220 mpm).

**2.18 SYSTEM SAMPLING TUBE DUCT SMOKE DETECTORS**

- A. Comply with “System Fire Detectors” Article.
- B. UL 268A, photoelectric spot-type system smoke detector listed for installation within detector housing mounted to exterior surface of air distribution ductwork, with connected sampling tubes transporting ductwork air to the external detector sensing chamber; with and without integral output relays.
- C. Mounting: For square and round ducts via factory furnished mounting kit.
- D. Air Velocity Range: 300 - 4,000 fpm (91 - 1,220 mpm).

**2.19 WEATHERPROOF ENCLOSURES**

- A. Basis of Design: Enviroarmour®, waterproof enclosure by Safety Technology International (STI)
- B. General: UL 50; NEMA-3R, 4 or 4x, non-metallic; lockable polycarbonate or fiberglass enclosure. Covers are lockable or screw-down door, A/C with heater option and dual thermostat.
- C. Operating Voltage: 120-V ac nominal for A/C with heater.

**2.20 SYSTEM HEAT DETECTORS**

- A. Comply with “System Fire Detectors” Article.
- B. UL 521, spot type heat detector actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless other temperature rating(s) are indicated on Drawings.

**2.21 SYSTEM CARBON MONOXIDE DETECTORS**

- A. Comply with “System Fire Detectors” Article.
- B. UL 2075 carbon monoxide sensor integral to fire detector housing or as an auxiliary detector base; and permitting distinct addressable point identification of smoke alarm and/or carbon monoxide alarm at each detector. Audible and visible CO indicators distinct from smoke and heat detector indicators.

**2.22 NOTIFICATION APPLIANCES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Simplex, (Johnson Controls)
- B. General Performance Requirements for Notification Appliances: Signaling appliances connected to notification appliance circuits for NFPA 72 public operating mode signaling to building occupants protected by the fire alarm system; and private operating signaling to those persons directly concerned with implementation and direction of emergency action and procedures. Appliance assemblies include audible, audible/intelligible, visible, and combination type as indicated on Drawings.
- C. Mounting: Wall or ceiling mount as indicated on Drawings.
- D. Housing: Thermoplastic, impact resistant, and flame retardant.
- E. Finish: White housing with Red contrasting engraved lettering.
- F. Identification: Engraved lettering on housing indicating ”FIRE”.
- G. Weather proof applications: Listed for indoor and outdoor installation.

**2.23 AUDIBLE/INTELLIGIBLE NOTIFICATION APPLIANCES**

- A. Comply with “Notification Appliances” Article.
- B. Speakers: UL 1480, 25 or 70 nominal VRMS speaker within dedicated housing, listed sound pressure level of 90 dBA measured at 10 feet.
  - 1. Frequency Range: 400 to 4000 Hz.
  - 2. Wattage Taps: Field selectable 0.25 W, 0.50 W, 1.0 W, 2.0W.
- C. High-Range Audible and Intelligible Notification Appliances (Re-entrant Speakers):
  - 1. UL 1480, 25 or 70 nominal VRMS, listed sound pressure level of 102 dBA measured at 10 feet.
  - 2. Frequency Range: 400 to 14000 Hz.
  - 3. Wattage Taps: Field selectable 0.9, 1.8 W, 3.8 W, 7.5 W, 15.0 W.
  - 4. Finish: Red.

**2.24 VISIBLE NOTIFICATION APPLIANCES**

- A. Comply with “Notification Appliances” Article.

- B. Strobes: UL 1971, LED with clear polycarbonate lens mounted on an aluminum faceplate and field selectable candela output setting within dedicated housing, 24-V dc; with candela setting indicator visible through viewing window.
  - 1. Strobe flashing in temporal pattern, synchronized throughout each evacuation zone and synchronized between evacuation zones where strobes from multiple evacuation zones can be observed by a single viewer.
  - 2. Comply with Drawings for appliance candela output.
  - 3. Where existing circuiting have Xenon type, xenon type strobes are acceptable.
- C. Flashing Beacons: UL 1638; 6-inch diameter, red lens beacon, 24-V dc; listed for indoor and outdoor applications.

**2.25 COMBINATION AUDIBLE/INTELLIGIBLE AND VISIBLE NOTIFICATION APPLIANCES**

- A. Combination audible/intelligible and visible notification appliance with audible and visible signaling elements assembled within a common housing.
  - 1. Audible/intelligible speakers - comply with "Audible/Intelligible Notification Appliances" Article.
  - 2. Visible strobe - comply with "Visible Notification Appliances" Article.

**2.26 ADDRESSABLE INTERFACE MODULES**

- A. General: Microelectronic interface module for supervision and control of premises fire safety functions with integral address-setting means, internal code for FACU identification by module type, and output contact ratings to match controlled/supervised equipment.
- B. Monitor Module: Provides a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Relay Module: Capable of providing a direct output signal to controlled equipment or device.
  - 1. Allows the FACU to switch the relay contacts on command.
  - 2. Minimum of two normally open and two normally closed contacts available for field wiring.
- D. Control Module: Capable of providing a supervised direct output signal to controlled notification appliance, equipment or device.
  - 1. Allows the FACU to switch the relay contacts on command.
  - 2. Minimum of two normally open and two normally closed contacts available for field wiring.

**2.27 INTERPOSING RELAYS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Simplex, (Johnson Controls)
- B. Description: Multi-voltage relay for supervision and control of interface devices, with integral status indicator light.

1. Minimum of one Form-C contact, rated at 10-amps, energized by one of three input voltages: 24-VDC, 24-VAC, 120-VAC, 277-VAC or 480-VAC.

**2.28 FAULT ISOLATION MODULES**

- A. Module capable of sensing and automatically isolating SLC short circuit fault.

**2.29 MAGNETIC DOOR HOLDERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Simplex, (Johnson Controls)Description: Normally powered hold opens, fail-closed; equipped for wall or floor mounting and complete with matching doorplate.
  1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
  2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
  3. Operating Voltage: 120-V ac.
- C. Material and Finish: Match door hardware.

**2.30 MAINTENANCE BYPASS SWITCHES**

- A. Description: Keyed or push-button operated switches to open connected circuits that permit system testing without operating associated auxiliary fire safety functions. Activated switches shall annunciate as a trouble condition at the fire alarm control unit. Include trim plate with LED indicators factory-marked "NORMAL" and "DISABLE".

**2.31 SYSTEM PRINTERS**

- A. Printer shall be listed and labeled as an integral component of the fire alarm system.

**2.32 GUARDS AND SHIELDS**

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
  1. Factory fabricated and furnished by device manufacturer.
  2. Finish: Paint of color to match the protected device.

**2.33 RECORD DOCUMENT BOX**

- A. Enclosure: 18 gauge cold rolled steel with a red powder coat epoxy finish. The cover shall be permanently screened with 1" high lettering "FIRE ALARM DOCUMENTS" with indelible ink; removable hinged door with keyed locking latch.

**2.34 FIRE DEPARTMENT KEY BOX**

- A. Basis of Design: KnoxBox 3200®, by Knox Associates, Inc. (The Knox Company).
- B. General: UL 1037, UL 1610, UL 1332 and UL 437; surface or recessed mount with hinged door with tamper alert. Weather-resistance door gasket.



- C. Lock: Double-action rotating tumblers and hardened steel pins accessed by a biased cut key. Dust cover.
- D. Finish: Steel housing, black.
- E. NEMA-3R, 4 or 4x, non-metallic; lockable polycarbonate or fiberglass enclosure. Covers are lockable or screw-down door, A/C with heater option and dual thermostat.
- F. Operating Voltage: 120-V ac nominal for A/C with heater.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Prepare and submit “Action Submittals” prior to equipment procurement.

#### **3.2 TECHNICIAN DESIGN AND LAYOUT**

- A. Roles and responsibilities shall be as set forth in NSPE Position Statement No. 1749 “SFPE/NSPE/NICET Joint Position of the Engineer and the Engineering Technician Designing the Fire Protection System”, available at [nspe.org](http://nspe.org). As applied to the Work, the Contract Documents have been prepared by the “Engineer” and Shop Drawings required by this Section of the Work are prepared by the “Certified Engineering Technician”.
- B. As the Certified Engineering Technician, prepare Shop Drawings including drawings, calculations, certifications, and statements indicating system layout, circuiting, and capacities in accordance with the requirements of the Contract Documents.
- C. Design and Installation Standard(s): NFPA 70 and NFPA 72.
- D. Comply with the performance requirements indicated by the Contract Documents where such requirements are more stringent than those of the Design and Installation Standard(s); otherwise, comply with the performance requirements of the Design and Installation Standard(s).

#### **3.3 EXAMINATION**

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
  - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Confirm fire resistance rating of building construction required to perform as fire alarm system Survivability protection before installation.
- C. Examine depth of stud walls to verify clearance for flush-mount equipment before installation.
- D. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- E. Examine proposed mounting locations of equipment cabinets with user displays and/or controls with the local fire official to verify satisfactory access and ease of identification before installation.

- F. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.4 EQUIPMENT INSTALLATION

- A. Comply with the most restrictive requirements of this Section and applicable Division 26 sections for the installation of low voltage electrical systems.
- B. Comply with NFPA 72, and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
- C. Install fire alarm system in accordance with the reviewed fire alarm system Shop Drawings. Where field modifications of layout are necessary, obtain prior approval from the fire alarm system vendor's qualified fire alarm system designer.
- D. Arrange equipment cabinets, wire-ways, and conduits with adequate clearances to facilitate access for inspection, maintenance, and component replacement.
- E. Install equipment cabinets with top and bottom of cabinets not more than 72 inches above finished floor and not less than 12 inches above finished floor, respectively.
- F. Install battery cabinets with top and bottom of cabinets not more than 48 inches above finished floor and not less than 12 inches above finished floor, respectively.
- G. Install fire alarm system modules and auxiliary components in accessible locations with bottom of modules and components not less than 12 inches
- H. Install equipment cabinets with user displays and/or controls including fire alarm control unit nodes and remote annunciators with displays and/or controls at natural user height.
- I. Flush-mount equipment cabinets/back-boxes not located in designated equipment rooms.
- J. Flush-mount wall- and ceiling-mounted initiating devices, modules, indicators, and notification appliances unless otherwise indicated.
- K. Surface-mount equipment cabinets/back-boxes located in designated equipment rooms.
- L. Surface-mount initiating devices, modules, indicators, and notification appliances installed on concrete or masonry unit walls.
- M. Surface-mount initiating devices installed to the underside of building structure.
- N. Surface-mount or pendant-mount notification appliances installed to the underside of structure.
- O. Install ceiling mounted devices, modules, indicators and notification appliances in alignment with adjacent ceiling fixtures and centered within ceiling tiles.
- P. Install wall mounted devices, modules, indicators and notification appliances in alignment with adjacent switches and wall fixtures.
- Q. Do not install addressable devices in areas subject to temperature extremes. Use conventional initiating devices supervised by addressable monitor modules remotely located within an adjacent conditioned space.

### 3.5 CABLE AND PATHWAY INSTALLATION

- A. Comply with Division 28.

**3.6 INSTALLATION FOR SURVIVABILITY**

- A. Where NFPA 72 Survivability Level 2 or 3 pathways are indicated or required, install fire alarm system cables and pathways within 2-hr fire resistance rated enclosures or comply with Division 28 for “Fire Resistive Pathway Installation”.
- B. Install control units, amplifiers, power supplies, junction boxes, terminal cabinets, or similar components within dedicated 2-hr fire resistance rated fire alarm system equipment rooms where the components originate or comprise a portion of a NFPA 72 Survivability Level 2 or 3 pathway.

**3.7 MANUAL FIRE ALARM BOX INSTALLATION**

- A. Install manual fire alarm boxes in the normal path of egress within 60 inches of the exit doorway.
- B. Install manual fire alarm boxes with operable handles between 42 inches and 48 inches above finish floor level.
- C. Install all manual fire alarm boxes at a common elevation with respect to finished floor.
- D. Install manual fire alarm boxes on a background of a contrasting color.
- E. Indoor Protective Covers: Provide covers for manual fire alarm boxes located in gym and pool areas.

**3.8 SYSTEM SPOT-TYPE FIRE DETECTOR INSTALLATION**

- A. Locate spot-type fire detectors in a manner that readily permits access – without the need of a lift - from the floor below for detector inspection, testing, and maintenance.
- B. Install fire detectors only after all dust and debris producing work is completed.
- C. Maintain factory provided detector covers on fire detectors until fire alarm system is approved for closeout and turnover.
- D. Install Remote Alarm Indicators in a visible location for each group of fire detector located within a normally locked room or area.
- E. Spot-type Smoke- and Heat-Detector Locations and Spacing:
  - 1. Comply with Drawings, and;
  - 2. Comply with NFPA 72 "Smoke-Sensing Fire Detectors".
  - 3. Comply with NFPA 72 "Heat-Sensing Fire Detectors".

**3.9 INSTALLATION OF AIR DISTRIBUTION DUCTWORK DETECTORS**

- A. Comply with NFPA 72, International Mechanical Code, and NFPA 90A.
- B. Install duct smoke detectors in accordance with manufacturer’s installation guidelines.
- C. Locate duct detectors in a manner that readily permits access for detector inspection, testing, and maintenance.
- D. Plan and coordinate duct detector locations and mounting requirements with Division 23 prior to ductwork fabrication and installation; show coordinated duct detector layout on Coordination Drawings and Shop Drawings.

- E. Furnish duct detector housings and ductwork attachments for installation under Division 23. Coordinate requirements for ductwork penetrations, attachments, sealant, and access panels with Division 23.
- F. Do not install duct detectors, housings, or sampling tubes in ductwork until all dust and debris producing work is complete and air distribution system cleaning and startup is complete. Duct detector housings may be attached to ductwork and connected to SLC/IDC prior to air distribution system startup provided they are protected from dust and debris using factory covers.
- G. Air Distribution Equipment Shutdown Applications: Use sampling-tube type system duct smoke detectors.
  - 1. Supply Air Systems: Locate duct smoke detectors downstream of fans and filters.
  - 2. Return Air Systems: Locate duct smoke detectors upstream of filters, exhaust air connections, outdoor air connections or decontamination equipment.
- H. Fire/Smoke Damper Control Applications: Where dampers are provided with conventional duct smoke detectors integral to the fire/smoke dampers (Division 23) supervise duct smoke detector alarm and trouble contacts via addressable interface modules.
- I. Fire/Smoke Damper Control Applications: Use in-duct (spot type) system smoke detectors that do not require a minimum air-stream velocity to operate or sampling-tube type system duct smoke detectors.
  - 1. Locate duct smoke detectors within 5 ft of the associated damper.
  - 2. Locate and support duct smoke detectors in accordance with manufacturer's installation guidelines.
- J. Applications for Detection of Carbon Monoxide within Air Distribution Ductwork: Locate carbon monoxide duct detectors within supply air ductwork served by fuel-fired air distribution equipment in accordance with applicable State or Municipal regulations.
- K. Install remote alarm test stations at each duct detector in readily accessible location that does not interfere with other sections of the Work.

### 3.10 NOTIFICATION APPLIANCE INSTALLATION

- A. Comply with Drawings and NFPA 72 "Notification Appliances".
- B. Wall-mounted Audible Notification Appliances: Install with top of appliance not less than 6 inches below the finished ceiling and not less than 90 inches below the finished floor.
- C. Wall-mounted Visible and -Combination Audible/Visible Notification Appliances: Install with top of appliance not less than 6 inches below the finished ceiling and the entire appliance strobe lens not less than 80 inches and not more than 96 inches above the finished floor.
- D. Install all wall-mounted notification appliances with top of appliance at a common elevation with respect to finished floor.
- E. Install exterior flashing beacons such that they are clearly visible from the primary fire department vehicle access route; and as indicated on Drawings. Use a dedicated NAC for each beacon.
- F. Install exterior alarm bells adjacent to each sprinkler fire department inlet connection; and as indicated on Drawings. Use a dedicated NAC for each bell.

3.11 CONNECTIONS AND INTERFACES

- A. Make connections to premises building systems and components via addressable interface modules. Include necessary interface modules, relays, wiring, resistors, and components as required to achieve the input/output sequence of operations performance criteria indicated by the Drawings.
- B. Coordinate voltage and current ratings of connected components such that connections and interfaces operate within listed limitations. Use interposing relays where connected loads exceed rating of addressable interface modules.
- C. Arrange connections and interfaces such that circuits are monitored for integrity as required by NFPA 72.
- D. Interface to premises systems and components requiring fire alarm supervision of status with addressable interface monitor modules.
- E. Interface to premises Preaction Sprinkler solenoids and/or Fire Extinguishing System actuators with addressable interface control modules listed for releasing service. Install a key operated maintenance disconnect switch in the releasing circuit to permit fire alarm system component testing without solenoid/actuator release. Operation of the maintenance disconnect switch be monitored by the fire alarm system as a supervisory condition.
- F. Interface to premises systems and components requiring Emergency Control Function Interface with addressable interface relay modules installed within 36 inches of the interface wiring termination point.
- G. Each addressable interface relay module used for Emergency Control Function Interface shall include one (1) set of spare contacts for monitoring connection to the premises Building Management System, Security System, or similar secondary premises system.
- H. For each HVAC air distribution unit, coordinate with Division 23 for exact interface requirements, quantity of fan drives, and detailed sequencing for proper shutdown of the associated air distribution equipment.
- I. Install maintenance bypass switches in output circuits for the following functions:
  - 1. Fire protection rated coiling door release.
  - 2. Building notification appliance circuits (audible and visual) - use maintenance switch with modules and necessary programming logic to achieve building wide supervised "silencing" during testing.
  - 3. Delayed Egress Doors.
  - 4. Security System Bypass.
  - 5. Audio/Visual System Bypass.
  - 6. Lighting Control Bypass.
  - 7. Elevator Recall Bypass.
  - 8. Air Handler Shutdown Bypass.
  - 9. Damper Bypass.
  - 10. Fire Suppression releasing modules (physical switch only permitted).
  - 11. Stair Pressurization.

3.12 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with Division 26.
- B. Label addressable initiating devices and bases and notification appliances. Comply with Drawings.
- C. Install framed instructions adjacent to the fire alarm control unit. Installed instructions shall be typewritten computer printout instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

3.13 GROUNDING

- A. Comply with Division 26.
- B. Comply with fire alarm system manufacturer installation guidelines for grounding.
- C. Ground fire alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control unit

3.14 FIELD QUALITY CONTROL

- A. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Devices placed in service before all other trades have completed cleanup shall be replaced.
- C. Field inspections and testing shall be performed by fire alarm system manufacturer's factory-authorized service technicians.
- D. Smoke Control Systems: In addition to Div. 28 fire alarm system inspection and testing requirements, perform additional inspections and integrated functional testing as required to support smoke control system Special Inspections commissioning.
- E. Prepare a typewritten computer-output Test Plan that clearly establishes the scope of fire alarm and signaling system testing. Include at a minimum testing methods, personnel, duration, planned impairments, and required coordination for integrated testing of emergency control function interfaces.
- F. Functional field tests shall be witnessed by the Construction Manager (CM) and their designees; provide notifications a minimum of two (2) weeks in advance.
- G. Acceptance field testing shall be witnessed by the CM, their designees, and authorities having jurisdiction (AHJ); provide notifications a minimum of two (2) weeks in advance.
- H. Perform visual inspections in accordance with fire alarm system manufacturer recommendations and NFPA 72 for Initial Acceptance Inspections. Correct deficiencies.
- I. Document inspections by completing applicable sections of the NFPA 72 "System Record of Inspection and Testing" report.
- J. Provide written notifications for functional field tests; include Test Plan.
- K. Perform functional testing in accordance with fire alarm system manufacturer recommendations and NFPA 72 for "Initial Acceptance Testing". Correct deficiencies. Repeat

functional testing including retesting of unaffected components in accordance with NFPA 72 for “Reacceptance Testing”.

- L. System type detectors shall be tested for their sensitivity compensation head room range (% dirty). Detectors shall not be greater than 20% dirty for their compensation range. Detectors over 20% shall be clean or replaced per the manufacturer’s requirements.
- M. Document 100 percent satisfactory functional tests by completing remaining sections of the NFPA 72 “System Record of Inspection and Testing” report.
- N. Submit NFPA 72 “Statement of Completion” and completed NFPA 72 “System Record of Inspection and Testing” report.
- O. Provide written notifications for acceptance field tests; include Test Plan, NFPA 72 “Statement of Completion”, NFPA 72 “System Record of Inspection and Testing” report, and NFPA 72 “System Record of Completion”.
- P. Perform acceptance field testing. Demonstrate system operation to the satisfaction of the AHJ. Correct AHJ noted deficiencies. Repeat functional testing including retesting of unaffected components in accordance with NFPA 72 for “Reacceptance Testing”. Amend NFPA 72 “System Record of Inspection and Testing” report, and NFPA 72 “System Record of Completion”.
- Q. Place system into normal operating service without system faults or outstanding work.

### 3.15 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include twelve (12) months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 1. Perform visual inspections at intervals required by NFPA 72 Chapter “Inspection, Testing, and Maintenance”.
  - 2. Perform tests at intervals required by NFPA 72 Chapter “Inspection, Testing, and Maintenance”.

### 3.16 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
  - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

### 3.17 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire alarm system.

END OF SECTION

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## **SECTION 283133 - TWO WAY RADIO PES COMMUNICATIONS ENHANCEMENT SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Bi-directional amplifiers.
  - 2. In-building service antennas.
  - 3. Outdoor donor antenna.
  - 4. Fire-resistive coaxial cabling.
  - 5. Fiber-optics cables and hardware.
  - 6. Coaxial cabling.
  - 7. Couplers and splitters.
  - 8. Remote indicator panels.

#### **1.3 DEFINITIONS**

- A. AHJ – Authority Having Jurisdiction.
- B. BDA – Bi-Directional Amplifier.
- C. FCC – Federal Communications Commission.
- D. ERRCS - Emergency Responder Radio Communications System.
- E. PES – Public Emergency Services.
- F. RF – Radio frequency.
- G. TRCES – Two-Way Radio Communications Enhancement System.

#### **1.4 SUBMITTALS**

- A. Comply with Division 20 for common mechanical/electrical requirements.
- B. Comply with Division 28 specifications and drawings; state/local regulations, NFPA 72, and NFPA 1221.

- C. Submit Action Submittals prior to applying for authority having jurisdiction installation permits (where required) and system installation.
- D. Submit Informational Submittals after successful initial system testing and prior to scheduling authority having jurisdiction final approval demonstration testing.
- E. Submit Closeout Submittals as part of project closeout procedure.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
  - 1. Include approvals and listings, construction details, material descriptions, dimensions, profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, and electrical characteristics.
  - 3. Include statement from TRCES vendor that all equipment and components are compatible and represent a complete TRCES meeting all requirements of the AHJ, FCC, NFPA 72, NFPA 1221, and this Specification.
- B. Software-simulated radio propagation modeling summary including with heat maps showing predicted signal coverage levels within the building.
- C. Shop Drawings: For TRCES.
  - 1. Floor Plans. Include floor plans to indicate final equipment, amplifier, power supplies, alarm panels, antennas, and cabling. Show complete point-to-point routing of all cable and pathways; indicate Class and Survivability Level. Show size and type of all conduits, cable, wire, and conductors. Indicate panel circuit designation for each normal power supply branch circuit.
  - 2. Location Map. Include location map showing project site location, RF signal donor site location, and the distance between the two locations.
  - 3. Riser Diagram. Include complete component accurate riser diagram; indicate equipment, amplifiers, power supplies, alarm panels, antennas, and cabling. Show each circuit and pathway; indicate Class and Survivability Level. Show size and type of all conduits, cable, splitters, couplers, wire, and conductors. Indicate panel circuit designation for each normal power supply branch circuit.
  - 4. Equipment Wiring Diagrams. Include wiring diagrams for each system component including amplifiers, power supplies, alarm panels, and antennas.
  - 5. Calculations - Power Supply and Battery Capacity. Include power capacity calculations inclusive of safety/spare capacity factor(s) for each system power supply and connected battery set.
  - 6. Sequence of Operation. Include complete and detailed input/output sequence of operation narrative description.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Designers and Field Technicians.
- B. Seismic Qualification Certificates: For fire alarm control unit, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Baseline Radio Signal Strength Testing Report: Detailed report indicating NFPA 72/1221 plotted interior RF signal strength and/or delivered audio quality (DAQ) score throughout building critical and general areas with all interior partitions constructed and doors installed, without TRCES installed. Format shall be approved by the AHJ.
- D. Statement of Completion: Written statement that system has been installed in accordance with approved plans and tested in accordance with the manufacturer's published instructions and appropriate NFPA 72/1221 requirements.
- E. Record of Inspection and Testing. Detailed documentation of completed TRCES acceptance testing. Format shall be approved by the AHJ.
- F. Sample Warranty: For special warranty.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Record Drawings. Provide complete Shop Drawing re-submittal updated to reflect actual final system installation and sequence of operation of all components.
- B. Operation and Maintenance Data: For TRCES to include in emergency, operation, and maintenance manuals.
1. Provide manufacturer's Owner's Operation and Maintenance Manuals with required related system warranty requirements.
  2. Provide Record of Inspection and Testing.

#### 1.8 QUALITY ASSURANCE

- A. Designer and Field Technician Qualifications: Personnel trained and certified by the TRCES manufacturer as an approved technician; and as required by the AHJ, in possession of a professional engineering license, radio licensing authority license, and/or industry certification.
- B. Source Limitations for TRCES: Single vendor source to provide TRCES components as a complete code-compliant, tested and functioning TRCES.
- C. Electrical Components, Devices, and Accessories: Approved by the AHJ and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
1. Specific Agency Requirements for All Products: RF emitting devices certified by the Radio Licensing Authority.

#### 1.9 COORDINATION

- A. Definition, "Coordinate": Where Sections of the Work interact, the Contractor responsible for this Section of the Work initiates verbal and/ or written communication with one or more different Contractors responsible for other interacting Sections of the Work for the purposes of

establishing a coordinated approach of product selections and installation sequencing that satisfies the individual requirements of the interacting Sections of the Work as well as the requirements of the Work as a whole.

- B. Coordinate construction operations with those of other Sections of the Work and other entities to ensure efficient and orderly installation of each part of the Work.
- C. Coordinate operations and product selections of this Section with operations and product selections included in different Sections that depend on each other for proper installation, connection, and operation.
- D. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
- E. Coordinate installation of different components with other Sections of the Work to ensure maximum performance and accessibility for required maintenance, service, and repair.
- F. Make adequate provisions to accommodate items scheduled for later installation.
- G. Coordination Drawings: Contribute to preparation of Coordination Drawings in the sequence established under Division 1 and Division 20; indicate water-based fire suppression system Work coordinated with other Sections of the Work.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace system equipment and components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
  - 2. Warranty Period: **Five (5)** years from date of Substantial Completion.

#### 1.11 SPECIAL SEQUENCE AND SCHEDULING

- A. Sequence and schedule TRCES design, submittal activities, installation, and approvals to allow for Baseline Testing prior to TRCES installation.
- B. TRCES installation shall be pre-planned and space for components and pathways necessary for full system installation reserved.
- C. Unless otherwise noted, proceed with TRCES component installation only after the need for radio signal enhancement is supported by Baseline Radio Signal Strength Testing.
  - 1. Install cabling system sections scheduled to be concealed within wall construction or similar in normal rough-in construction sequence.
- D. Perform Baseline Radio Signal Strength Testing upon substantial completion of building exterior façade and interior wall partitions including door installation.
  - 1. Baseline testing shall be performed by personnel in possession of a radio licensing authority license, and/or industry certification as required by the AHJ.
  - 2. Provide written notifications for baseline tests.
  - 3. Baseline tests shall be witnessed by the Construction Manager (CM) and their designees; provide notifications a minimum of two (2) weeks in advance.

4. Perform baseline testing in accordance with NFPA 72/1221 and AHJ requirements for plotted interior building RF signal strength and/or delivered audio quality (DAQ) score.
5. Document baseline tests via AHJ approved report format.
- E. Where Baseline Radio Signal Strength Testing demonstrates that minimum required radio signal strength values are provided within building areas as required by the AHJ without the use of a TCRES, obtain approval from the AHJ to omit the TCRES installation from the Work within those building areas.
  1. All TCRES component and pathway space requirements shall remain reserved for such use to permit future TCRES installation should delivered radio signal strength to the building site decrease during the lifetime of the building.
- F. Where Baseline Radio Signal Strength Testing demonstrates the need for a TCRES, proceed with installation. Incorporate the results of the Baseline testing into the design layout for in-building service antenna locations.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

- A. UL 2524 and FCC certified Two-Way Radio Communications Enhancement System (TRCES) inclusive of Bi-Directional Amplifier(s) (BDA), transmission lines, cables, power supplies, antennas and other ancillary equipment that allows radio signals to pass to and from the interior of a structure for the purpose of facilitating radio communications using public emergency services (PES) radio frequencies.
- B. System components, and power supplies inclusive of boards and expansion modules necessary to support the specified system performance criteria, minimum quantity of circuits, and NFPA 72/1221 circuit pathway class designations.
- C. System circuiting and component power loading to provide minimum specified spare capacities, safety factors, and redundancies.
- D. NFPA 72/1221 Pathway Survivability Level (Fire Resistance):
  1. Riser coaxial cables: Level 2 or 3.
  2. Feeder coaxial cables: Level 0.
- E. Component Primary Power: 24-V dc obtained from premises AC power supply.
  1. Capacity: Component current draw of components connected to each power-supply module no greater than 80 percent of the power-supply module rating.
- F. Component Standby Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
  1. Base Capacity: System operation for **24** hours.
  2. Spare Capacity: 20 percent.
- G. TRCES status signals displayed at a dedicated TRCES Remote Indicator Panel.
- H. TRCES status signals supervised by the protected premises Fire Alarm System.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Operational Performance: TRCES shall provide no less than minimum downlink and uplink radio signal strength coverage in all critical and general building areas as required by the AHJ. TRCES shall be capable of transmitting all radio frequencies assigned to the jurisdiction as required by the AHJ. TRCES shall be capable of using any modulation technology in current use by the public safety agencies in the jurisdiction as required by the AHJ.
- B. Survivability Performance: TRCES fire resistive performance capability shall comply with the NFPA 72/1221 circuit Level designations as indicated within the "System Description" Article and as indicated on the Drawings.
- C. Seismic Performance: Fire alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- D. Baseline Radio Signal Strength Testing: Where baseline testing demonstrates that minimum required radio signal strength values are provided within building areas as required by the AHJ without the use of a TCRES, obtain approval from the AHJ to omit the TCRES installation from the Work in those areas.

## 2.3 BI-DIRECTIONAL AMPLIFIERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Advanced RF Technologies, Inc.
  - 2. Bird Technologies.
  - 3. Comprod.
  - 4. Comba Telecom, Inc.
  - 5. Radio Solutions, Inc.
  - 6. Or approved equal.
- B. General: RF signal booster suitable for public safety emergency responder communications; field-programmable gain adjustment; microprocessor-based control system for monitoring voltage, current, temperature, and output level control status; with panel-mounted backlit LCD display, controls, and LED indicators for indication of system status.
- C. Primary Power Supply: 120-V ac.
- D. Secondary Power Supply: 24-V dc supply system including sealed lead acid batteries, automatic float-charge battery charger, and automatic transfer switch.
- E. Supervision: Auxiliary contacts for remote status supervision of signal booster failure, antenna malfunction, loss of primary power, low battery voltage, battery charger failure at a minimum; additionally any other system status supervision required by the AHJ.
- F. Cabinet Enclosures: For amplifiers, power supplies, and other system components. NEMA 4 steel back-box with top, bottom, and side knockouts metal raceway;; key-lock latching, left or right swing hinged, removable steel front door panel; with trim accessories for flush mount

where indicated in Part 3 “Equipment Installation” and Drawings; steel box and door surfaces in factory-finish red enamel.

## **2.4 IN-BUILDING SERVICE ANTENNAS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Comprod.
  - 2. Fractal Antenna Systems, Inc.
  - 3. Laird Technologies, Inc.
  - 4. PCTEL Antenna Products Group, Inc.
  - 5. Or approved equal.
- B. General: Wideband omnidirectional, multi-band type; low-profile ceiling-mount, white finish.
  - 1. Single-band permitted if multi-band is not required within the applicable jurisdiction and approved by the AHJ.
- C. Plenum Application Fire Test Listing: UL 2043.
  - 1. Manufacturer’s standard flame retardant/flame resistant product option permitted for non-plenum applications.

## **2.5 OUTDOOR DONOR ANTENNA**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Comprod.
  - 2. Laird Technologies, Inc.
  - 3. PCTEL Antenna Products Group, Inc.
  - 4. Or approved equal.
- B. General: Factory assembled and tuned directional UHF Yagi antenna; welded or seamless corrosion resistant aluminum construction; DC grounded; with stainless steel mounting hardware.
- C. Wind Velocity Withstand Rating: Comply with minimum Building Code wind load requirements for building appurtenances.

## **2.6 FIRE-RESISTIVE COAXIAL CABLING**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide DragonSkin Coaxial Cable, manufactured by Radio Frequency Systems.
  - 1. UL 2196, UL System FHIT 1250, 2-hour rated circuit integrity coaxial cable.
  - 2. Pathway Survivability Level: 2 or 3.

**2.7 FIBER OPTIC CABLES FOR EMERGENCY RESPONDER RADIO COMMUNICATIONS SYSTEM**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden Inc.
  2. CommScope, Inc.
  3. Corning Cable Systems.
  4. General Cable Technologies Corporation.
  5. Optical Cable Corporation.
  6. 3M Communication Markets Division.
  7. Tyco Electronics Corporation; AMP Products.
  8. Or approved equal.
- B. Description: Single-mode, 9/125-micrometer, 6-strand minimum, tight buffer, fiber optic cable; with performance characteristics to satisfy fire alarm system manufacturer requirements for digital network and voice applications.
1. Multi-mode fiber permitted where required by fire alarm system manufacturer.
  2. Comply with ICEA S-83-596 for mechanical properties.
  3. Comply with TIA/EIA-568-B.3 for performance specifications.
  4. Comply with TIA-492-CAAA for detailed specifications.
  5. Maximum Attenuation (Premises): 1.0 dB/km at 1310 nm; 1.0 dB/km at 1550 nm.
  6. Maximum Attenuation (Outside Plant): 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.
- C. Jacket:
1. Jacket Color: Yellow for 9/125-micrometer cable.
  2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
  3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

**2.8 OPTICAL FIBER CABLE HARDWARE**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden Inc.
  2. Corning Cable Systems.
  3. Optical Cable Corporation.
  4. 3M Communication Markets Division
  5. Tyco Electronics Corporation; AMP Products.
  6. Or approved equal.



- B. Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
  - 1. Number of Connectors per Field: One for each cable of fibers assigned to field, plus
  - 2. spares and blank positions adequate to suit specified expansion criteria.
- C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.
- D. Cable Connecting Hardware:
  - 1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
  - 2. Quick-connect, simplex and duplex, Type SC or Type LC connectors. Insertion loss not more than 0.75 dB.
  - 3. Type SFF connectors may be used in termination racks, patch panels, and equipment enclosures.

## 2.9 COAXIAL CABLING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CommScope, Inc.
  - 2. Trilogy Communications, Inc.
  - 3. West Penn Wire.
  - 4. Or approved equal.
- B. Riser Coaxial Cable: Nominal 0.5-inch, 50 Ohm coaxial cable, with corrugated copper or aluminum outer conductor and UL 1666 CATVR jacket.
- C. Plenum Coaxial Cable: Nominal 0.5-inch, 50 Ohm coaxial cable, with corrugated copper or aluminum outer conductor and UL 910 CATVP jacket.
- D. Plenum Radiating Coaxial Cable: Nominal 0.5-inch, 50 Ohm radiating coaxial cable, with corrugated copper or aluminum outer conductor and UL 910 CATVP jacket.
- E. Connectors: Nominal 0.5-inch, 50 Ohm N-type coaxial cable connectors.

## 2.10 COUPLERS AND SPLITTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cobham Wireless.
  - 2. CommScope, Inc.
  - 3. Scientific Components Corp as Mini Circuits.
  - 4. Or approved equal.
- B. General: 50 Ohm RF couplers and splitters; bandwidth and dB rating as required by TRCES performance requirements; NEMA 4/IP65 enclosure with nominal 0.5-inch N-type coaxial cable connectors.

**2.11 REMOTE INDICATOR PANELS**

- A. General: Zone indicator panel constructed of 16-gauge steel with factory applied red enamel finish; with LED indicators and corresponding factory-screened labels; includes piezo sounder and switches for lamp test and alarm silence.
- B. LED Indicators: Green indicator for primary power in normal state; Red indicators for each individual fault status required to be indicated by the AHJ.

**PART 3 - EXECUTION**

**3.1 PREPARATION**

- A. Prepare and submit "Pre-Installation Submittals" prior to equipment procurement.

**3.2 EXAMINATION**

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
  - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Confirm fire resistance rating of building construction required to perform as TRCES Survivability protection before installation.
- C. Examine depth of stud walls to verify clearance for flush-mount equipment before installation.
- D. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- E. Examine proposed mounting locations of equipment cabinets with user displays and/or controls with the local fire official to verify satisfactory access and ease of identification before installation.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.3 EQUIPMENT INSTALLATION**

- A. Comply with the most restrictive requirements of this Section and applicable Division 26 sections for the installation of low voltage electrical systems.
- B. Comply with NFPA 72/1221, and requirements of authorities having jurisdiction for installation and testing of TRCES. Install all electrical wiring to comply with requirements in NFPA 70.
- C. Arrange equipment cabinets, wire-ways, and conduits with adequate clearances to facilitate access for inspection, maintenance, and component replacement.
- D. Install equipment cabinets with top and bottom of cabinets not more than 72 inches above finished floor and not less than 12 inches above finished floor, respectively.
- E. Install battery cabinets with top and bottom of cabinets not more than 48 inches above finished floor and not less than 12 inches above finished floor, respectively.

- F. Install equipment cabinets with user displays and/or controls including fire alarm control unit nodes and remote annunciators with displays and/or controls at natural user height.
- G. Flush-mount equipment cabinets/back-boxes not located in designated equipment rooms.
- H. Surface-mount equipment cabinets/back-boxes located in designated equipment rooms.
- I. Install outdoor donor antenna with clear view to donor site with a minimum 2-ft vertical clearance above nearby obstacles.
- J. Secure outdoor donor antenna to mounting mast in accordance with manufacturer requirements.
- K. Install NFPA 780 compliant lightning protection at connection to outdoor donor antenna.

### 3.4 CABLE AND PATHWAY INSTALLATION

- A. Comply with NFPA 70, NFPA 72/1221, and requirements of authorities having jurisdiction.
- B. Comply with Division 28.

### 3.5 INSTALLATION FOR SURVIVABILITY

- A. Where NFPA 72/1221 Survivability Level 2 or 3 pathways are indicated or required, install cables and pathways within 2-hr fire resistance rated enclosures or comply with Division 28 for fire resistive pathway installation.
- B. Install BDA units, power supplies, junction boxes, terminal cabinets, or similar components within dedicated 2-hr fire resistance rated fire alarm system equipment rooms if the components originate or comprise a portion of a NFPA 72/1221 Survivability Level 2 or 3 pathway.

### 3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with Division 26.
- B. Comply with AHJ requirements for TRCES component identification.

### 3.7 GROUNDING

- A. Comply with Division 26.
- B. Comply with each TRCES component's manufacturer installation guidelines for grounding.

### 3.8 FIELD QUALITY CONTROL

- A. Components installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Components placed in service before all other trades have completed cleanup shall be replaced.
- C. Field inspections and testing shall be performed by factory-authorized service technicians.
- D. Prepare a typewritten computer-output Test Plan that clearly establishes the scope of TRCES testing. Include at a minimum testing methods, personnel, duration, and required coordination for integrated testing of fire alarm system interfaces.
- E. Functional field tests shall be witnessed by the Construction Manager (CM) and their designees; provide notifications a minimum of two (2) weeks in advance.

- F. Acceptance field testing shall be witnessed by the CM, their designees, and authorities having jurisdiction (AHJ); provide notifications a minimum of two (2) weeks in advance.
- G. Perform visual inspections in accordance with NFPA 72/1221. Correct deficiencies.
- H. Document inspections via formal check-list format or AHJ approved format report.
- I. Provide written notifications for functional field tests; include Test Plan.
- J. Perform functional testing in accordance with NFPA 72/1221 and AHJ requirements for plotted interior building RF signal strength and/or delivered audio quality (DAQ) score. Correct deficiencies.
- K. Document 100 percent satisfactory functional tests via AHJ approved report format.
- L. Provide written notifications for acceptance field tests; include Test Plan, Inspection Report, and Functional Test Report.
- M. Perform acceptance field testing. Demonstrate system operation to the satisfaction of the AHJ. Correct AHJ noted deficiencies.
- N. Place system into normal operating service without system faults or outstanding work.

### 3.9 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include **twelve (12)** months' full maintenance by skilled and certified employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 1. Perform visual inspections at intervals required by NFPA 72/1221 and the AHJ.
  - 2. Perform tests at intervals required by NFPA 72/1221 and the AHJ.

### 3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire alarm system.

END OF SECTION

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## SECTION 312000 – MONITORING OF ADJACENT STRUCTURE

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Monitoring of existing structures shall be performed in accordance with the requirements of the Contract Documents.
- B. Work in this Section includes, but is not necessarily limited to the following:
  - 1. All labor, materials, equipment, and services necessary to document conditions and protect existing structures (including but not limited to buildings, roadways, sidewalks, walls) from damage during construction.
  - 2. All engineering, surveying, layout, monitoring, and submittals in connection with the work in this Section.
  - 3. Documentation of pre-construction conditions of adjacent structures, buildings and streets.
  - 4. Survey monitoring of adjacent structures and nearby buildings for the duration of construction.
  - 5. Crack propagation monitoring of adjacent structures and nearby buildings for the duration of construction.
  - 6. Vibration monitoring of adjacent structures and nearby buildings during excavation, foundation installation and other below-grade construction for the duration of construction.
  - 7. Review of existing relevant, subject buildings and structural drawings as needed to perform a structural stability assessment by a New Jersey State licensed professional engineer engaged by the Contractor.
  - 8. Other labor and materials as may be reasonably inferred to be required to make the work under this Section complete.
- C. Related Work Specified elsewhere:
  - 1. Section 312000 – Earthwork
  - 2. Project Specifications and Contract Drawings
  - 3. In case of conflict the most stringent shall apply.
- D. Definitions:
  - 1. Where “structure” is used herein, it shall include all buildings, tunnels, sheds, roadways, sidewalks, utilities, poles, curbs, pavements, and other appurtenances which are to remain during construction.
  - 2. “Review Level”: The instrumentation value above which will trigger the evaluation of current construction methodology and, if necessary, implementation of mitigative action as shown in this specification to avoid detrimental effects on the surrounding facilities.
  - 3. “Alert Level”: The instrumentation value above which will halt the construction, require evaluation of subject, relevant structures affected, and necessitate mitigative action as

shown in this specification to prevent damages to surrounding structures. The action must be such that the Alert Level is not exceeded in subsequent construction.

## **1.2 REFERENCES**

- A. All work shall comply with all applicable codes and regulations having jurisdiction, including but not limited to the requirements of the 2021 International Building Code New Jersey edition (Building Code).
- B. United States Bureau of Mines (USBM), Report of Investigations (RI) 8507, "Structure Response and Damage Produced by Ground Vibrations from Surface Blasting," by D. E. Siskind, M. S. Stagg, J. W. Kopp, and C. H. Dowding, dated 1980.
- C. Deutsche Institut für Normung (DIN) 18723 – Field Procedure for Precision Testing of Surveying Instruments.
- D. National Institute of Standards and Technology (NIST).
- E. The following project-specific documents shall be referenced for the work of this Section:
  - 1. Project Specifications and Contract Drawings
  - 2. Geotechnical Engineering Report prepared by Langan Engineering, and Environmental Services, LLC dated 3 May 2024.
- F. In case of conflict, the most stringent shall apply

## **1.3 SUBMITTALS**

Unless noted otherwise, the contractor shall prepare and submit the following items to the engineer for approval at least 30 days before the start of said work. All submittals shall be prepared and signed by a licensed land surveyor or licensed professional engineer.

- A. Submit documentation verifying that those performing the monitoring program have the required qualifications as specified herein.
- B. Survey Monitoring: The Contractor shall submit a survey monitoring plan prepared by a licensed professional land surveyor. The plan shall show the location of all installed monitoring points and the survey benchmark(s) that will be used for optical survey monitoring. Submit monitoring plan and periodic elevation and lateral position control point monitoring data for temporary support of excavation (SOE) and underpinning systems, neighboring/bordering structures, lots, walkways and adjacent sidewalks as specified herein.
- C. Provide proposed method and locations of elevation and lateral position control points to be established to monitor any vertical and horizontal movements during excavation and sheeting, bracing, and underpinning installation.
- D. Provide results of monitoring point survey within 24 hours of taking the readings.
- E. Weekly Reports: Weekly monitoring reports shall be submitted to the Owner's Engineers for review. The reports shall include incremental and cumulative deviation in vertical, longitudinal, and transverse axes; vertical and horizontal deviation at crack gauges; elevation of and change in groundwater level at observation wells; maximum daily peak particle velocity in vertical, longitudinal, and transverse axes; waveform recording of vibrations that exceed the threshold specified below.
- F. Vibrations: Submit a plan prepared by a licensed professional engineer showing the locations of the vibration monitoring devices. The vibration monitoring readings shall be provided to

Owner, Construction Manager and Geotechnical Engineer real time via remote notification.

- G. Crack Propagation: Submit a plan prepared by a licensed professional engineer showing the locations of the installed crack propagation monitoring devices (gages or reference lines). The readings shall be taken once a week and shall be submitted to Owner, Construction Manager and Geotechnical Engineer within 24 hours of the readings.

#### 1.4 QUALITY ASSURANCE

- A. Optical survey monitoring shall be performed by a Professional Land Surveyor licensed in the state of New Jersey with a minimum of three years of experience (or as approved by the Engineer) in deformation measurements of the types and accuracies specified herein.
- B. Crack propagation and vibration monitoring shall be performed under the supervision of a Professional Engineer licensed in the State of New Jersey with a minimum of 3 years of experience (or as approved by the Engineer) in monitoring of the types and accuracies specified herein.
- C. The engineer responsible for Structural Stability of adjacent structures shall be a Professional Engineer licensed in the State of New Jersey State with a minimum of 5 years of experience (or as approved by the Engineer) in performing structural stability assessment.

#### 1.5 PROJECT CONDITIONS

- A. Prior to entering a bid, the Contractor shall visit the site and become familiar with all existing conditions. Surrounding buildings, below grade structures, trees and utilities shall be inspected by the Contractor prior to entering a bid. The Contractor shall review the above mentioned geotechnical engineering report and contract documents to familiarize himself with the existing conditions.
- B. The project site is located within the north portion of the WPU campus in a tiered parking area. The site is bound by University Drive to the north and east, the existing recreation center building to the south and Mills Drive to the west. Century and Skyline Halls are to the southwest of the site and a soccer field is to the south of the existing recreation center. A steep drop off with an existing brook is located to the southeast and east of the site.
- C. The subject area is immediately north of the Sports and Recreation building that is to remain. It is currently occupied by stepped parking lot with solar canopies.
- D. The work area is limited to the property limits. Contractor shall assume that there is no access to the adjacent properties. All adjacent structures, properties and streets shall be protected and shall be taken into account for shoring, underpinning and dewatering.
- E. The work shall be executed so that no damage or injury will occur to the existing adjoining or adjacent structures, streets, walkways, trees or utilities. Should any damage or injury occur that is caused by the Contractor, or by anyone in Contractor's employ, or by the work under this Contract, the Contractor shall repair such damage at his own expense and shall assume all responsibility for such injury.
- F. Structures that are within 30 feet lateral distance of the proposed construction consist of "Buildings/Structures of Interest" for Preconstruction Documentation and Monitoring Purposes. The buildings/structures of Interest include but not limited to the following:
  - 1. Existing Sports and Recreation Building
  - 2. Solar Panels

3. Temporary Support of Excavation (SOE) Systems, if any, (monitoring purposes only)
  - B. Contractor and its engineer shall obtain and review all available existing buildings information and verify the as-built information (levels, depths, dimensions, elevations etc) of the subject buildings prior to design and construction. By submitting his design, it shall be assumed that the Contractor and its engineer verified all the as-built conditions.
  - C. No guarantee is expressed or implied for the inferred information based on the subsurface logs and profiles provided in the geotechnical study mentioned above. No information derived from such boring logs or plans will, in any way, relieve the Contractor from the responsibility of making his own evaluations, inspections and determinations in regards to the conditions at the site. The Contractor shall make his own assumptions of subsurface conditions that may affect methods of construction of the work hereunder, and he agrees that he will make no claims for damages or compensations, except as are provided under the agreement, should he find conditions during the progress of the work different from those as calculated and/or anticipated by him. Additional borings and other exploratory operations may be performed by the Contractor, at the Contractor's expense and following the Owner's approval. No change in the Contract Sum will be authorized for such additional exploration undertaken by the Contractor.
  - D. The locations of utilities shall be verified in the field by the Contractor prior to the installation. Protection of all utilities located on the site is the sole responsibility of the Contractor.
  - E. The Contractor, by careful examination, shall inform himself of the nature and location of the work, the conformation of the ground, the nature of the subsurface conditions, the locations of the groundwater table, the character, quality and quantity of the materials to be encountered, the character of the equipment and facilities needed prior to and during the execution of the work, and all other matters which can in any way affect the work.
  - F. The Contractor shall be held to have visited the site and to have familiarized himself with the existing conditions of adjoining properties, utilities and buildings.
  - G. The Contractor shall investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation, and ingress and egress to/from the site of the work. The Contractor shall conform to all local, New Jersey State, and Federal regulations in regard to the transportation of materials to, from, and at the job site and shall secure in advance such permits as may be required.
  - H. The Contractor shall investigate the existing conditions present within the project area prior to mobilization of any equipment. The Contractor shall inform himself of limitations to vertical and horizontal clearances, restrictions, and other limitations affecting transportation to, ingress and egress of the locations of the proposed work.
  - I. The Contractor shall perform the work of this Section in a manner that will result in no harmful effects to existing on-site or off-site structures. Any damage to structures resulting from the Contractor's work shall be the sole responsibility of the Contractor.
  - J. Existing Utilities: Prior to start of work locate existing underground utilities in and beyond the areas of work. If utilities are indicated to remain in place, provide adequate means of support and protection during the work. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
    1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with the Owner



and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

2. Do not interrupt existing utilities serving facilities occupied by the Owner or others, during occupied hours, except when permitted in writing by the Construction Manager and then only after acceptable temporary utility services have been provided. Provide minimum of 48 hour notice to the Construction Manager, and receive written notice to proceed before interrupting any utility.
  3. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.
- K. Examine drawings to determine sequence of operations and relation to work of other trades. Start of work will signify acceptance of field conditions and will acknowledge coordination with other trades.
- L. Comply with all federal, state and local environmental and health and safety regulators, including but not limited to Occupational Safety and Health Administration (OSHA).
- M. Comply with all campus required environmental and health and safety guidelines.

## **PART 2 - PRODUCTS**

### **2.1 MONITORING EQUIPMENT**

- A. Optical Survey Monitoring Points and Equipment
1. Optical monitoring points on buildings for vertical and lateral displacement shall be mountable targets or prisms.
  2. Settlement monitoring points may be set using pins or cross hatches in the structure to be monitored.
  3. Accuracy of the survey monitoring readings shall be within 1/16 inch (0.005 ft) or better. Use appropriate calibrated survey equipment and procedures to achieve the specified accuracy level operated by qualified licensed land surveyors. Check benchmarks with off-site monuments/benchmark before each round of readings.
- B. Crack Gauges
1. If allowed by the Property Owner, clear plastic crack gauges with reference line and measuring grid shall be used. Crack gauges shall be attached to structures using epoxy or bolts in accordance with manufacturer's recommendations. Photographic documentation should be used for monitoring.
  2. If the Property Owner will not allow installation of crack gauges, reference lines may be used. A reference line should be drawn across and perpendicular to the crack. Two measurement points (one on either side of the crack) should be drawn and the initial distance between the two measurement points recorded for future comparison. Measurements should be taken in 1/32-inch increments.
- C. Vibration Monitoring Equipment
1. Portable seismographs with the ability to record vibration events up to 10 inches per second (in/sec) with an accuracy of  $\pm 5\%$  over a range of frequencies from 2 to 250 Hz.
  2. Seismographs shall have the ability for remote monitoring and shall be set up to send recorded data at least twice daily and send out immediate, automatic alerts if threshold

values are exceeded.

### **PART 3 - EXECUTION**

#### **3.1 PROTECTION OF ADJACENT STRUCTURES**

- A. The project site is an urban area and there are structures adjacent to and within the vicinity of the site. The work shall be executed so that no damage or injury will occur to the existing adjoining or adjacent structures, subject landmark buildings, streets, railroads, paving, sewers, gas, water, electric or any other utilities. Should any damage or injury occur that is caused by the Contractor, or by anyone in Contractor's employ, or by the work under this Contract, the Contractor shall repair such damage at his own expense and shall assume all responsibility for such injury.
- B. The above shall also include the protection of all existing utilities (including sewers, water lines, electrical lines and telecommunication lines) to remain in use within and adjacent to the area affected by the work of this project.
- C. Prior to commencement of any work, consult the records for existing utilities, and note all conditions and limitations which might affect the work required under this Section. The Contractor shall not damage any utilities that are to remain and shall leave them accessible.
- D. Monuments, benchmarks and other reference features on streets bounding this project, shall be protected. Should these be disturbed in any manner, the Contractor shall have them replaced at no cost to the Owner.

#### **3.2 PRE-CONSTRUCTION CONDITIONS DOCUMENTATION**

- A. General: The Owner's Consultant shall perform a pre-construction condition documentation of all the adjoining properties, structures, buildings, walkways and roadways which are within the lateral distance of the construction site specified in Part I of these specifications. The "buildings/structures of interest" are identified in Part 1 of these specifications.
- B. The documentation shall document conditions of the structures of interest prior to construction work and shall be used as a reference document for potential claims. The documentation shall include photographs, sketches, crack reference lines, movement control points and measurements of ambient vibrations. Crack monitoring gages or crack reference lines shall be installed on existing structural cracks. Locations of the lateral and vertical movement monitoring points shall be chosen in advance for monitoring during construction. Ambient vibrations shall be measured. The documentation shall serve as a pictorial and quantitative reference document to assess conditions prior to, during, and after construction.
- C. Photographs: Take photographs of the building walls of the adjoining properties and existing school (if applicable) so that the surfaces may be examined during construction and compared with the pre-work condition. If any cracks or other stress signs are exhibited by the buildings, halt operations until corrective action has been provided and is acceptable to the Owner.
- D. Crack Reference Lines/Gauges: Install several crack monitoring gauges or lines on any nearby existing crack on adjacent properties. Monitor the lines/gauges during construction and compare with the pre-work condition. If increased stress signs are observed on the crack reference lines/gauges, halt operations until corrective action has been provided and is acceptable to the Owner.
- E. Movement Control Points: Choose or identify location of the movement (vertical and lateral) points on the adjacent structures of interest for monitoring during construction. The land

surveyor retained by the contractor will install these points and will monitor during construction.

- F. Vibration: Measure ambient vibration levels using a seismograph near each structure/building of interest.
- G. A copy of the pre-construction conditions documentation of the subject structures will be made available to the Contractor upon contract award.
- H. The Contractor may perform, if he wishes, his own conditions verification survey and shall submit any findings that differ from the Owner's Engineer's documentation at least 20 work days before beginning the work.
- I. Before starting work, the Contractor's Professional Engineer and Land Surveyor shall check and verify governing dimensions and elevations, survey conditions of adjoining properties and historic landmark buildings, and record any prior settlement or cracking of structures, pavements, and other improvements. The Contractor shall video all relevant, subject structures prior to the beginning of any construction activities.

### **3.3 MONITORING OF EXISTING STRUCTURES**

- A. For this project, the buildings, structures, elements of interest for monitoring purposes are identified in Part 1 of these specifications.
- B. Vertical and Lateral Displacements -
  - 1. Monitor each building/structure/element of interest within 30 feet of the site laterally.
  - 2. Install a minimum of 10 optical survey monitoring points on the existing recreation building northern most facade (minimum of 5 sets of 2 points each – each set consisting of one point within the lower level or street level and one point at the roof line or upper portion of building) for monitoring vertical and lateral displacement. A minimum of 5 optical survey monitoring points shall be placed on the solar canopies north of the site. Monitoring locations shall not be spaced at intervals exceeding 25 feet laterally. Install additional sets of monitoring points as necessary to maintain this spacing. Install monitoring points on the building facades facing the construction site.
  - 3. Install a minimum of 10 settlement monitoring points (at 25 feet on center) on the adjacent sidewalks, roadways and adjacent building entryways for monitoring vertical displacement.
  - 4. The Contractor shall install and monitor points at a maximum horizontal spacing of 25-feet on-center around the entire perimeter of the excavation, to monitor the ground movements behind the support of excavation (SOE). As the excavation proceeds, install points on the SOE elements (at the top of excavation) to measure potential lateral deflection. These locations shall be subject to review by the Engineer of Record for the excavation support system.
  - 5. All monitoring locations shall be subject to review by the Owner's Engineers.
  - 6. The monitoring points shall be established and monitored by the Contractor employing a Professional Land Surveyor licensed in the State of New Jersey, and referenced to a fixed, off-site benchmark.
  - 7. The Contractor may establish additional monitoring points on the existing adjacent structures, subject to the Property Owner's approval, to adequately monitor and otherwise keep himself informed of the structures' conditions during the work.

**C. Crack Gauge Monitoring**

1. Install crack gauges at large visible cracks in the walls, foundation walls on the buildings/structures of interest to monitor changes in crack width during construction. Initial conditions of the crack gauges shall be measured and/or documented photographically.
2. Location of crack gauges shall be selected by agreement between the building owner, Contractor, the engineer responsible for Structural Stability and the Owner's Engineer.

**D. Vibration Monitoring**

1. 1 seismograph is are to be installed at the lowest level of the recreation building at a point closest the construction anticipated to cause maximum vibrations (e.g. demolition, excavation, foundation construction).
2. Alerts shall be sent out automatically to designated recipients (Owner's Engineer, Owner's Representative, Contractor, and engineer responsible for Structural Stability) if threshold levels specified below are exceeded.
3. Waveform recording of vibrations shall be provided for vibration events exceeding a peak particle velocity of 0.25 inches per second as measured along any axis.

**3.4 FREQUENCY AND REPORTING**

**A. Optical Survey Monitoring of Displacements**

1. Monitoring shall be performed at least once weekly (one reading per week) by the Contractor's Professional Land Surveyor during demolition and all below-grade construction (soil and rock excavation, support of excavation work, cut stabilization, underpinning, or foundation construction) until the first floor slab is constructed. The accuracy (margin of error) of the survey readings shall be 0.005 feet (1/16 inch) or better. All monitoring data shall be transmitted to the Owner on a weekly basis.
2. After the first floor slab has been poured, monitoring shall be performed once monthly by the Contractor's Professional Land Surveyor until building top-off. All monitoring data shall be transmitted to the Owner on a monthly basis.

**B. Crack Gauges:** Crack gauges shall be monitored once a week during demolition and below-grade construction activities. Monitoring shall consist of measuring the distance between the points established during installation or by documenting the crack gauge photographically.

**C. Vibrations:** Vibration monitoring shall be performed on a continual basis during demolition and foundation construction and below-grade construction activities.

**D. Should movements or vibrations exceed the specified thresholds, monitoring intervals shall be increased to daily unless otherwise instructed by the Owner's Engineer.**

**3.5 ALERTING**

- A. Alerts shall be generated when data collected are determined by those responsible for that aspect of monitoring to have reached or exceeded the Review and Alert Level thresholds as defined herein.
- B. Alerts for Review and Alert Level thresholds shall be promptly forwarded to the Construction Manager, Owner, and Owner's Engineer. The alert shall contain the monitoring point that has exceeded its Review and Alert Level threshold, the data, the date and time of the reading, the reading value and the Review or Alert Level. For vibrations exceeding the Review or Alert Level

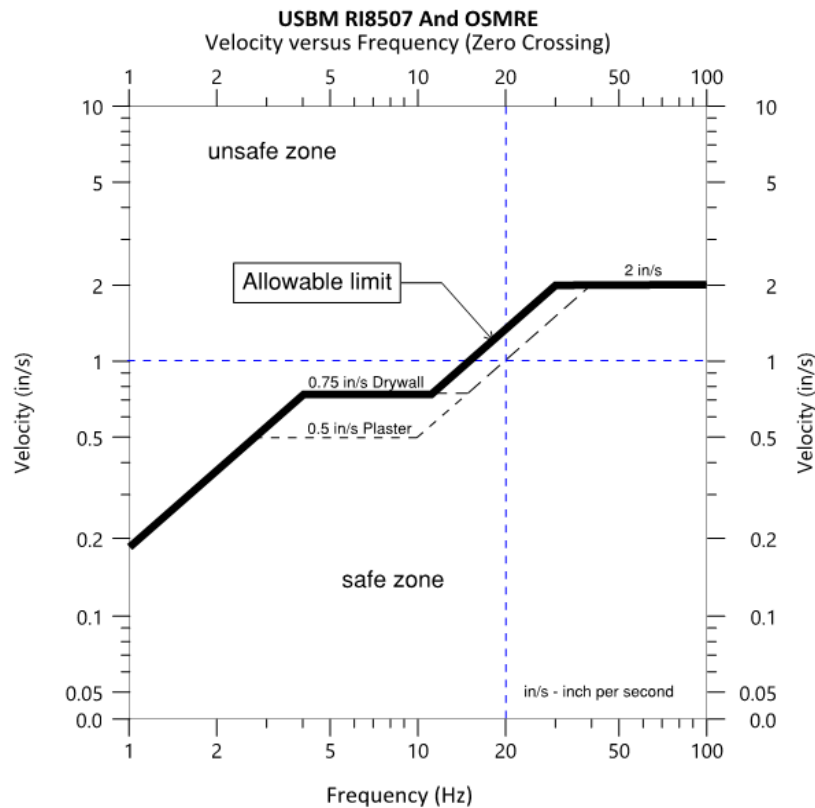
thresholds, the alert should include the waveform recording of the vibrations.

- C. The alert system shall include a means for the recipient of the alert to acknowledge that the alert has been received and to disable repeated alarming on that sensor.
- D. The Contractor shall make every effort to work with those responsible for monitoring to provide timely readings for review of data and sending of alerts.

### 3.6 THRESHOLD LIMITING VALUES

- A. The Contractor shall take every precaution to guard against excessive movement, settlement, groundwater drawdown, vibration, or damage of adjacent buildings and structures. The Contractor is solely and entirely responsible for the safety and support of such structures, and liable for any damage and injury caused thereby or resulting therefrom.
- B. The following Review Level Thresholds shall require that the Contractor cease construction, review their means and methods of construction and suggest revised means and methods to limit movements and vibrations in adjacent structures. A written description of revised means and methods must be submitted by the Contractor before work can proceed. The Review Level Thresholds are as follows:
  - 1. Vertical or Horizontal Displacements (Movements)
    - a. Buildings or other Structures or retaining walls: Two consecutive readings of 1/8 inch of movement, or one confirmed reading of ¼ inch.
    - b. Support of Excavation (SOE) Systems: Three consecutive readings of 1/8 inch of movement, or one confirmed reading of ¼ inch.
  - 2. Crack Gauges: three consecutive readings of 1-millimeter, or one confirmed reading of 3 millimeters.
  - 3. Vibrations
    - a. Buildings of Interest and Other Structures: Peak Particle Velocity exceeding 0.5 inches per second (ips) measured along any axis.
- C. The following Alert Level (Maximum Allowable) Threshold values shall require the Contractor to cease construction activities and notify the construction manager, Owner, Owner's Engineer immediately. The engineer for Structural Stability engaged by the Contractor will make an inspection of the affected building within 24 hours of the reported exceedances. The contractor's engineer will prepare a report assessing the condition of the affected building and any required remediation. The report will be submitted to the construction manager, the design team within 48 hours of the incident. Construction activities shall not continue until adequate measures are in place to achieve stability of adjacent structures or excavation support systems. Where significant movements are detected, the frequency of data collection shall be increased to once daily or as directed by the Owner's Engineer. The Alert Level (Maximum Allowable limits) Thresholds are as follows:
  - 1. Vertical and Horizontal Movements
    - a. Buildings or other Structures: 0.4 inch total vertical or 0.4 inch total horizontal.
    - b. Support of Excavation (SOE) Systems away from buildings: 0.5 inch total movement.
  - 2. Crack Gauges: 4 millimeter increase in crack width.

3. Vibrations: Buildings of Interest: Peak particle velocities (PPV) exceeding the USBM plot of allowable PPV versus frequency as published in RI 8507 (graphically shown below).



- D. Any movement or vibration levels exceeding the above criteria shall be reported immediately to the Owner. If the above thresholds are exceeded:
  1. The Contractor will immediately stop work in the vicinity of the exceedance.
  2. The engineer for Structural Stability engaged by the Contractor will make an inspection of the affected building or structure within 24 hours of the reported exceedances. The Contractor's engineer will prepare a report assessing the condition of the affected building and any required remediation. The report will be submitted to the construction manager and the design team within 48 hours of the incident.
  3. The Contractor shall develop alternate methods and procedures, subject to the review and approval of the Owner's Engineers and the affected building's engineers.
  4. Resume work using the agreed upon alternative method.
  5. Corrective measures to achieve stability of adjacent structures shall be the responsibility of the Contractor. The Contractor shall restore, to the satisfaction of the Property Owner, by repair or otherwise, the portions of buildings, or their contents, altered by the Contractor's work. Restoration shall be completed to the conditions which existed prior to the start of work.

### 3.7 CAMPUS REQUIREMENTS

- A. The campus may require more strict monitoring requirements for its structures. Contractor shall

#### MONITORING OF ADJACENT STRUCTURES

coordinate and comply with the monitoring criteria and frequency.

- B. The campus may establish more restrictive allowable movement and vibration criteria during construction. Contractor shall comply with the limiting criteria.

### 3.8 QUALITY CONTROL

A. Owner's Responsibilities

1. Preconstruction Conditions Documentation: The Owner will retain a qualified engineer who will perform the Preconstruction Conditions Documentation of the structures of interest.
2. Vibration Monitoring: The Owner will retain a qualified engineer, who will perform vibration monitoring.
3. Crack Propagation Monitoring: The Owner will retain a qualified engineer, who will perform vibration monitoring.
4. The owner will retain a geotechnical engineer who will review contractor's submittals and readings.

B. Contractor's Responsibility

1. The contractor shall cooperate with the owner's consultants and inspector when performing their specified monitoring.
2. Survey Monitoring: The Contractor shall retain a licensed surveyor who shall install and monitor lateral and vertical control points during construction. The licensed surveyor shall have at least 5 years of experience in such work and shall utilize the suitable precise equipment to measure the movements within the specified levels of accuracy.
3. Other: The Contractor shall be also responsible for retaining qualified professional engineers, certified testing agencies and licensed surveyors to perform inspection and monitoring services not specifically defined as being provided by the Owner.
4. Monitoring, inspections and testing performed by the Owner shall not relieve the Contractor of responsibility for performing all other monitoring, testing and inspection specified herein or otherwise necessary to meet the quality control and quality assurance requirements of this Section. No testing and/or analysis by the Owner shall relieve the Contractor of the responsibility of conforming to the requirements of these specifications.
5. Time for conducting the monitoring, tests and/or inspections defined in these specifications shall be considered as part of the Work of this Project and neither extension of time nor additional costs shall be accepted as a result

END OF SECTION 310913

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## **SECTION 311000 - SITE PREPARATION**

### **PART 1 - GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Cleaning site of debris, grass, trees, and other plant life in preparation for site or building earthwork.
- B. Protection of existing structures, trees, or vegetation indicated in Contract Documents to remain.
- C. Stripping topsoil from areas that are to be incorporated into limits of project and where so indicated on Construction Drawings.
- D. Removal of asphalt pavement and concrete slabs from areas that are to be incorporated into limits of project and where so indicated on Construction Drawings.

#### **1.02 RELATED SECTIONS**

- A. Section 011100 – General Requirements
- B. Section 024119.1 – Site Demolition
- C. Section 312000 – Earthwork
- D. Section 312200 – Erosion and Sedimentation Control
- E. Construction Drawings

#### **1.03 REFERENCE STANDARDS**

- A. New Jersey Soil Erosion and Sediment Control (SESC) Manual
- B. SESC Project Permit and Conditions

#### **1.04 ENVIRONMENTAL REQUIREMENTS**

- A. Construct temporary erosion control systems to protect adjacent properties and water resources from erosion and sedimentation.
- B. Owner will obtain the Soil Erosion and Sediment Control (SESC) permit governing the discharge of STORMWATER from the construction Site.
- C. Contractor shall be totally responsible for conducting soil erosion and sediment control and the storm water management practices and for enforcement action taken or imposed by Federal or State agencies, including cost of fines, construction delays, and remedial



actions resulting from Contractor's failure to comply with all provisions of the Federal or State agencies.

**1.04 PROJECT CONDITIONS**

- A. Conditions existing and described by the Owner at time of inspection for bidding purposes will be maintained by Owner in so far as practical.
- B. Variations to conditions or discrepancy in actual or described as proposed conditions as they apply to site preparation operations are to be brought to attention of Owner prior to commencement of sitework.

**PART 2 - PRODUCTS**

Off-site materials shall be transported to project using well maintained and operating vehicles. Once on site, transporting vehicles shall stay within limits of disturbance or on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping.

**PART 3 - EXECUTION**

**3.01 PREPARATION**

Verify existing plant life that is to remain and any clearing limits are clearly tagged, identified, and marked in such manner as to insure their safety throughout construction operations.

**3.02 PROTECTION**

- A. Locate and identify existing utilities that are to remain and protect from damage.
- B. Protect trees, plant growth, wetlands and features designated to remain as part of final landscaping.
- C. Conduct operations with minimum interference to public or private accesses and facilities. Maintain ingress and egress at all times and clean or sweep roadways daily as required by the governing authority. Dust control shall be provided with equipment provided by Contractor.
- D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.
- E. Provide traffic control as required, in accordance with the New Jersey Department of Transportation's rules and regulations and applicable State, Local and County requirements.

**3.03 CLEARING**

- A. Clear areas required for execution of work.

- B. Unless otherwise indicated on Construction Drawings, remove trees, shrubs, grass, other vegetation, improvements, or obstructions interfering with installation of new construction. Removal includes digging out stumps and roots. Depressions caused by clearing and grubbing operations are to be filled to subgrade elevation to avoid ponding of water. Satisfactory fill material shall be placed in accordance with Section 312000.
- C. Remove grass, trees, plant life, stumps, and other construction debris from site to disposal material that is suitable for handling such material in accordance with State, County and Local laws and regulations.

### 3.04 TOPSOIL EXCAVATION

- A. Topsoil shall consist of organic surficial soil typically found in depths of not less than 4-inches. Satisfactory topsoil to be recovered shall be reasonably free of subsoil, clay lumps, stones and other objects over 2-in. in diameter, weeds, roots, and other objectionable material.
- B. Cut heavy growths of grass from areas before stripping and remove cuttings with remainder of cleared vegetative material.
- C. Strip topsoil from areas that are to be filled, excavated, landscaped, or re-graded to such depth that it prevents intermingling with underlying subsoil or questionable material.
- D. Stockpile topsoil in storage piles in areas as directed by Owner. Construct storage piles to freely drain surface water. Cover storage piles as necessary to prevent windblown dust. Dispose of unsuitable topsoil as specified for waste material, unless otherwise specified by Owner. Excess topsoil shall be removed from site by Contractor unless specifically noted otherwise on Construction Drawings.
- E. Stockpiled topsoil shall be reused as general fill in landscaped areas as permitted by the Geotechnical Engineer and as specified in Section 312000.

### **END OF SECTION 311000**

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## **SECTION 311500 - PROJECT SURVEY AND LAYOUT**

### **PART 1 GENERAL**

#### **1.01 WORK INCLUDED**

- A. The Contractor shall employ a New Jersey Licensed Land Surveyor for necessary surveying required to construct all elements of the Project as shown on the Contract Drawings and specified herein. The Contractor will also provide additional horizontal and vertical control points along the project area as required for construction or as directed by the Owner's Engineer.
- B. All surveys shall be signed and sealed by the Contractor's Land Surveyor, licensed to practice in the State of New Jersey.
- C. All project installations improperly constructed as a result of inadequate or erroneous survey layout shall be properly relocated by the Contractor at no cost to the Owner.

#### **1.02 RELATED SECTIONS**

- A. Section 31200 - Earthwork
- B. Section 334200 - Sanitary Sewer System
- C. Section 265615 - Site Lighting
- D. Section 334100 - Storm Drainage
- E. Section 321216 - Asphaltic Concrete Paving
- F. Section 321315 - Curbs and Sidewalks
- G. Contract Drawings

#### **1.03 REFERENCE STANDARDS**

In accordance with local rules and regulations.

#### **1.04 QUALITY ASSURANCE**

- A. All construction layout work shall be performed under the direction of a Professional Land Surveyor.
- B. The survey crew will discuss all layout procedures with the Contractor's supervisor prior to commencing work.
- C. The survey crew daily report shall be filled out and signed by the Contractor's supervisor at the end of that day's layout.

- D. Copies of sketches, cut sheets, etc. shall be provided to the Contractor by the end of the next workday.
- E. All costs related to re-staking due to construction or Contractor's work resulting in destruction or movement of stakes shall be paid for by the Contractor and at no additional expense to the Owner.
- F. Building dimensions to be coordinated with approved architectural plans.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

Provide all instruments, equipment, stakes, marking paints and other materials necessary to perform the work satisfactorily.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Qualified personnel and adequate equipment shall be made available by the Contractor to maintain control points and layout all lines and grades throughout the duration of the Contract.
- B. The exact position of all work points shall be established from control points, base line transit points and/or other points of similar nature based upon information provided in Contract Documents.
- C. The Contractor shall establish, re-establish when necessary and maintain control points throughout the life of the Contract to permit the Engineer to make the necessary preliminary, interim and final measurements and to check the Contractor's layout.
- D. The Contractor shall be responsible for the preservation of all control points. If control points are damaged, lost or moved, they shall be reset at no additional expense to the Owner. Control points outside as well as inside the Contract Limits shall be used for construction.
- E. The Contractor shall provide and maintain offset stakes for each base line, at each station, and out of the limits of grading and construction. Each stake shall be identified and marked to show the offset distance from the base line and the Contractor shall furnish sheets showing cuts and fills to the finished profile and cross section lines.
- F. Any error, apparent discrepancy or absence of data shown or required for accurately accomplishing the survey work shall be referred to the Owner's Engineer for interpretation or furnishing when such is observed or required.
- G. The Owner's Engineer may check all or any portion of the survey work or notes made by the Contractor. Any necessary correction to the work shall be made immediately by the

Contractor. Such verification by the Owner's Engineer shall not relieve the Contractor of any responsibilities for the accuracy and completeness of his work.

- H. The Contractor shall keep a survey transit and level with tripod and survey rod on the project at all times to be used for checking inverts, surveyor's stakes, etc.
- I. The Contractor shall submit all survey data for daily checks, to the Office of the Owner's Engineer after the data is obtained.
- J. The Contractor shall submit cut sheets for the Owner's Engineers approval prior to any construction activity, for the purpose of verifying the construction layout. Cut sheets for any particular item of work shall be submitted prior to the need for approval. All cut sheets shall be prepared by a Licensed Land Surveyor and shall bear his seal and signature.
- K. In cases where extra excavation is required, before and after cut sheets shall be submitted for determination of quantities for excavation and backfill and extra bedding.
- L. All project installation improperly constructed or located as a result of inadequate or erroneous survey layout shall be relocated or reconstructed, after demolition and/or removal of the improper work as necessary, by the Contractor at no charge to the Owner.

### 3.02 LAYOUT

- A. Building Layout – Set a minimum of 4 corners.
- B. Curb Layout – Stakes will be located at 50-ft stationing and also at the point of curvature, points of tangency and radius points with 4-ft offsets to the face of the curb. Cut sheets shall be provided to the Contractor by the Surveyor.
- C. Storm drainage and sanitary sewer lines (including manholes and catch basins) – Stakes will be located at 50-ft stationing along the centerline of the utility at 15-ft offsets. Manholes and catch basins will have 2 offsets per structure. Cut sheets shall be provided to the Contractor by the Surveyor.
- D. Water Layout – Offset stakes will be located at deflections and at hydrant locations. Hydrant elevations will be to grade ring.
- E. Lighting Layout – Centerline of lighting structure with 5-ft offsets and finished grade elevations.
- F. Allowable tolerances for the project shall be generally as follows:
  - 1. Structural work, site furnishings: horizontal location 0.1 feet; vertical elevation 0.01 feet.
  - 2. Paving, fine grading: vertical elevation 0.1 feet.
  - 3. Trees: horizontal location 0.5 feet.

**END OF SECTION 311500**

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## **SECTION 312000 - EARTHWORK**

### **PART 1 – GENERAL**

#### **1.01 SECTIONS INCLUDES**

- A. Cutting, proofrolling, filling and grading to required lines, dimensions, contours and elevations for proposed improvements as shown on the Contract Drawings.
- B. Removal of above-grade rubble, curbs, pavement, slabs, and all other above-grade items that will interfere with the proposed work.
- C. Removal of below-grade elements, including concrete foundations, walls, existing utilities, and all other below-grade items that will interfere with the proposed work.
- D. Removal and legal disposal of material deemed by Owner's Geotechnical Engineer to be geotechnically unsuitable for reuse as on-site fill, to ensure proper preparation of areas for the proposed improvements.
- E. Excavation for utilities, structures, foundations, walls, and slabs.
- F. Excavation of soil and rock.
- G. Segregation and stockpiling of excavated soils.
- H. Off-site disposal of excavated soils/rock.
- I. Dewatering as necessary and in accordance with the requirements of this section.
- J. Scarifying, compaction, moisture content control of final subgrade and fill materials.
- K. Placing and compacting fill where indicated on Contract Drawings.
- L. Provide temporary excavation support as necessary.
- M. Backfilling utility trenches with bedding material (as specified) and suitable fill materials.
- N. All excavations (soil and rock), preparations and improvements required to provide satisfactory subgrades and to construct foundations, slabs, pavements, walls, pits, below grade structures, manholes, areaways, utilities and landscaping as required and indicated on drawings or to a lower elevation to achieve required bearing.
- O. Proof rolling, filling and grading to required lines, dimensions, contours and elevations for proposed improvements.
- P. Stabilization of soil cuts and rock cuts including, but not limited to, shoring and bracing, anchors, rock bolts and steel netting, if required.
- Q. Monitoring of adjacent structures and roadways during construction.

- R. Other labor and materials as may be reasonably inferred to be required to make the work under this Section complete.
- S. Requirements of the construction contract.
- T. Placement of drainage fill/ bedding layer and drainage pipes under building slabs on grade and elsewhere as indicated.
- U. Placement of vertical drainage mats behind foundation walls.
- V. Placement of perimeter drainage system behind foundation walls
- W. Processing of on-site materials for reuse.
- X. Performing soil testing and inspection services.
- Y. All other site preparation and earthwork specified herein as necessary to make the work of this Section complete.

#### 1.02 RELATED SECTIONS AND DOCUMENTS

- A. Section 310913 – Monitoring of Adjacent Structures
- B. Section 331000 – Protection of Existing Utilities
- C. Section 311000 – Site Preparation
- D. Section 315000 – Temporary Excavation Support and Underpinning
- E. Section 334200 - Sanitary Sewer Systems
- F. Section 334300 - Sewer Manholes, Frames, and Covers
- G. Section 334100 - Storm Drainage
- H. Section 312100 - Aggregate Materials
- I. Section 265615 – Site Lighting
- J. Section 312333 - Excavation, Backfill, And Compaction for Utilities
- K. Section 313200 - Soil Stabilization
- L. Section 332334 -Excavation, Backfill, And Compaction for Pavement
- M. New Jersey Soil Erosion and Sediment Control (SESC) Manual
- N. SESC Project Permit and Conditions



- O. 3 May 2024 Geotechnical Engineering Study Report prepared by Langan Engineering and Environmental Services, LLC. (Langan)
- P. In case of conflict, the most stringent shall apply.

#### 1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) – latest edition
  - 1. D422 Method for Particle Size Analysis of Soils
  - 2. D1557 Test for Moisture-Density Relations of Soils Using 10-lb (4.5 Kg) Hammer and 18-inch (457 mm) Drop (Modified Proctor)
  - 3. D2216 Laboratory Determination of Moisture Content of Soil
  - 4. D2487 Classification of Soils for Engineering Purposes
  - 5. D2922 Tests for Density of Soil and Soil – Aggregate in Place by Nuclear Methods (Shallow Depth)
  - 6. D3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
  - 7. D 4253 - Test Method of Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
  - 8. D 4254 - Test Methods for Minimum Index Density and Unit Weight of Soils and Calculations of Relative Density.
  - 9. D 4318 - Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils.
- B. 2021 International Building Code New Jersey Edition.
- C. The current specifications of the New Jersey Department of Transportation (NJDOT) as amended and supplemented herein, shall be followed for all earthwork.
- D. The latest New Jersey Department of Environmental Protection (NJDEP) Regulations.
- E. The latest American Association of State Highway and Transportation Officials (AASHTO) regulations.
- F. OSHA Regulations - 29 CFR 1926 Subpart P.
- G. In case of conflict, the most stringent shall apply.

#### 1.04 DEFINITIONS

- A. Wherever the word "excavating", "excavate", "excavation", "carried down", "remove", etc., are used, they shall be taken to include the removal of all existing work, including brick

work, rubble work, rubbish, earth, as well as rock, boulders, steel grillages and concrete and all other materials and obstructions encountered; they shall also be taken to include all sheet piling, bracing, pumping, and all operations and items needed for the proper execution of the work. All excavation in soil and rock is considered unclassified.

- B. For the purpose of these specifications, rock is defined as any solid material that cannot be excavated or removed with reasonable effort by a large hydraulic excavator equipped with hardened rock teeth such as Caterpillar CAT 349F excavator with a minimum 396 horsepower (hp) net flywheel power.
- C. Where the words "finished grades", "finished grade lines", or "future finished grades", appear in these specifications, they shall be taken to mean the finished elevations as indicated on the drawings.
- D. Rough grading consists of cutting or filling to the elevation herein established with a permissible tolerance of plus or minus 1 inch. This tolerance shall be so used within any area of 100 square feet that it will not be necessary to remove excess or bring in additional fill to meet the required elevations.

#### 1.05 QUALITY ASSURANCE

- A. Provide at least one supervisory person who shall be present at all times during execution of the Work and who is thoroughly familiar with the type of Work being performed and its best methods for completion. This person shall have the authority to act on behalf of Contractor.
- B. Comply with any provisions of all applicable Federal, State, and Local requirements, codes, regulations and standards.
- C. The Geotechnical Engineer, selected and paid by Owner, will be retained to perform construction observation on-site based on density testing, visual observation, and judgment. Such observation shall not relieve Contractor from its responsibility to complete the Work in accordance with the plans and specifications. Visual field confirmation and density testing of subgrade preparation and fill placement procedures will be performed by field Geotechnical Engineer as part of the construction testing requirements. Geotechnical Engineer will be responsible for determining what material is geotechnically unsuitable.
- D. The Geotechnical Engineer shall prepare field reports that indicate compaction test location, elevation data, testing results and acceptability. The Owner, Architect, and Contractor shall be provided with copies of reports within 14 days of time test was performed.
- E. All costs related to re-inspection due to failures shall be paid for by the contractor at no additional expense to Owner. The Owner reserves the right to direct any inspection that is deemed necessary. Contractor shall provide free access to site for inspection activities.

#### 1.06 SUBMITTALS

- A. Contact all utility companies and identify any requirements that may impact Work of this section. Contractor shall submit written confirmation of the status of all utility construction to Owner no later than two (2) weeks prior to mobilization of equipment and materials to the Site.

- B. At least two (2) weeks prior to mobilization of equipment and materials to the Site, Contractor shall submit to Owner and Engineer a schedule detailing the sequence and time of completion of all phases of Work under this section.
- C. At least two (2) weeks in advance of imported fill delivery to the site for proposed use, Contractor shall submit the following laboratory test data to Geotechnical Engineer for each type of imported soil/gravel material to be used as compacted fill.
  - 1. Moisture and Density Relationship: ASTM D1557
  - 2. Grain Size Analysis: ASTM D4222

Together with the above test data, Submit a 25-pound sample of each type of proposed off-site fill material in an air tight container for the review and approval by Geotechnical Engineer. Submit the name and details of the source for the proposed material. Any change in source or soil type throughout the job requires approval of Geotechnical Engineer. Certification of environmental compliance for each type of proposed off-site fill material shall be submitted in accordance with the requirements of this Section.

- D. At least two (2) weeks prior to mobilization of equipment and materials to the Site, Contractor shall submit to Owner and Engineer evidence substantiating its experience and qualifications as required herein.
- E. At least two (2) weeks prior to mobilization of equipment and materials to the Site, Submit to Owner and Engineer a Health and Safety Plan.
- F. Contact utility companies and determine if additional easements or access permits will be required to complete project. Provide written confirmation of the status of all easements or access permits to Owner at time of Preconstruction Conference or no later than 90 days prior to project possession date.
- G. Samples:
  - 1. The Contractor shall submit a 25 lb representative sample of the proposed off-site fill materials (backfill, drainage fill etc.) to the Geotechnical Engineer for review and approval.
  - 2. The Contractor shall submit a 12 inch by 12 inch sample of geotextile fabric sample for review and approval.
  - 3. The Contractor shall submit a 12-inch-long drainage pipe sample for review and approval.
  - 4. The Contractor shall submit a 12-inch by 12-inch sample of the vertical drainage mat for review and approval.
  - 5. The Contractor shall submit a 12-inch by 12-inch sample of the plastic sheet vapor barrier for slab-on-grades for review and approval
- H. Test Reports:

1. Submit the test reports for each source of each fill material submitted for review and approval by the Geotechnical Engineer. Test reports shall include the results of the following tests:
  - a) Soil classification in accordance with ASTM D 2487
  - b) Moisture content in accordance with ASTM D 2216
  - c) Modified Compaction Test in accordance with ASTM D 1557.
  - d) Particle size analysis in accordance with ASTM D 422 (sieve only)
  - e) Plasticity index in accordance with ASTM D 4318
2. Submit the name of each material supplier and specific type and source of each material. Any change in source or soil type throughout the job requires approval of the Construction Manager and the Engineer. Submit certifications and test results for proposed materials as described below.

**I. Certification:**

1. Imported fill shall be free of all hazardous substances as listed by the New Jersey Department of Environmental Protection in New Jersey Administrative Code, Title 7; Chapter 1E, Appendix A. Contractor shall submit certification of compliance and test results substantiating compliance to the Construction Manager by the Contractor not less than 2 weeks prior to its intended use.
2. Before proceeding with work, Contractor shall submit a certification in an acceptable form, stating that careful examination has been made of the site, existing structures, existing adjacent structures, records of utility lines, test boring records, soil samples, subsurface exploration reports, the drawings, and all other contract documents.

**J. Catalog Cuts:**

1. Submit catalog cuts and manufacturer's literature for the equipment to be used for compaction and proof rolling. Static drum weight shall be provided for the proof rolling equipment.

**K. Shop Drawings:**

1. The Contractor shall submit a shop drawing showing the procedures, layout and the limits of the proposed excavation for review by the Geotechnical Engineer.
2. The Contractor shall submit drawings and calculations for his proposed temporary excavation support system and construction dewatering system for review by the Geotechnical Engineer. Submittals shall be prepared, signed and sealed by a professional engineer licensed in the State of New Jersey.
3. The Contractor shall submit drawings for his proposed protection plan of adjacent structures. Submittal shall be prepared, signed and sealed by a professional engineer. The contractor shall submit his lateral and vertical movement monitoring plan during construction for review. Submittal shall be prepared, signed and sealed by a land surveyor licensed in the State of New Jersey.

4. The contractor shall submit drawings and calculations for permanent retaining walls (mafia block, boulder, MSE) retaining walls for review by the Geotechnical Engineer, if necessary. Submittal shall be prepared, signed and sealed by a professional engineer licensed in the State of New Jersey.
5. The contractor shall submit his proposed method and procedures (line/channel drilling, hoe-ram, blasting etc.) for soil and rock excavations for review by the Geotechnical Engineer. Submit details and permits for rock blasting, if applicable.
6. The Contractor shall submit a shop drawing showing the layout, slopes and details of the perimeter drainage system for review and approval.

L. Environmental testing and sampling:

1. Contractor shall submit sampling and testing results of the soils excavated from the site, which are to be legally disposed of off-site.

1.07 EXISTING CONDITIONS

- A. The project site is located within the north portion of the WPU campus in a tiered parking area. The site is bound by University Drive to the north and east, the existing recreation center building to the south and Mills Drive to the west. Century and Skyline Halls are to the southwest of the site and a soccer field is to the south of the existing recreation center. A steep drop off with an existing brook is located to the southeast and east of the site.
- B. Contractor shall visit the site, read geotechnical engineering reports and shall familiarize himself with the existing project conditions prior to bidding.
- C. Subsurface conditions reported in the geotechnical engineering reports and memorandums are not intended as representations or warranties of accuracy or continuity between soil borings or test pits. It is expressly understood that the Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor. Data are made available for convenience of Contractor. Additional test borings and other exploratory operations may be made by Contractor at no cost to the Owner.
- D. The anticipated top of competent natural soils and rock elevations given in the geotechnical report and contract documents are approximate and shall be verified in the field by the Contractor and the Owner's Geotechnical Engineer. Footing subgrades shall be inspected and approved by a qualified geotechnical engineer.

1.08 ERRORS IN DEPTH

- A. In the event that any part of the excavation be carried, through error, beyond the depth and the dimensions indicated on the drawings or called for in the specifications, then the Contractor, at own expense, shall furnish and install gravel, stone, suitable backfill with which to fill to the required level, in all locations except beneath footings, in accordance with the Backfilling and Compaction Section below. At footing locations, Contractor shall be required to fill over-excavations to level of bottom of footing with concrete having a 28-day compressive strength not less than 3,000 psi at no additional cost to the Owner.

**1.09 ENVIRONMENTAL CONSIDERATIONS**

- A. Install erosion control measures in the sequence shown on the Contract Drawings or as directed by the Engineer or regulatory agencies to protect adjacent properties and water resources from erosion and sediment damage.
- B. Certification that imported fill materials are free of all contaminants above non-restricted use standards, as defined by NJDEP, will be required.
- C. Contractor shall read the environmental assessment reports (if available) and shall familiarize himself with the existing environmental conditions. Environmental issues shall be handled in accordance with environmental specifications, if any.
- D. Contractor shall perform environmental sampling and laboratory testing for the soils excavated from the site and to be disposed legally off-site. Sampling and testing shall be in accordance with the NJDEP requirements and as per disposal facility requirements.
- E. Excess materials (soil and/or geotechnically unsuitable materials) that are not re-used on site shall be disposed of in accordance with all applicable regulations. All fees associated with this activity (e.g. sorting co-mingled materials, load-out, transportation, disposal sampling, permits, etc.) are the responsibility of the Contractor.
- F. Contractor shall coordinate with all receiving facilities and shall be responsible for performing all testing to ensure soil and other materials are in compliance with receiving facilities criteria.
- G. Pumping groundwater off the site shall be in accordance with the applicable local and federal regulations. Contractor shall obtain necessary permits to pump the water off the site.

**1.10 QUALIFICATIONS**

- A. Contractor for Work of this Section shall specialize in performing earthwork operations of the magnitude of this project with a minimum of five (5) years of satisfactory experience.

**1.11 PROJECT RECORD DOCUMENTS**

- A. Accurately record and promptly inform Owner and Geotechnical Engineer of actual locations of all subsurface utilities, structures, and obstructions encountered.
- B. Accurately record any as-built variation from the construction plans and specifications. Contractor shall provide as-built drawings within 30 days of project completion.

**PART 2 – PRODUCTS**

**2.01 MATERIALS**

- A. Soil and rock materials generated by excavation procedures, and utilized to complete the work as specified herein, shall comply with the specific requirements associated with these materials as they are listed below. The constituents and proportions given are to be verified by the Owner's Geotechnical Engineer prior to fill placement. To obtain the specified

material gradations, the Contractor may utilize on-site crushing methods. Any variations to the gradations described below shall be subject to the prior review and approval by the Owner's Geotechnical Engineer.

**B. On-Site Fill:**

1. On-site borrow shall consist of those materials previously excavated from on-site excavation areas judged to be suitable by the Engineer. Usable on-site materials shall consist of clean soils free of wood, metal, organic and other deleterious materials and shall meet the gradation requirements for structural and non-structural fill given below. Recycling of on-site concrete demolition debris is encouraged. Crushing of excavated rock is encouraged. The excavations will generate excess materials (soil and rock). The most of the on-site soils contain higher fine soil particles (silt, clay) content and is expected not to meet the gradation criteria for structural fill. On-site soils and rock can be processed (screening, crushing, mixing, aeration, moisture conditioning, etc.) for reuse as structural fill.

**C. Off-Site Imported Fill**

1. Off-site common borrow shall consist of inorganic soil free of wood, metal, etc. and shall meet the required structural fill gradation requirements given in the sections below. The Contractor shall notify the Engineer of the proposed borrow area and shall deliver a minimum 25 lb sample of the soil to the project site at least 1 week prior to use of material to permit inspection and testing of the material to establish field density criteria. The borrow material shall have a water content such that adequate compaction can be achieved.

**D. Structural Fill**

1. Approved off-site fill meeting the following gradation requirements:

<u>Sieve Size</u>	<u>Percent</u>
<u>Passing 4 inches</u>	100
¾ inch	70 – 100
No. 4	30 – 80
No. 50	10 – 35
No. 200	5 – 15

On-site fill meeting the above given criteria can also be used as structural fill. The amount of material passing No.200 sieve can be up to 30% for on-site soils and the maximum particle size can be up to 8 inches. Structural fill shall be used in areas to receive slabs, pavement and utilities.

For areas behind below-grade walls and behind retaining walls, structural fill shall contain 15% or less passing No. 200 sieve.

**E. Non-Structural Fill**

1. Approved on-site or off-site fill free of hazardous and deleterious materials. Non structural fill shall not contain any particle larger than the lift thickness or 6 inches whichever is less. Non-structural fill shall be used only in landscape areas.
- F. Drainage Fill, Crushed Stone Layer or Bedding Layer
1. Drainage or Crushed Stone fill or bedding layer shall be clean evenly graded mixture of crushed stone, or crushed or uncrushed gravel known in the industry as  $\frac{3}{4}$ - inch crushed stone meeting ASTM D448, coarse aggregate grading size 57. Recycled concrete aggregate shall not be acceptable.
- G. Soil Materials Availability
1. Provide approved borrow soil materials from off- site when sufficient approved soil materials are not available from excavations.
- H. Drainage Composite
1. Vertical composite drainage mat shall be Miradrain 6000 or approved equal.
- I. Filter Fabric:
1. Mirafi 140N, or approved equal.
- J. Drainage Pipe
1. 4-inch-diameter, perforated, schedule 40 PVC pipe and shall be embedded in a 6-inch thick layer of clean crushed stone wrapped in filter fabric. Crushed stone shall meet the requirements of AASTO No.57.
- K. Plastic Vapor Barrier
1. The plastic sheet vapor barrier shall not be less than 15-mil-thick and shall conform to ASTM E 1745 Class A requirements.
- L. Waterproofing Membrane for Below-Grade Walls
1. Preprufe 160 R Plus manufactured by GCP, or equivalent
- M. Dense-Graded Aggregate
1. Dense Graded Aggregate (DGA) shall be mixture of crushed stone and shall meet the composition and gradation requirements of NJDOT DGA requirements.

## 2.02 EQUIPMENT

- A. Compactor – Minimum 5-ton static drum weight vibratory smooth drum and sheeps-foot rollers as approved by Owner’s Engineer.
- B. Compactor – Wacker RT 82-SC (or equivalent, as approved by Owner’s Engineer) articulated walk-behind vibratory trench roller for areas where access or maneuverability is limited.



- C. Compactor – Wacker BS500 (or equivalent, as approved by Owner’s Engineer) jumping jack compactor for backfilling of very narrow trenches.
- D. Proofrolling Compactor (Soil Subgrade Areas, where specified): Proofrolling vibratory compactor shall have a static drum weight of at least 5 tons. For cohesive soils use sheeps-foot or padded surface compactors. No heavy proofrolling within 7 feet lateral distance of a wall or below-grade structure/utility
- E. Proofrolling Dump-Truck (soil subgrade, where specified): A fully loaded tri-axle dump truck with a static weight no less than 20 tons. No heavy proofrolling within 10 feet lateral distance of a wall or below-grade structure/utility
- F. Rock excavation equipment, such as hoe-rams, splitters, or other mechanical equipment as required.
- G. Lightweight construction equipment for grading proposed lawn areas.
- H. All equipment and tools required to perform the work. All equipment and tools shall be in perfect operating conditions.
- I. Excavator: Caterpillar CAT 349F hydraulic excavator which shall have a minimum 396 hp net flywheel power and shall be equipped with hardened rock teeth.
- J. Transport off-site materials to project using well-maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping.

### **PART 3 – EXECUTION**

#### **3.01 PRE-CONSTRUCTION MEETING**

- A. Before commencing work of this Section, meet with representatives of governing authorities, Owner, Geotechnical Engineer, Site Contractor, Demolition Contractor, and other concerned entities. Review the earthwork procedures and responsibilities including testing and inspection procedures and requirements. Notify participants at least three (3) working days prior to convening the conference. Record discussions and agreements and furnish a copy to each participant.

#### **3.02 GENERAL**

- A. Identify required lines, levels, contours and datum to bring site grades to the proposed subgrade conditions inferred from the drawings.
- B. Do not allow the Work of this section to be performed or installed without necessary inspections, tests and approvals.
- C. By submitting its bid, Contractor represents that it has reviewed the information provided and investigated the Site to determine type, quantity, quality, and character of excavation Work to be performed. Contractor shall become thoroughly familiar with the available geotechnical information, as well as the Site, site conditions, and all portions of the Work falling within this Section.

- D. Contact NJ One Call at 811 or (800) 272-1000 and local utility companies in a suitable timeframe before excavation begins to accommodate the respective utility company's response time to provide mark-outs where needed.
- E. Where existing grades are above proposed subgrade elevation, excavate materials to the lines and grades shown on the Contract Drawings. The Work covered under this Section shall include excavation for shallow foundations.
- F. Perform excavation using capable, well maintained equipment and methods acceptable to Owner and governing agencies.
- G. Blasting of rock shall not be permitted.
- H. Material with deviations from the above requirements may be used as suitable fill if acceptable to Owner's Engineer; Engineer will be the sole judge of the suitability of all materials, whether from on-site excavations or off-site sources.
- I. When performing grading operations during periods of prolonged wet or dry weather, provide adequate measures for surface drainage and groundwater control, and moisture control of soils (i.e., wetting or drying by discing) so as to place and compact the soil at a moisture content within a few percentage points of the material's optimum water content. Any disturbed areas shall be sealed using a smooth drum roller at the end of each day.
- J. Shoring, bracing, and fencing shall be installed in accordance with Federal OSHA requirements as well as the requirements of all State and Local authorities having jurisdiction.
- K. Protect persons and property from damage and discomfort caused by dust. Water as necessary to quell dust. Contractor shall ensure that no sidewalks and roadways will have any issue with icing when water spraying is used during freezing temperatures.
- L. All underground installation of pipes, conduit, etc. in the area to be paved shall be completed prior to placement of any asphalt or concrete paving.
- M. Allow no debris to accumulate on-site. Haul debris away from the site and dispose of at no cost to the Owner.
- N. Excess on-site soils shall be disposed of off-site in accordance with the applicable regulations at no cost to the Owner.
- O. Contaminated on-site soils, if any, shall be disposed of off-site in accordance with the applicable regulations at no cost to the Owner.

### 3.03 PREPARATION

- A. Prior to all work of this section, the Contractor shall become thoroughly familiar with the geotechnical engineering studies as well as the site, site conditions, and all portions of the work falling within this section.
- B. The Contractor shall refer to the soil erosion and sediment control plans for staging of earthwork operations and for erosion control measures to be implemented prior to commencement of earthwork.

- C. Locate and identify existing utilities that are to remain and protect them from damage. Notify utility companies to allow removal and/or relocation of any utilities that are in conflict with the proposed improvements.
- D. Protect fences, structures, sidewalks, paving, curbs, etc. to remain from equipment and vehicular traffic.
- E. Protect benchmarks, property corners and all other survey monuments from damage or displacement. If a marker needs to be removed/relocated it shall be referenced by a licensed land surveyor and replaced, as necessary, by the same at no additional cost to the Owner.
- F. Remove from the site, material encountered in earthwork and grading operations that, in the opinion of the Owner or Engineer, is unsuitable or undesirable for backfilling in subgrade or foundation areas as per Part 2 of these specifications.
- G. Contractor shall perform environmental sampling and laboratory testing for the soils excavated from the site and to be disposed legally off-site. Sampling and testing shall be in accordance with the NJDEP requirements and as per disposal facility requirements.

#### 3.04 CLEARING, GRUBBING AND STRIPPING

- A. Thoroughly clear and grub any surface debris, vegetation, trees (including removal of any associated roots systems), brush, etc. from the future building pad and pavement areas, along the alignment of proposed retaining walls, and any other areas to receive new fill. Cleared and grubbed materials shall be properly disposed of in accordance with all applicable codes and ordinances.
- B. Strip any topsoil from the ancillary structures, pavement, and retaining wall areas. Excess stripped materials shall be disposed of in accordance with all applicable codes and ordinances.
- C. Strip asphalt within the building and ancillary structure footprint area and 10 ft beyond, and from any areas to receive new fill. Removed asphalt can be milled by the Contractor and asphalt millings can be re-used as subbase material beneath new pavements. Asphalt to be used as recycled material shall be milled to form a well-graded material having a maximum particle size of 2-inches. The Contractor shall provide dust control measures during any milling process. Excess asphalt materials shall be properly disposed of in accordance with all applicable codes and ordinances.
- D. Perform all site demolition and clearing work, including removal of existing concrete structures and foundation systems associated with previous structures. All excavations and/or below-grade removals during the demolition phase shall be properly backfilled in accordance with this Section. This work shall be performed immediately following below-grade removal.
- E. Allow no debris to accumulate on-site. Haul debris away from the Site and dispose of at no cost to Owner.
- F. Any abandoned structures or utilities encountered during excavation shall be removed and disposed of, or abandoned in-place by complete filling with grout or sand, subject to review and approval by Owner's Engineer on a case-by-case basis.

- G. Stockpile excess soil on-site, at the location designated on the Contract Drawings.

3.05 PROTECTION OF EXISTING ADJACENT STRUCTURES, UTILITIES AND ROADWAYS

- A. Construction activities such as excavation and rock chipping with hydraulic hammers may affect the surrounding structures, if not adequately protected and monitored during construction.
  - B. The work area is adjacent to the existing buildings, structures and utilities to remain. The Contractor shall be responsible for repairing all construction related damages to the satisfaction of the damaged property owners at Contractor's expense.
  - C. The work shall be executed so that no damage or injury will occur to the existing public, adjoining, adjacent structures, streets or utilities. Should any damage or injury caused by the Contractor or anyone in Contractor's employ or by work under this Contract occur, the Contractor shall, at own expense, repair such damage and shall assume all responsibility for such injury and damage.
  - D. Excavation sides and adjacent structures, foundations, streets and utilities shall be protected by means of adequate bracing, shoring and sloping, at all times. No excavation shall be carried below adjacent existing foundations or utilities unless adequate measures designed by a Professional Engineer are taken to protect adjacent structures and utilities.
  - E. Obtain all required permits and perform all construction work in a safe manner in accordance with applicable codes and regulations. Owner shall not entertain any delays to project delivery date due to delays in permit procurement by the contractor.
  - F. Prior to commencement of any Work, consult the records for existing structures and utilities and note all conditions and limitations which might affect the Work required under this Section. Notify utility locator service for area where the project is located prior to excavation and earthwork. Any damage to utilities, permanent or temporary structures, and trees, slopes, and vegetated areas designated to remain undisturbed, as a result of Contractor's procedures/operation shall be Contractor's sole responsibility, and shall be immediately reported to Owner and respective utility Owner(s).
  - G. Provide barricades, warning lights, and barriers to prevent accidents, to avoid all necessary hazards and protect the public, the Work, and the property at all times, including Saturdays, Sundays and Holidays. Minimize interference of vehicular and pedestrian traffic with adjoining roads, streets, walks, and other adjacent occupied or used facilities during all operations. Protect fences, structures, sidewalks, paving, curbs, etc. to remain from equipment and vehicular traffic.
- 1. Dust and Dirt Control:
    - a) Use all means necessary to control dust on or near Work.
    - b) Thoroughly moisten all surfaces as required to prevent dust being a nuisance to the public, neighbors and performance of other Work on the Site.
  - H. Provide vehicle wheel cleaning to prevent tracking of soil, dirt, etc., onto public streets and in parking and access drive areas.

- I. Contractor shall be solely responsible for safety at the Site as it relates to earthwork operations.

3.06 MONITORING OF ADJACENT STRUCTURES, STREETS, SIDEWALKS AND UTILITIES

- A. Monitoring (displacement, vibration) of the relevant buildings, structures sidewalks and streets shall be performed per Section 310913.

3.07 PRE-CONSTRUCTION CONDITIONS DOCUMENTATION

- A. A pre-construction conditions documentation of the relevant buildings, structures sidewalks and streets shall be performed per Section 310913.

3.08 EXCAVATION AND DISPOSAL

- A. The subsurface conditions of the site consist of fill layer overlying natural sandy soils with underlain by rock strata. The overburden soils contain large boulders and cobbles. The excavation shall be unclassified and shall comprise and include the satisfactory removal and legal disposal of all materials encountered regardless of the nature of the materials and shall be understood to include rock, boulders, cobbles earth, hardpan, miscellaneous fill, foundations, structures, slabs, walls, utilities, pavements, curbs, piping and debris.
- B. Excavation shall be performed in a safe manner in accordance with the applicable regulations. Shoring, bracing shall be used where necessary.
- C. Rock Excavation, if encountered, - Significant rock excavation in rock to reach design levels is not anticipated. Rock excavation will require the use of hydraulic hoe-rams, splitters and excavators fitted with special ripping teeth. Line and channel drilling can be performed to ease excavation by creating artificial fractures in the rock mass.
- D. All excavation shall extend to the depths of the form and size required for the installation of the work as indicated on the Drawings. When excavations for foundations have reached the required depths, project Geotechnical Engineer shall make an inspection of the conditions.
- E. The materials excavated shall be separated during excavation. Unsuitable materials shall be defined as unsuitable for reuse as structural fill, and as soils having an excess of wood, metal, other objectionable material, saturated material and organic soil. Materials that, in the opinion of the Owner's Geotechnical Engineer, are not suitable for fill; any surplus earth and all rock shall be removed from the site and legally disposed of off-site at no cost to the owner.
- F. Graded areas outside the building area shall be excavated/filled to within 4 inches of final grades in landscaped areas and to within 0.1 foot of final subgrade within paved areas as shown on the plans.
- G. Excess on-site soils shall be disposed of off-site in accordance with the applicable regulations at no cost to the Owner.
- H. Contaminated on-site soils, if any, shall be disposed of off-site in accordance with the applicable regulations at no cost to the Owner.

3.09 REMOVAL OF REMNANTS OF DEMOLISHED STRUCTURES

- A. Any existing buried structure (i.e. foundations, slabs, walls, tanks, utilities, pits, solar panel) below the proposed foundations and slabs shall be removed completely.

- B. No utility line or pipe (operational or abandoned) shall be left beneath the proposed foundations and slabs. Any existing buried abandoned rigid structure beneath the proposed slabs shall be removed at least 3 feet below the bottom of the proposed slabs to prevent rigid spots. No void or pit shall be left beneath the proposed slabs or foundations.

### 3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind blown dust and to prevent moisture susceptible soils from becoming saturated, and therefore, unsuitable for reuse. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
- B. Contractor shall be solely responsible for the stability of stockpiles and the areas where stockpiles are placed. Contractor shall stockpile materials in a manner so as not to compromise the stability or cause damage to or loss of support to existing structures, surfaces, and embankments.

### 3.11 SHORING, BRACING, STABILIZATION, UNDERPINNING

- A. The proposed construction requires excavations along the property lines, and adjacent to structures, foundations, utilities and streets.
- B. Provide and install temporary excavation support, shoring, bracing, and fencing and such other protection as required to ensure against any damage to existing roadways, pavement, other structures, and utilities when excavation Work occurs adjacent to or below same. Shoring and bracing shall be installed in accordance with Section 315000 – Temporary Excavation Support and Underpinning and in accordance with Federal OSHA requirements as well as the requirements of all State and Local authorities having jurisdiction.
- C. The Contractor shall utilize all appropriate methods to shore, brace and stabilize excavations and cuts in accordance with OSHA regulations, Building Code and Contract Documents. In case of conflict, the most stringent shall apply.
- D. Inspect the site, examine existing conditions and make all necessary preparations for the safe and proper sequence of work. Properly guard and protect excavations so as to prevent them from becoming dangerous to person or property.
- E. Properly slope sides of excavation or provide shoring, sheeting and bracing to prevent caving, erosion, or gulying of sides of excavations.
- F. Brace, shore and protect existing structures, foundations, streets, and utilities when excavations are made adjacent to the existing structures, streets, utilities or within a distance that they will be affected by the excavation. Underpin adjacent structures if excavations are to be carried to a depth below the foundations of the adjacent structure and adjacent foundations.
- G. Existing Building Foundations – Do not excavate below the adjacent building/structure foundations unless adequate shoring measures are taken. If required, underpin the existing building foundations prior to proceeding with the excavations extending below the base of adjacent foundations.
- H. All temporary excavation support systems and underpinning shall be designed by a Professional Engineer retained by the Contractor. Submit temporary support and underpinning calculations and drawings for review by the Engineer.

- I. Maintain sides and slope of excavation in safe condition until backfilling or other work is complete. Maintain shoring and bracing in place until completion of work.
- J. Provide materials for work in good serviceable order.
- K. All shoring, bracing, and stabilization etc. is to be removed upon completion of the work where they are installed, including any portion thereof, outside of street and lot lines. Within the lot, remove all wood and cut steel elements to a minimum of 4 feet below grade. Where they interfere with new work and utilities, remove in their entirety.
- L. Install appropriate temporary excavation support systems as required. All sheeting, shoring and underpinning shall be designed and inspected by a professional engineer retained and paid by the Contractor.
- M. Establish vertical and lateral control points on temporary excavation support system to monitor movements during construction. Points shall be monitored once a week by a licensed surveyor. Submit results to the geotechnical engineer for review and directions.
- N. All rock cuts shall be inspected by a qualified geotechnical engineer retained by the contractor. The engineer shall determine stabilization methods. Stabilization for cuts may consist of anchors, bolts, netting and benching.
- O. Bench, step and slope excavations in accordance with OSHA regulations. Use rakers, soldier piles, lagging, trench box, etc to support the cuts, where necessary. Implement of all required safety measures to prevent damage to adjacent structures and public. Do not excavate below adjacent building foundations unless adequate shoring measures are taken.
- P. No excavation shall be carried out below adjacent existing foundations or utilities unless adequate measures (underpinning and/or shoring) designed by a Professional Engineer licensed in the state of New Jersey are taken.
- Q. Along the property lines, the contractor shall design and install adequate shoring system acceptable to Owner and geotechnical engineer. Obtain the required permits for shoring and construction from Owner.

### 3.12 DEWATERING

- A. Contractor shall utilize appropriate dewatering equipment and methods as necessary to perform the required work (excavation, preparation, proofrolling, backfilling, concreting, utility installation etc) in a dry environment. The contractor shall be responsible to maintain the work area dry at all times.
- B. Contractor shall remove all groundwater and surface water from the work areas. Maintain groundwater level at least 2 feet below the work areas, below the foundation/slab subgrades and below the invert of utilities until such time that work is complete.
- C. Contractor shall supply necessary equipment (wells, pumps and crushed stone, etc.) to maintain the work area dry at all times.
- D. Water collected shall be removed legally before any fill is placed or concrete poured.
- E. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared subgrades, and from flooding project site and surrounding area. Protect subgrades and foundation soils from softening and damage by rain or water accumulation. Maintain water level at least 2 feet below the foundation and slab subgrades.

- F. No pipe, concrete or bedding shall be placed in water unless specific approval is obtained from the Engineer.
- G. Water removed from an excavation shall be disposed of in such a manner as to avoid interference with vehicular or pedestrian traffic and to prevent damage to adjacent property or construction. Discharge directly into manholes or existing pipes will not be permitted unless approved by the Engineer or appropriate local authority. It shall be the Contractor's responsibility to discharge the water in such a manner that mud and silt are not discharged into the existing system, to remove from such facilities any mud, silt, and debris which has accumulated and to leave the drainage facility in a condition similar to that which existed prior to his operations.
- H. Pumping groundwater off the site shall be in accordance with the applicable local and federal regulations. Contractor shall obtain the necessary permits to pump the water off the site.
- I. It is the Contractor's responsibility to provide adequate dewatering of the site by means and methods approved by the Owner's Engineer, if groundwater is encountered during the earthwork activities. Dewatering shall be in accordance with these specifications. The Contractor shall review the Geotechnical Reports to obtain information regarding the depth of groundwater on-site.

### 3.13 FOUNDATION SUBGRADE PREPARATION

- A. All foundations for buildings and structures (i.e. spread, combined and continuous footings) subgrade preparation shall be accomplished as follows or as directed by the Geotechnical Engineer:
  - 1. Locate and mark in the field the limits of the proposed foundations. Perform dewatering as needed. Provide sufficient safe slope or shoring and bracing measures to prevent collapses and cave-ins. Underpin existing foundations where required.
  - 2. Bearing Material: Foundations shall bear directly on natural dense, undisturbed, sandy soils or rock (where encountered at shallow depths) which can support an allowable bearing pressure provided in the Contract Documents.

Foundations to bear on soil subgrade can alternatively be supported on approved materials (compacted structural fill, lean concrete or  $\frac{3}{4}$  inch crushed stone) placed directly over competent, natural bearing materials (dense sandy soils).

Foundations to bear on rock subgrade can alternatively be supported on lean concrete (minimum 4,000 psi) placed directly over properly prepared rock subgrade, only.

The inspecting geotechnical engineer shall have the sole authority to determine the suitable bearing strata.

- 3. Unsuitable bearing materials (existing fill, loose/soft soils, obstructions, and remnants, where encountered) shall be removed to reach the suitable natural competent bearing subgrade. The influence zone is defined as a 1H on 2V theoretical line drawn downward from the edge of the proposed foundation. This will require excavations which shall be sloped / shored appropriately. Over-excavations can be filled with the approved materials to reach the design levels or foundations can be constructed at lower elevations with piers extending to the



design levels if approved by Structural Engineer.

4. Variations: The anticipated competent bearing strata elevations noted in the contract documents are approximate and vary across the site. Contractor shall assume in his bid that suitable natural bearing soils and rock may be 2 feet lower or higher than shown on contract documents. Contractor shall perform all related work (excavation, shoring, dewatering, backfilling, improvement etc.) to remove all unsuitable materials below the foundations to reach competent natural bearing materials at no additional cost to the Owner.
5. Inspection: Foundation subgrades shall be inspected and approved by a qualified geotechnical engineer who shall verify the allowable bearing capacity of the subgrade provided in the Contract Documents. No foundation shall be constructed without approval of the subgrade by the inspecting geotechnical engineer.
6. Soil Subgrade Preparation: Remove all unsuitable materials including any soft or disturbed natural soils until competent natural soils are encountered. Perform excavation for the final 6 inches using a flat bucket (bucket with no teeth) to minimize the disturbance of the anticipated natural subgrade. If natural soil at the bearing elevation becomes loosened or disturbed during excavation, it shall be removed or compacted utilizing a vibrating plate compactor (backhoe attachment).
7. Rock Subgrade Preparation: If rock is encountered, refer to the rock excavation section of this specification. Following the rock excavation, the rock subgrade shall be cleaned to remove all loose rock pieces and debris. Rock subgrades shall be flat and shall not have a slope exceeding 10 degrees from horizontal.
8. Buried Elements: No pipes, utilities or remnants (foundations, slabs, walls, etc.) shall be left beneath the proposed foundations.
9. Subgrade Protection: Foundation subgrades shall be protected against moisture and frost prior to placing concrete. Foundation bearing surfaces shall be level and clear of debris, standing or frozen water and other deleterious materials, and shall be protected against frost. Exposed subgrades shall be protected against weather and run-off water. Water shall not be allowed to pond and sit over the subgrades. Appropriate measures shall be taken to prevent disturbance of the subgrade. Once the suitable bearing stratum is encountered, the subgrades shall be compacted with a vibratory plate compactor having a static weight of not less than 0.5 ton. Any areas exhibiting evidence of inadequate bearing capacity shall be removed to competent material.
10. Protective mud mat: The inspected and approved subgrades shall be sealed with a thin lean concrete layer (2-inch-thick mud mat) until the footings are cast for protection against weather effects. The lean concrete shall have a 28-day compressive strength not less than 3,000 psi. Excavation sides shall be maintained sufficiently stable to prevent cave-ins during placement of the lean concrete. Once the lean concrete is sufficiently cured, construct the foundations over the lean concrete at conventional depths in accordance with the contract documents.
11. Foundations Near Existing Structure or Utilities (existing or proposed): Some of the proposed foundations will be immediately adjacent to the existing recreation

center structure to remain and utilities (existing or proposed). Foundations adjacent and near the existing below-grade walls/foundations shall be lowered and constructed at the same level as the existing foundations and utilities as per structural drawings to avoid inducing load on existing structures/foundations.

12. Once the excavation is complete and suitable natural bearing subgrade is exposed, the project surveyor should locate the center and edges of the proposed foundation. Verify that the base of the excavation (limits of the exposed subgrade) is at least 1.5 feet wider than the proposed foundation dimensions.
13. Perform dewatering as needed. Provide sufficient safe slope to prevent collapses and cave-ins. Implement of all required safety measures to prevent damage to adjacent structures and public. Do not excavate below adjacent building foundations unless adequate shoring measures are taken.
14. Inspecting geotechnical engineer shall verify that the exposed subgrade can support an allowable bearing pressure provided on the Project Documents and Geotechnical Report.
15. The materials excavated from the foundation locations may be processed for re-use as backfill in other areas of the site.

#### 3.14 BUILDING SLAB SUBGRADEPREPARATION

- A. The building pad (slab-on-grade) subgrade preparation shall be accomplished as follows:
  1. The building area shall include the building footprint plus a minimum of 5 feet beyond the building limits or as defined by the Geotechnical Engineering Report, whichever is more stringent.
  2. Slabs-on-grade shall bear on natural soil, compacted structural fill. Subgrades shall be improved and shall be inspected by a qualified Geotechnical Engineer.
  3. Remove all materials to reach design elevations and as determined by the Geotechnical Engineer. In fill areas, all surficial materials (topsoil etc.) shall be removed.
  4. Any existing below-grade rigid obstructions such as concrete, boulders, debris etc. shall be removed at least 3 feet below the base of the proposed slabs.
  5. Upon completion of the required excavations, the exposed subgrades shall then be proofrolled. In fill areas place structural fill in lifts over the proofrolled subgrade and compact each lift. Backfilling, compaction and proofrolling shall be in accordance with Part 3 of these specifications. The fill materials gradation shall meet the requirements given in Part 2 of these specifications. Properly processed excavated materials may be utilized for backfilling
  6. Once the design elevations are reached, place the specified bedding layer over the improved subgrade to serve as bedding and capillary break layer immediately beneath the building slab. The bedding/capillary break layer shall consist of a minimum 6-inch thick layer of 3/4-inch crushed stone. Install also the

specified plastic sheet vapor barrier beneath the slab at the position shown on the Structural Drawings.

7. On-site soils contain varying amounts of silt which are sensitive to moisture and are hard to work with when saturated. Protect the subgrades against the effects of weather and equipment. Appropriate surface drainage and protection methods such as trenching, sloping, and pumping should be implemented to maintain the subgrades in a dry and workable condition at all times.
8. Upon completion of building pad preparation, the Contractor shall provide a sealed survey of the building pad elevation on a 50-foot grid to the Engineer and Owner for approval.

### 3.15 PAVEMENT AND PAD SUBGRADE PREPARATION

A. Pavement and pad subgrades shall be accomplished as follows:

1. Pavement shall bear on improved existing fill, natural soils or rock, or import granular fill. Subgrades shall be inspected by a qualified Geotechnical Engineer.
2. Remove all surficial material (topsoil, asphalt, etc.) and proofroll the exposed subgrade (soil subgrades only) that is to receive pavements in accordance with the requirements of Proofrolling section given below.
3. If rock is encountered, refer to the rock excavation section of this specification.
4. In fill areas, structural fill shall be placed in lifts over the proofrolled subgrade and shall be compacted. The fill materials gradation shall meet the requirements given in Part 2 of these specifications. Placement and compaction of fill shall be in accordance with the requirements given below in the Backfilling and Compaction section.
5. Protect the subgrades against the effects of weather and equipment. Appropriate surface drainage and protection methods such as trenching, sloping, and pumping should be implemented to maintain the subgrades in a dry and workable condition at all times.

### 3.16 LAWN AREA SUBGRADE PREPARATION

A. Lawn area subgrade preparation shall be accomplished as follows:

1. In fill areas, excavate all topsoil. Excavate natural and/or fill materials down to subgrade elevation and stockpile on-site. The fill materials gradation shall meet the requirements given in Part 2 of these specifications. Placement and compaction of fill shall be in accordance with the requirements given below in the Backfilling and Compaction section.
2. In cut areas, remove all material to the proposed elevation provided on the Contract Documents.

### 3.17 RETAINING WALL SUBGRADE PREPARATION

- A. Retaining walls subgrade preparation shall be accomplished as follows:
1. Walls shall bear on suitable natural soils or imported granular fill over suitable natural soil or rock with an allowable bearing pressure as specified on the Contract Documents or Manufacturers Recommendations.
  2. Remove all surficial material (topsoil, asphalt, etc.) and proofroll the exposed subgrade that is to receive pavements in accordance with the requirements of Proofrolling section given below.
  3. If rock is encountered, refer to the rock excavation section of this specification.
  4. In fill areas, structural fill shall be placed in lifts over the proofrolled subgrade and shall be compacted. The fill materials gradation shall meet the requirements given in Part 2 of these specifications or in accordance with the manufacturer's recommendations, the more stringent shall apply. Placement and compaction of fill shall be in accordance with the requirements given below in the Backfilling and Compaction section.
  5. Protect the subgrades against the effects of weather and equipment. Appropriate surface drainage and protection methods such as trenching, sloping, and pumping should be implemented to maintain the subgrades in a dry and workable condition at all times.

### 3.18 PROOFROLLING

- A. The work shall consist of proofrolling of all excavated soil subgrades for slabs, pavements and roadways.
1. Proofroll the subgrade with a heavy vibratory drum roller having a minimum static weight as specified in Part 2. A minimum of 6 passes shall be carried out over the exposed subgrades.
  2. If any material exhibits instability (i.e. pumping, weaving or rutting) under the action of the roller, the unstable areas should be over-excavated to remove the unstable soil and should be backfilled with compacted clean structural fill. Backfilling and compaction shall be performed in accordance with the requirements of Backfilling and Compaction section below.
  3. The Contractor shall establish operating procedures whereby uniform coverage of an area is obtained and the number of passes of the compaction equipment can be readily determined.

### 3.19 BACKFILLING AND COMPACTION

- A. Backfill excavations promptly, but not before completing the following:
1. Acceptance of construction below finished grade including, where applicable, damp proofing, waterproofing, and perimeter insulation, as specified in Contract Documents.

2. Surveying locations of underground utilities for record documents.
3. Testing, inspecting, and approval of underground utilities.
4. Removing concrete formwork, trash and debris from excavation.
6. Removing temporary shoring, bracing, and sheeting in accordance with the relevant specifications. Any material left in place to minimize damage to existing utilities to remain shall be cut off at least 2 feet below grade.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place and compact the fill as described below:

1. Suitable on-site and/or imported off-site fill shall be placed and compacted as required within site improvement areas. Structural fill shall be used in areas to slabs, pavements, utilities and behind below-grade walls. Non- structural fill shall be used only in landscape areas. Drainage fill shall be used where specified in the Contract Documents.
2. Fill placed between existing subgrade and slabs, pavements and lawn subgrade areas shall be placed in loose lifts not exceeding 12 inches in thickness and should be compacted with a heavy vibratory plate compactor or roller. Correspondingly, thinner loose lifts should be used in areas where smaller compaction equipment must be utilized due to restricted access.
3. No fill shall be placed in standing water. Any seepage or ponding of water shall be pumped from the excavation prior to placement of fill. No fill shall be placed on frozen ground.
4. Each lift of fill placed for foundation, building slab and pavement support, shall be compacted to a minimum dry density equal to 95% of the maximum dry density as determined by ASTM D1557 (Modified Proctor Test). If the water content of the fill is such that proper compaction cannot be achieved, water shall be added or the soil dried in order to obtain a water content at which the required compaction can be achieved. Fill placed for lawn area subgrade shall be compacted to 90% of the maximum dry density.
5. The Contractor shall establish operating procedures whereby uniform coverage of an area is achieved and the number of passes of the compaction equipment can be readily determined. At the completion of the day's work, the fill surface shall be sealed with the roller.
6. No frozen material shall be used as fill. If the fill material which has been compacted, tested and approved by the Engineer becomes frozen, the Engineer shall be notified and shall determine whether it can remain in place or shall be removed before additional fill can be placed.
7. During rainy weather, the contractor shall take measures to protect fill from becoming saturated. The Contractor shall not place or attempt to compact fill

during rainy weather unless approved by the Geotechnical Engineer. Any water collecting in fill areas shall be removed before further fill placement.

8. After fill work has been completed in a pavement area, the area shall be graded smooth to within 0.1 ft of the final subgrade elevations shown on the Contract Drawings and shall be proofrolled as specified herein.

### 3.20 SHORING, BRACING, CUT STABILIZATION

- A. The Contractor shall utilize all appropriate methods to shore, brace and stabilize excavations and cuts in accordance with OSHA regulations, Building Code and Contract Documents. In case of conflict, the most stringent shall apply. This work shall also be completed in accordance with shoring specifications also.
- B. Contractor shall supply all necessary equipment, labor to perform the work in a safe manner and to protect labor, adjacent structures, utilities, streets and people.
- C. Bench, step and slope excavations in accordance with OSHA regulations. Use rakers, soldier piles, lagging, trench box, etc. to support the cuts, where necessary. Implement of all required safety measures to prevent damage to adjacent structures and public.
- D. All temporary excavation support systems shall be designed by a Professional Engineer retained by the Contractor. Submit temporary support calculations and drawings for review by the Engineer.
- E. Excavation sides and adjacent structures, foundations, streets shall be protected by means of adequate bracing, shoring, sloping at all times.
- F. All temporary excavation support systems shall be designed by a professional engineer retained by the Contractor. Submit temporary support calculations and drawings for review by the Owner's engineer.
- F. Establish vertical and lateral control points on adjacent structures, streets and sidewalks to monitor movements during construction. Points shall be monitored twice a week by a licensed surveyor. Submit results to the geotechnical engineer for review and directions.
- G. All rock cuts shall be inspected by a qualified geotechnical engineer retained by the contractor. The engineer shall determine stabilization methods for cuts. Stabilization for cuts may consist of anchors, bolts, netting and benching.

### 3.21 DEWATERING

- A. The excavations are anticipated to be above the observed groundwater levels but cuts in impervious strata (sandy soils and rock) will collect surficial water seeping down or traveling over the impervious layers.
- B. The Contractor shall utilize appropriate dewatering equipment, tools, gravel sumps and pumps as necessary to remove groundwater, perched water and accumulated water in excavated areas, utility trenches and other excavations until such time that backfilling and the relevant construction is complete.

- C. Contractor shall supply necessary all equipment and labor including but not limited to wells, pumps and crushed stone.
- D. Water collected in fill areas shall be removed by conventional sumps and pumps before any fill is placed.
- E. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding project site and surrounding area. Protect subgrades from softening and damage by rain or water accumulation.
- F. No concrete, formwork, pipe, or bedding shall be placed in water unless specific approval is obtained from the Engineer.
- G. Water removed from an excavation shall be disposed of in such a manner as to avoid interference with vehicular or pedestrian traffic and to prevent damage to adjacent property or construction. All pumping and discharging shall be performed in accordance with local and federal regulations. Contractor shall obtain the required permits and approvals for groundwater discharge from the authorities having jurisdiction. Discharging directly into manholes or existing pipes will not be permitted unless approved by the appropriate local authority and the Owner. It shall be the Contractor's responsibility to discharge the water in such a manner that mud and silt are not discharged into the existing system, to remove from such facilities any mud, silt, and debris which has accumulated and to leave the drainage facility in a condition similar to that which existed prior to his operations.

### 3.22 DRAINAGE MAT

- A. Place vertical drainage mats specified in the contract drawings behind the foundation walls prior to backfilling. Installation shall be in accordance with the manufacturer's recommendations.
- B. Protect the drainage mats during backfilling.
- C. Connect the vertical drainage mats with the perimeter drainage pipe system.

### 3.23 PERIMETER DRAINAGE PIPE

- A. Perimeter drainage pipes shall be installed behind the below-grade wall sections as shown on contract documents. Perimeter drainage pipes shall be installed at elevation indicated on the Contract drawings. The contractor shall prepare a shop drawing showing the layout, slopes and details of the drainage pipe for review by the Geotechnical Engineer.
- B. The perimeter drainage system shall consist of 4-inch diameter, schedule 40, perforated PVC pipes embedded in a 12-inch-thick layer of  $\frac{3}{4}$ -inch clean crushed stone. Recycled concrete aggregate shall not be used in lieu of crushed stone.
- C. A layer of filter fabric such as Mirafi 140NL, or approved equal, shall be wrapped around the crushed stone layer.

### 3.24 WATERPROOFING

- A. Install the specified waterproofing membranes as shown on the contract drawings.

- B. Waterproofing installation shall be installed in strict accordance with the manufacturer's guidelines by qualified installers approved by the manufacturer.
- C. Have a preconstruction meeting with the manufacturer's representative at the site.
- D. Manufacturer's representative shall visit the site at the beginning of the installation and periodically thereafter to verify that the installation is performed to the manufacturer's satisfaction.

### 3.25 FIELD QUALITY CONTROL

#### A. Owner's responsibilities:

- 1. The Owner shall retain a qualified geotechnical engineer to inspect all earthwork operations (subgrade preparation, ground improvement, bearing material determination, backfilling, compaction, proofrolling, drainage system etc).
- 2. Foundation Subgrade: A qualified geotechnical engineer shall inspect and approve all foundation subgrades. No foundation shall be constructed over a subgrade, which was not inspected by the geotechnical engineer. Subgrade preparation and improvement measures shall be performed under supervision of a geotechnical engineer.
- 3. Pavement and Slab Subgrades: A qualified engineer shall inspect and approve the subgrades that will receive pavements and slabs-on-grade. Subgrade preparation and improvement measures, including proofrolling, shall be performed under supervision of a geotechnical engineer.
- 4. In-Situ Density Testing: In-place density testing shall be performed when fill was beneath slabs/pavements, behind walls and in trenches and over utilities. Field in-place density tests where required, shall be performed using a nuclear densometer in accordance with ASTM D 2922. In each compacted backfill layer (lift), perform at least 1 field-in-place density test for each 1,000 sq-ft of slab/pavement area, 100 feet of wall/trench length, but no fewer than 2 tests per lift. When test results indicate that subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, re-compact and retest until required density is obtained.
- 5. Drainage Elements: Installation of perimeter drainage pipe, and vertical drainage mats shall be inspected by a qualified geotechnical engineer.
- 6. Waterproofing: Installation of waterproofing shall be inspected by a qualified geotechnical engineer.
- 7. Vibration Monitoring: Vibrations during construction shall be monitored per Section 310913.
- 8. Excavation, shoring and underpinning shall be inspected by a qualified geotechnical engineer.
- 9. Preconstruction Conditions Documentation: The Owner shall retain a professional engineer to perform a pre-construction conditions documentation per Section 310913.

#### B. Contractor's Responsibilities:



1. The Contractor shall retain qualified certified testing agencies, professional engineers and professional land surveyors to perform inspection services not provided by the Owner.
2. Contractor shall retain a professional engineer who shall design and inspect dewatering system, support of excavation (SOE) systems (shoring, bracing, stabilization) and underpinning.
3. Monitoring: Contractor shall retain a licensed surveyor who shall install and monitor lateral and vertical control points on adjacent structures and streets and temporary excavation support systems (i.e. soldier pile and timber lagging) before and during excavation and foundation work.
4. Waterproofing: Installation of waterproofing shall be inspected and certified by the manufacturer's representative retained by the Contractor.
5. Contractor shall be also responsible for retaining qualified professional engineers, certified testing agencies and licensed surveyors to perform required inspections and monitoring not covered by the Owner.

### 3.26 FINISH ELEVATIONS AND LINES

- A. For setting and establishing finish elevations and lines, secure the services of a licensed land surveyor acceptable to the Owner and Owner's Engineer.
- B. Provide elevation grade stakes and any other surveying necessary for the layout of the work. The Contractor shall conduct his work in such a manner that survey stakes will be protected as long as their need exists. Grade stakes which are damaged or stolen shall be replaced by the Contractor's Surveyor at the Contractor's expense.
- C. Graded areas shall be uniform, hard and smooth, free from rock, debris, or irregular surface changes. Finished subgrade surface shall not be more than 0.10 feet above or below the design finished subgrade elevation; any deviation shall not result in changes in drainage areas or ponding. All ground surfaces shall vary uniformly between indicated elevations. Finish drainage ditches shall be graded to allow for proper drainage without ponding and in a manner that will minimize the potential for erosion.
- D. Areas having drainage slopes of one-quarter inch per foot or more shall have grade stakes, set with an instrument, at grid intervals of 50-ft.
- E. Areas having drainage slopes of one-quarter inch per foot or less shall have grade stakes, set with an instrument, at grid intervals of 25-ft.
- F. Correct all settlement and eroded areas for one year after date of project completion at no additional expense to Owner. Bring paved and landscaped areas to proper elevation. Replant or replace any grass, shrubs, bushes, or other vegetation disturbed by construction using corrective measures.

### 3.20 MAINTENANCE AND PROTECTION

- A. Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Protect subgrade from excessive construction traffic and wheel loading including concrete and dump trucks.

- C. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions. Scarify or remove and replace material to depth directed by the Engineer; reshape and recompact at optimum moisture content to the required density.
- D. Where settling occurs during the project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration. The subgrade material is extremely moisture sensitive so appropriate surface drainage and protection methods such as trenching, sloping, and pumping should be implemented to maintain the subgrade in a dry and workable condition.

**END OF SECTION 312000**

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## SECTION 312100 - AGGREGATE MATERIALS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Aggregate materials for use as specified in other Sections.

#### 1.02 RELATED SECTIONS

- A. Section 312100 - Earthwork
- B. Section 312200 - Erosion Control and Sedimentation
- C. Geotechnical report (under separate cover)
- D. Construction Drawings

#### 1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition
  - 1. C136 Method for Sieve Analysis of Fine and Coarse Aggregates
  - 2. D 698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN.m/m<sup>3</sup>))
  - 3. D 1557 Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 Kn.m/m<sup>3</sup>))
  - 4. D 2216 Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
  - 5. D 2487 Classification of Soils for Engineering Purposes
  - 6. D 2922 Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)
  - 7. D 3017 Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
  - 8. D 4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition T 88 Particle Size Analysis of Soils.

#### 1.04 QUALITY ASSURANCE

- A. Tests and analysis of aggregate materials will be performed in accordance with ASTM and AASHTO procedures specified herein.

**1.05 SUBMITTALS**

- A. Submit 30-pound sample of each aggregate or mixture that is to be incorporated into project in air-tight containers to the independent testing laboratory or submit gradation and certification of aggregate material that is to be incorporated into project to the independent testing laboratory for review.
- B. Submit name of each material supplier and specific type and source of each material. Any change in source requires approval of Owner.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. Construction and materials shall meet or exceed the most stringent requirements of this Section and/or the requirements of the Geotechnical report prepared by others, and applicable state highway department specifications section(s) referred to or noted on the Construction Drawings which pertain to paving base course design, materials, preparation, and execution. Materials shall be as indicated in the Construction Documents and shall comply with state highway department specifications regarding source, quality, gradation, soundness, absorption, liquid limit, plasticity index, and mix proportioning.
- B. Soil Materials
  - 1. Class II: Coarse-Grained Soils; conforming to ASTM D2487 Group Symbol, GW, GP, SW and SP.
  - 2. Class III: Coarse-Grained Soils with Fines; conforming to ASTM D2487 Symbol GM, GC, SM and SC.
  - 3. Class IV-A: Fine-Grained Soils (inorganic); conforming to ASTM D2487 Group Symbol ML and CL.
  - 4. Class IV-B: Fine Grained Soils (inorganic); conforming to ASTM D2487 Group Symbol MH and CH.
  - 5. Class V: Organic Soils; conforming to ASTM D2487 Group Symbol OL, OH, and PT.
- C. Aggregate Material
  - 1. Coarse Aggregate Type A1: Material shall be sound crushed limestone, crushed slag, granulated slag, crushed gravel, or other types of suitable material meeting the requirements of this section. Crushed limestone, crushed slag and crushed gravel shall meet the following grading requirements:

Sieve Size	Percent Passing
1 1/2 inches	100
1 inch	75-100
3/4 inch	60-100
3/8 inch	35-75
No. 4	30-60
No. 30	7-30
No. 200	0-5

2. Coarse Aggregate Type A2: Material shall be crushed carbonate, crushed gravel, crushed air-cooled slag, granulated slag, a mixture of crushed and granulated slag, or other types of suitable material meeting the requirements of this item. Crushed carbonate stone or mixtures of crushed and granulated slags shall meet the following gradation requirements:

Sieve Size	Percent Passing
2 inches	100
1 inch	70-100
3/4 inch	50-90
No. 4	30-60
No. 30	7-30
No. 200	0-5

3. Aggregate Type A3: Pea Gravel – Natural stone; washed, free of clay, shale, organic matter; graded in accordance with ASTM C136 and D2487; to the following limits:

- a. Minimum size: 1/4 inch
- b. Maximum Size: 5/8 inch

4. Fine Aggregate Type A4: Sand – Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter; graded in accordance with ASTM C136 and D2487; within the following limits:

Sieve Size	Percent Passing
No. 4	90-100
No. 50	7-40
No. 200	0-5

5. Class I-A: Material shall be sound crushed limestone, crushed slag, granulated slag, crushed gravel, or other types of suitable material meeting the requirements of this item. Crushed limestone, crushed slag and crushed gravel shall meet the following grading requirements:

Sieve Size	Percent Passing
1-1/2 inches	100
No. 4	≤ 10
No. 200	< 5

6. Class I-B: Material shall be crushed carbonate, crushed gravel, crushed air-cooled slag, granulated slag, a mixture of crushed and granulated slag, or other types of suitable material meeting the requirements of this item. Crushed carbonate stone or mixtures of crushed and granulated slags shall meet the following gradation requirements:

Sieve Size	Percent Passing
1-1/2 inches	100
No. 4	≤ 50
No. 200	< 5

7. Free draining crushed stone for beneath building floor slab shall be ¾ inch class crushed AASHTO No. 57 stone.
8. Dense graded aggregate shall consist of broken stone conforming to NJDOT Section 901.08 and shall meet the following gradation requirements:

Sieve Size:	Percent
1 ½"	100
¾"	55-90
No. 4	25-60
No. 50	5-25
No. 200	30-12

## 2.02 EQUIPMENT

- A. Transport off-site materials to project using well-maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated limits of disturbance and haul roads and shall at no time endanger any improvements by rutting, overloading, or pumping.

## PART 3 EXECUTION

### 3.01 STOCKPILING

Stockpile on-site at locations indicated by Owner in such manner that there will be no standing water or mixing with other materials.

### 3.02 BORROW AND SPOIL SITES

Upon completion of borrow and/or spoil operations, clean up borrow and/or spoil areas as indicated on Construction Drawings in neat and reasonable manner to satisfaction of property owner and Owner.

## END OF SECTION 312100

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## **SECTION 312200 - SOIL EROSION AND SEDIMENTATION CONTROL**

### **PART 1 - GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Installation of temporary and permanent erosion control systems.
- B. Installation of temporary and permanent slope protection systems.

#### **1.02 RELATED SECTIONS**

- A. Section 312000 – Earthwork
- B. Section 334100 – Storm Drainage
- C. Section 329100 – Planting
- D. Construction Drawings

#### **1.03 QUALITY ASSURANCE**

- A. The Contractor shall implement soil erosion controls in a timely manner.
- B. The Contractor shall carefully adhere to the construction sequence that is shown on the construction drawings.
- C. The Contractor shall follow Soil Erosion and Sediment Control Notes that are shown on the construction drawings and local regulations.
- D. The Contractor shall make frequent inspection of temporary soil erosion controls and maintain them in working order until permanent soil erosion controls are established.

#### **1.04 ENVIRONMENTAL REQUIREMENTS**

- A. The contractor shall protect adjacent properties and water resources from soil erosion and sediment damage throughout construction.
- B. Discharge from dewatering operations shall not be directed to surface waters.

## **PART 2 - PRODUCTS**

### **2.01 MATERIALS**

- A. Quick growing grasses such as wheat, rye, or oats in accordance with Section 329100.
- B. Hay or straw bales as specified on Construction Drawings.
- C. Fencing for siltation control as specified on Construction Drawings.
- D. Curlex blankets by American Excelsior Company or approved equal.
- E. TMAX by North American Green or approved equal.
- F. Bale stakes for each bale shall be minimum of 4-feet in length and shall be either two #2 rebars, two steel pickets, or two 2-inch x 2-inch hardwood stakes driven 1'-6" into ground.
- G. Temporary mulches such as loose hay, straw, netting, wood cellulose, or agricultural silage.
- H. Fence stakes shall be minimum of 5-ft in length and be either metal stakes or 2-inch x 2-inch hardwood stakes driven 1'-6" into ground.
- I. Temporary and Permanent Outfall Structures as specified on Construction Drawings.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Review Construction Drawings.
- B. Conduct pre-construction meeting with Site Contractor.

### **3.02 EROSION CONTROL AND SLOPE PROTECTION IMPLEMENTATION**

- A. Place erosion control systems in accordance with Construction Drawings or as may be dictated by site conditions in order to maintain the intent of the specifications and permits at no additional cost to Owner.
- B. Deficiencies or changes on Construction Drawings shall be implemented as site conditions change.
- C. Owner has authority to limit surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations and to direct Contractor to provide immediate permanent or temporary pollution control measures.



- D. Maintain temporary erosion control systems as directed by Owner or governing authorities to control siltation during life of contract. Contractor shall respond to maintenance or additional work ordered by Owner or governing authorities within 48 hours or sooner if required at no additional cost to the Owner.
- E. Contractor will be required to incorporate permanent erosion control features into project at earliest practical time to minimize need for temporary controls.
- F. Permanently seed and mulch cut slopes as excavation proceeds to extent considered desirable and practical.
- G. Slopes that erode easily or that will not be graded for a period of 14 days or more shall be temporarily seeded as work progresses with wheat, rye, or oats application in accordance with Section 329100 unless otherwise specified on the Construction Drawings.

**END OF SECTION 312200**

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## **SECTION 312333 – EXCAVATION, BACKFILL AND COMPACTION FOR UTILITIES**

### **PART 1- GENERAL**

#### **1.01 SUMMARY**

- A. Excavation of trenches for installation of utilities.
- B. Backfilling trenches with bedding material as specified and filling trenches with suitable material to proposed subgrade.
- C. Compacting backfill materials in acceptable manner.

#### **1.02 RELATED SECTIONS**

- A. Section 024113 – Site Demolition
- B. Section 312200 – Earthwork
- C. Section 331100 - Water Distribution Systems
- D. Section 334900 - Storm Drainage
- E. Section 321123 - Aggregate Materials
- F. Construction Drawings

#### **1.03 REFERENCE STANDARDS**

See Related Sections.

#### **1.04 QUALITY ASSURANCE**

- A. An independent testing laboratory will perform testing at intervals not exceeding 200-feet of trench for first and every other 8-inch lift of compacted trench backfill and furnish copies of results as specified herein.
- B. Testing shall be in accordance with Part 3, Section 3.06, “Field Quality Control”.

#### **1.05 SUBMITTALS**

- A. Shop drawings or details pertaining to site utilities are not required unless required by regulatory authorities or unless uses of materials, methods, equipment, or procedures that are contrary to Construction Drawings or Specifications are proposed. Do not perform work until Owner has accepted required shop drawings.
- B. Submit 30-pound sample of each type of off-site fill material that is to be used in backfilling in air-tight container(s) to the independent testing laboratory or submit gradation and certification of aggregate material that is to be used at the site to the independent testing laboratory for review.

1.06 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of subsurface utilities, structures, and obstructions installed or encountered.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Bedding Material: Aggregate Type as indicated on the plans and as specified in Section 321123.
- B. Haunching Material: As specified in Section 321123. Aggregate Type as indicated on the plans and as specified in Section 321123.
- C. Backfill material from off-site as specified in Section 312200 and approved by Owner.
- D. Backfill material shall not contain rock or stone with a maximum size greater than 2 inches.

2.02 LOCATOR TAPE

- A. Locator tape shall be heavy duty 6" wide underground warning tape. Tape shall be made from polyethylene material, 3.5 mils thick, with a minimum tensile strength of 1,750 psi. Place the tape at one-half the minimum depth of cover for the utility line or a maximum of 3', which ever is the lesser, but never above the top of subgrade. Color of tape shall be determined by APWA Color Standards: Electric - Red, Telephone - Orange.

2.03 EQUIPMENT

- A. Transport off-site materials to project using well-maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Set lines, elevations, and grades for proposed systems.
- B. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.
- C. Maintain in operating condition existing utilities, previously installed utilities, and drainage systems encountered in utility installation. Repair surface or subsurface improvements shown on Construction Drawings.

- D. Verify location, size, elevation, and other pertinent data required making connections to existing utilities and drainage systems as indicated on Construction Drawings.
- E. Over excavate and properly prepare areas of subgrade that are not capable of supporting proposed systems. Stabilize these areas by using acceptable geotextile.
- F. Provide dewatering systems as required for utility excavations. Dewatering systems shall comply with requirements of Section 312200.

### 3.02 EXCAVATION

- A. Contract local utility companies before excavation begins. Dig trench at proper width and depth for laying pipe, conduit, or cable. Cut trench banks vertical, if possible, and remove stones from bottom of trench as necessary to avoid point-bearing. Over excavate wet or unstable soil, if encountered, from trench bottom as necessary to provide suitable base for continuous and uniform bedding.
- B. Trench excavation sidewalls shall be sloped, shored, sheeted, braced, or otherwise supported by means of sufficient strength to protect workmen in accordance with applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Lateral travel distance to exit ladder or steps shall not be greater than 25-feet in trenches 4-feet or deeper.
- C. Perform excavation as indicated on Construction Drawings for specified depths. During excavation, stockpile materials suitable for backfilling in orderly manner far enough from bank of trench to avoid overloading, slides, or cave-ins.
- D. Remove excavated materials not required or not suitable for backfill or embankments and waste off-site or at on-site locations approved by the Owner and in accordance with governing regulations. Dispose of structures discovered during excavation as specified in Section 024113.
- E. Prevent surface water from flowing into trenches or other excavations by temporary grading or other methods, as required. Remove accumulated water in trenches and other excavations as specified in Section 312200.
- F. Open cut excavation with trenching machine or backhoe. Where machines other than ladder or wheel-type trenching machines are used, do not use clods for backfill. Dispose of unsuitable material and provide other suitable material at no additional cost to Owner.
- G. Accurately grade trench bottom to provide uniform bearing and support for each section of pipe on bedding material at every point along entire length, except where necessary to excavate for bell holes, proper sealing of pipe joints, or other required connections. Dig bell holes and depressions for joints after trench bottom has been graded. Dig no deeper, longer, or wider than needed to make joint connection properly.
- H. Trench width below top of pipe shall not be less than 12-inches or more than 18-inches wider than outside surface of pipe or conduit that is to be installed to designated elevations and grades. Other trench width for pipe, conduit, or cable shall be least practical width that will allow for proper compaction of trench backfill.

- I. Trench depth requirements measured from finished grade or paved surface shall meet the following requirements or applicable codes and ordinances, whichever is more stringent:
  - 1. Water Mains: 30-inches to top of pipe barrel or 6-inches below frost line, established by local building official, whichever is deeper.
  - 2. Storm Sewer: Elevations and grades as indicated on Construction Drawings.
  - 3. Electrical Conduits: 24-inches minimum to top of conduit or as required by NEC 300-5, NEC 710-36 codes, or local utility company requirements, whichever is deeper.
  - 4. Telephone Conduits: 18-inches minimum to top of conduit, or as required by local utility company, whichever is deeper.

### **3.03 PIPE BEDDING**

- A. Accurately cut trenches for pipe or conduit that is to be installed to designated elevations, 4-inches below bottom of pipe and to the width as specified herein. Place 4-inches of bedding material, compact in bottom of trench, and accurately shape to conform to lower portion of pipe barrel.

### **3.04 BACKFILLING**

- A. Criteria: Do not backfill trenches until required tests are performed and utility systems comply with and are accepted by applicable governing authorities. Backfill trenches as specified in Sections 312200 and one or more of the following sections, as applicable: or 332334 for trenches below pavements. If improperly backfilled, reopen to depth required to obtain proper compaction. Backfill and compact, as specified herein, to properly correct the condition in an acceptable manner.
- B. Backfilling: After pipe or conduit has been installed, bedded, and tested as required, backfill trench or structure excavation with specified material placed as given in the Construction Documents.
- C. Backfill trenches to contours and elevations shown on Construction Drawings with unfrozen materials.
- D. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

### **3.05 COMPACTION**

- A. Exercise proper caution when compacting immediately over top of pipes or conduits. Water jetting or flooding is not permitted as method of compaction.
- B. Maintain optimum moisture content of fill materials as specified in Section 312200 to attain required compaction density.
- C. Materials used for backfill shall comply with requirements of Section 321123 and as specified herein.

### **3.06 FIELD QUALITY CONTROL**

**PART 4 - MEASUREMENT AND PAYMENT**

**4.01 MEASUREMENT AND PAYMENT**

The price bid for all excavation, backfill, compaction and testing as described in Section 312333 Excavation, Backfill, and Compaction for Utilities shall be included in the respective Items that include excavation, backfill and compaction for utilities in order to properly complete Contract work.

**END OF SECTION**

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## SECTION 313200 – SOIL STABILIZATION

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Excavation, treatment, and backfilling of subgrade for lime stabilization.
- B. Excavation, treatment, and backfilling of subgrade for cement stabilization.
- C. Excavation, treatment, and backfilling of subgrade for fly ash stabilization.
- D. Excavation, treatment, and backfilling of subgrade for bridge lift stabilization.
- E. Installation of Geotextile Fabric for stabilization of subgrade.

#### 1.02 RELATED SECTIONS

- A. Section 312200 - Earthwork
- B. Section 312333 - Excavation, Backfill, and Compaction for Utilities
- C. Section 332334 - Excavation, Backfill, and Compaction for Pavement
- D. Section 321123 - Aggregate Materials
- E. Construction Drawings

#### 1.03 REFERENCE STANDARDS

- A. American Society for Testing Materials (ASTM) latest edition
  - 1. C 150 Portland Cement
  - 2. C 618 Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete
  - 3. C 977 Quicklime and Hydrated Lime for Soil Stabilization
  - 4. D 1633 Compressive Strength of Molded Soil-Cement Cylinders
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition
  - 1. M 216 Lime for Soil Stabilization
- C. National Lime Association (NLA)
  - 1. Bulletin 326 Lime Stabilization Construction Manual

1.04 ENVIRONMENTAL REQUIREMENTS

- A. Do not install mixed materials in wind in excess of 10 mph or when temperature is below 40 degrees Fahrenheit.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with state and local standards in conjunction with requirements specified herein.

1.06 SUBMITTALS

- A. Submit 30-pound sample of each material to be used at the site in airtight containers to the independent testing laboratory or submit gradation and certification of material that is to be used to the independent testing laboratory for review.
- B. Submit name of each materials supplier and specific type and source of each material. Change in source requires approval of Owner.
- C. Submit mix design and materials mix ratio that will achieve specified requirements of state and local agencies for soil stabilization.

**PART 2 - PRODUCTS**

2.01 MATERIALS

- A. Hydrated Lime
- B. Portland Cement: ASTM C150, Normal Type I
- C. Fly Ash: ASTM C977 or AASHTO M216
- D. Coarse Aggregate: Type A1
- E. Fine Aggregate: Type A4
- F. Subsoil: Existing to be Reused, Type S1
- G. Surge Stone

2.02 ACCESSORIES

- A. Curing Seal: Asphalt Emulsion Primer
- B. Geotextile Fabric for Stabilization
  - 1. Mirafi 500X or 600X
  - 2. Phillips 66 Supac 6WS



3. Dupont Typar 3401 and 3601
4. Trevira S1114 and S1120
5. Tensar SS-1 and SS-2
6. Exxon GTF-200 or 350
7. TerraTex HD and GS
8. Or approved equal

### 2.03 EQUIPMENT

- A. Perform operations using suitable, well maintained equipment capable of excavating subsoil, mixing and placing materials, wetting, consolidating, and compacting of material.

## PART 3 - EXECUTION

### 3.01 PREPARATION

- A. Obtain approval from the independent testing laboratory of mix design before proceeding with placement.
- B. Start stabilization only when weather and soil conditions are favorable for successful application of proposed material.
- C. Proofroll subgrade to identify areas in need of stabilization.

### 3.02 EXCAVATION

- A. Excavate subsoil to depth sufficient to accommodate soil stabilization.
- B. Remove lumped subsoil, boulders, and rock that interfere with achieving uniform subsoil conditions.
- C. Do not excavate within normal 45 degree bearing splay of any foundation.
- D. Notify Construction Manager of unexpected subsurface conditions. Discontinue affected work in area until notified to resume work.
- E. Correct areas over-excavated in accordance with Section 312200.
- F. Remove excess excavated material from site.

### 3.03 GEOTEXTILE FABRIC

- A. Place geotextile fabric over subsoil surface, lap edges and ends in accordance with manufacturer's recommendations in those areas that are shown on Construction Drawings

or in those areas that need additional stabilization prior to placement of base course. Bridge lift sections may require the use of geotextile fabric for stabilization prior to placement of fill.

- B. Place geotextile fabric specified on Construction Drawings and in Specifications in accordance with manufacturer's recommendations.

### 3.04 SOIL TREATMENT AND BACKFILLING

- A. Lime Stabilized Subgrade: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade with hydrated lime in accordance with state highway department specifications.
- B. Cement Stabilized Subgrade: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade with portland cement in accordance with state highway department specifications.
- C. Fly Ash Stabilized Subgrade: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade with fly ash in accordance with state highway department specifications.
- D. Bridge Lifts: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade by application of a bridge lift. Bridging over existing soils shall be acceptable only when approved in writing by the Owner. Place geotextile fabric or geogrid over existing soils to be bridged. The geotextile fabric or geogrid selected shall be appropriate for the bridge lift material being placed. Place bridge lift over geotextile fabric or geogrid. Bridge lift material may be surge stone, granular fill, or shot rock fill. Granular material shall be in accordance with Section 321123. Surge stone and shot rock will be approved by the Owner's representative on a submittal basis. The Owner and the Owner's representative shall have sole discretion as to the acceptability of all submittals.
- E. Backfill and compaction of treated subsoil shall be in accordance with Sections 312200, 312333 and 332334.
- F. Maintain optimum moisture of mixed materials to attain required stabilization and compaction.
- G. Finish subgrade surface in accordance with Section 312200.
- H. Remove surplus mix materials from site at no additional cost to the Owner.

### 3.05 CURING

- A. Immediately following compaction of mix, seal top surface with curing seal.
- B. Do not permit traffic for 72 hours after sealing top surface.

### 3.06 FIELD QUALITY CONTROL

- A. Compression test and analysis of hardened fill material will be performed in accordance with Section 312200.
- B. If tests indicate work does not meet specified requirements, remove work, replace and retest.

**END OF SECTION**

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## **SECTION 315000 - TEMPORARY EXCAVATION SUPPORT AND PROTECTION**

### **PART 1 - GENERAL**

#### **1.1 SCOPE OF WORK**

- A. Provision of all temporary excavation support necessary to facilitate proposed construction at the Site required by the Construction Drawings and Technical Specifications. Contractor shall supply all materials, equipment and labor required to furnish, install, maintain, and remove an excavation support and protection system capable of supporting excavation sidewalls, and of resisting soil and hydrostatic pressure.
- B. Protection of adjacent structures, utilities, parking lot areas, and roadways which are to remain. Contractor shall install, maintain, and (where required) remove its temporary excavation support and protection system so as not to damage any existing utilities that are to remain.

#### **1.2 RELATED SECTIONS AND DOCUMENTS**

- A. Section 011100 – General Requirements
- B. Section 311000 – Site Preparation
- C. Section 312000 – Earthwork
- D. Federal Occupational Safety and Health Administration (OSHA), U.S. Department of Labor general industry (29 CFR 1910) and construction (29 CFR 1926) standards, latest adopted version.

#### **1.3 QUALITY ASSURANCE**

- A. Contractor shall provide at least one supervisory person who shall be present at all times during execution of the Work and who is thoroughly familiar with the type of Work being performed and its best methods for completion. This person shall have the authority to act on behalf of Contractor.
- B. Contractor shall comply with any provisions of all applicable Federal, State, and Local requirements, codes, regulations and standards.
- C. Contractor shall be solely responsible for the method and adequacy of his temporary excavation support system.
- D. Contractor shall have the sole responsibility for coordinating his Work with Geotechnical Engineer to assure that all tests and procedures required by the Construction Documents are properly provided. Contractor shall cooperate fully with Geotechnical Engineer and Owner's Engineer in the performance of its Work.

#### **1.4 SUBMITTALS**

- A. Unless otherwise indicated, transmit all submittals to Owner and Geotechnical Engineer. Contractor will receive acknowledgement for concepts and details shown. Such acknowledgement shall be of the concept only and shall not in any way diminish or relieve Contractor of sole responsibility for the adequacy of his procedures and the satisfactory performance of his excavation support and protection system.
- B. Contractor shall submit satisfactory proof of qualifications for performing the Work specified herein, at least two weeks prior to the delivery of any equipment or materials to the Site.
- C. Contractor shall submit his excavation support and protection plan and methods a minimum of two weeks prior to the start of Work and shall include the following:
  - 1. Details, arrangement, and method of assembly of proposed system components.
  - 2. Location of the excavation support system installation.
  - 3. Typical cross-section, including:
    - ☐ Full excavation depth.
    - ☐ Elevation for the bottom of the excavation.
    - ☐ Elevation for the top and toe of the support system.
    - ☐ Minimum embedment below the bottom of the excavation.
    - ☐ Location of any necessary bracing.
  - 4. Any required calculations, signed and sealed, as prepared by a New Jersey licensed Professional Engineer. The component members of the system shall be designed for earth pressures, unrelieved hydrostatic pressures, and any construction or vehicle surcharges.
  - 5. The materials and procedures Contractor intends to use for installing and, where necessary, removing the temporary excavation support.
- D. Review of Contractor's plans and methods of construction does not relieve Contractor of the responsibility for the adequacy and performance of his temporary excavation support system.

## **PART 2 - PRODUCTS**

### **2.1 EXCAVATION SUPPORT SYSTEM**

- A. Materials comprising or used to fabricate the excavation support system shall be determined by Contractor.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Contractor shall install and maintain an excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and superimposed and construction loads.
- B. Contractor shall proceed with caution in the vicinity of existing utilities. Contractor shall expose them by hand excavation or other methods necessary so as to prevent damage to subject utilities. If existing utilities interfere with proposed method of support, the Contractor shall notify Owner and Geotechnical Engineer.
- C. The Contractor shall coordinate Work of this Section with any dewatering requirements.

**3.2 EXCAVATION SUPPORT SYSTEM**

- A. Contractor shall furnish and construct a temporary excavation support system in accordance with its submitted and reviewed plans.
- B. Contractor shall maintain the temporary excavation support system as necessary to facilitate Contract Work.
- C. The excavation support system shall be removed in a manner which permits compaction of the backfill as specified in Section 312000 – Earthwork and results in filling of voids (if any).
- D. The temporary excavation support system shall be left in place only with prior written permission of Owner.

**END OF SECTION 315000**

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## SECTION 321216 - ASPHALTIC CONCRETE PAVING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Preparation and placement of asphaltic concrete binder course.
- B. Preparation and placement of asphaltic concrete surface course.
- C. Preparation and placement of asphaltic concrete overlay
- D. Preparation and placement of bituminous seal coat

#### 1.02 RELATED SECTIONS

- A. Section 312000 - Earthwork
- B. Section 321218 - Base Course
- C. Section 321315 - Curbs and Sidewalks
- D. Construction Drawings

#### 1.03 REFERENCE STANDARDS

- A. The Asphalt Institute (AI) latest edition
  - 1. MS 2 Mix Design Methods for Asphaltic Concrete and Other Hot Mix Types
  - 2. MS 3 Asphalt Plant Manual
  - 3. MS 8 Asphalt Paving Manual
  - 4. MS 19 Basic Asphalt Emulsion Manual
- B. State Highway Department Standard Specifications
- C. American Society of Testing and Materials (ASTM) latest edition
  - 1. D 946 Penetration - Graded Asphalt Cement for use in Pavement Construction
  - 2. D 1188 Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
  - 3. D 1559 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
- D. American Association of State Highway and Transportation Officials (AASHTO) latest edition
  - 1. M 117 Mineral Filler "Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing"
  - 2. M 140 Tack Coat "Emulsified Asphalt"
  - 3. M 208 Tack Coat "Cationic Emulsified Asphalt"
  - 4. M 226 Viscosity Graded Asphalt Cement
  - 5. T 245 Marshall Mix Design

#### 1.04 QUALITY ASSURANCE

- A. An independent testing laboratory, selected and paid by Contractor, will be retained to perform construction testing of in-place asphaltic concrete courses for compliance with requirements for thickness, compaction, and surface smoothness.
- B. All failed test results to be faxed to the Construction Manager.
- C. In-place compacted thickness shall not be less than thickness specified on Construction Drawings. Areas of deficient paving thickness shall receive tack coat and minimum 1-in. overlay; or shall be removed and replaced to proper thickness, at discretion of Owner; until specified thickness of course is met or exceeded at no additional expense to Owner.
- D. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by Owner.

#### 1.05 SUBMITTALS

- A. Before asphaltic concrete paving is constructed, submit actual design mix to Civil Engineering Consultant of Record and independent testing laboratory for review and approval. Design mix submittal shall follow a format as indicated in Asphalt Institute Manual MS-2, Marshall Stability Method; and shall include type/name of mix, gradation analysis, grade of asphalt cement used, Marshall Stability in pounds (lb.) flow, effective asphalt content in percent (%), and direct references to state highway department specifications sections for each material. Design shall be for mixture listed in current edition of state highway department specifications. Mix designs over 3 years old will not be accepted by Owner.
- B. Submit materials certificate to the independent testing laboratory that is signed by materials producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein.
- C. The Contractor may submit an option for an equivalent Superpave mix, which if accepted, will be provided at no additional expense to the Owner.

#### 1.06 PROJECT CONDITIONS

- A. Weather Limitations:
  - 1. Apply prime and tack coats when ambient or base surface temperature is above 40 degrees Fahrenheit, and when temperature has been above 35 degrees Fahrenheit for 12 hours immediately prior to application. Do not apply when base is wet, contains excess moisture, during rain, or frozen.
  - 2. Construct asphaltic concrete paving when atmospheric temperature is above 40 degrees Fahrenheit.



- B. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Provide asphalt-aggregate mixture in accordance with this Section. If specified aggregate is scarce, use locally available materials and gradations that meet state highway department specifications and exhibit satisfactory records of previous installations.
- B. Asphalt Cement: Comply with AASHTO M 226; Table 2 AC-10, AC-20, or AC-40, viscosity grade, depending on local mean annual air temperature. See chart below:

<u>Temperature Condition</u>	<u>Asphalt Grades</u>
Cold, mean annual air temperature At 45 degrees Fahrenheit or lower	AC-10 85/100 pen.
Warm, mean annual air temperature Between 45 degrees Fahrenheit and 75 degrees Fahrenheit	AC-20 60/70 pen.
Hot, mean annual air temperature At 75 degrees Fahrenheit or higher	AC-40

- C. Prime Coat: Medium curing cut-back asphalt or asphalt penetrating prime coat consisting of either MC-30 or SS-1h.
- D. Tack Coat: Emulsified asphalt; AASHTO M 140 or AASHTO M 208, SS-1h, CSS-1, or CSS-1h, diluted with 1 part water to 1 part emulsified asphalt.
- E. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with AASHTO M 117, if recommended by state highway department specifications.
- E. Asphalt-Aggregate Mixture: Unless otherwise noted on Construction Drawings, Design Mix shall have minimum stability based on 75-blow Marshall complying with ASTM D 1559 of 1000 pounds with flow between 0.08 and 0.16 inches. The Design Mix shall be within sieve analysis and bitumen ranges specified below unless approved otherwise by Owner prior to placement.

#### SIEVE ANALYSIS OF MIX

Sieve No.	Total Percent Passing	Percent Tolerance
3/4"	100	7
1/2"	90-100	5
4	44-74	4
8	28-58	4
50	5-21	2
200	2-10	0

Percent bitumen by weight of total mix: 5.0 - 8.5 percent

Air voids: 3 - 6 percent

Aggregate voids filled with asphalt cement: 70 - 82 percent

Allowable variance of bitumen by weight of total mix = 0.4 percent

- F. Asphalt Base Course: Base Course Design Mix shall conform to NJDOT TYPE I-2.
- G. Asphalt Wearing Course: Wearing Course Design Mix shall conform to NJDOT TYPE I-5.

## **2.02 EQUIPMENT**

- A. All equipment necessary for the paving of asphaltic concrete shall be on the project prior to beginning paving operations.
- B. Maintain equipment in satisfactory operating condition and correct breakdowns in manner that will not delay or be detrimental to the schedule of paving operations.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Proofroll prepared base material surface to check for unstable areas. Paving work shall begin only after unsuitable areas have been corrected and are ready to receive paving.
- B. Remove loose material from compacted base material surface immediately before applying prime coat.
- C. Establish and maintain required lines and elevations.
- D. Cover the surfaces of curbs, gutters, manholes and other structures the asphaltic concrete mixture will be placed against with a thin, uniform coat of liquid asphalt. Where the asphaltic concrete mixture will be placed against the vertical face of an existing pavement, clean the vertical face to remove foreign substances and apply a coating of liquid asphalt at a rate of approximately 0.25 gallons per square yard.
- E. Asphalt overlay work shall include installing a new bituminous pavement wearing course over a properly prepared existing bituminous pavement. Longitudinal joints should not be placed over existing longitudinal joints. If possible, paving should be placed in the opposite direction to the original and at a minimum; the longitudinal joints should be placed at the center of the existing paving strips. Paved transition areas will be installed to allow smooth egress from the new bituminous pavement overlay to the existing pavement.
- F. The Contractor is required to correct the weaker areas of the existing pavement in order to provide a uniform foundation for the overlay. The Contractor will utilize a heavily loaded tandem to traverse the existing pavement that will receive the new overlay. Under the supervision of the Owners geotechnical field engineer, areas showing deflections in

excess of 1" should be improved in accordance with the procedures for repair of alligator-type distress cracks and potholes. Any large distortions of the grade shall be corrected by construction of leveling courses and/or leveling wedges so as to restore the proper line and cross section prior to the installation of the new overlay. Repair cracks of less than one inch in width by thoroughly cleaning the cracks with compressed air and filling the cracks with the appropriate sealant. Large cracks in excess of one inch are to be filled with bituminous pavement material after cleaning, but prior to applying the sealant. When performing the above crack repairs, a hand torch or weed killer is to be used to destroy all existing vegetation. Any areas in the opinion of the Owner's geotechnical field engineer that after crack and pothole repair pose the danger of reflective cracking through the new overlay are to be reinforced with a pavement reinforcement Geogrid equal to HATELIT 2015 Geogrid manufactured by Huesker Inc., Charlotte, NC (800-942.9418). The Contractor will be required to make any adjustments to manholes, valve boxes and other pavement fixtures in order to bring them up to the new proposed finished grade.

- G. Before placement of the new overlay, the Contractor will thoroughly clean and sweep the existing pavement in order to remove all loose materials and contaminants. After cleaning, a tack coat of SS-1, SS-1h CSS-1 or CSS-1h in emulsified asphalt, diluted with equal parts of potable water will be applied at a rate of 0.05 to 0.15 gals/sy in a manner that will provide thorough coverage of the entire surface. Any pools of tack coat material shall be swept to higher areas to dry. Extreme care should be taken during tack coat application to thoroughly protect all buildings, walls, curbs or other improvements from the emulsion spray.
- H. Localized areas of alligator-type distress cracks, potholes or other severely distressed areas are to be sawcut in a neat manner using a pavement saw forming a square or rectangular shape to a distance of at least one foot beyond the limits of the affected area. Remove the bituminous pavement and expose the existing sub-base materials so that the sub-base materials can be proof-rolled in order to visually assess the stability of the sub-base materials. Materials that are observed to be unstable are to be removed to expose suitable materials or to a depth of two feet beneath the ground surface, whichever is less. The resulting excavation shall be backfilled to the design pavement subgrade level with material meeting the requirements for Dense Graded Aggregate and compacted to 95 percent of maximum dry density as determined by the ASTM-D 1557 test procedure. Four inches of bituminous stabilized base material is to be placed on top of the new OGA material to an elevation equal to the existing surrounding grade after applying a tack coat to the surface of the existing pavement to insure a good bond between the new stabilized base material and existing asphalt.
- I. Where the new bituminous overlay abuts concrete curbing that is not required to be replaced, a minimum 4" reveal must be maintained. The Contractor will be required to remove enough existing pavement in order to maintain the overlay thickness within three feet of the curb.
- J. The Contractor shall construct transition pavement at a minimum width of four feet in order to taper from the new overlay thickness to the existing pavement elevation. The four foot transition area is to be milled and the transition pavement is to be anchored to the existing pavement by neatly cutting and removing a 12' wide section of the existing pavement and installing the end of the transition pavement in the 12' *wide* section. The edges of the transition pavement shall be sealed.

- K. Pavement areas determined by the Owner's geotechnical engineer to be in good condition and identified on the plans to receive seal coats and generally exhibiting random cracking of up to 1" inch in width and some raveling of the fine aggregate shall be covered with two (2) seal coats of coal emulsion blend with 3 to 5 # of sand per gallon with appropriate latex additives. The emulsion should be diluted and sprayed at a rate of 0.1 to 0.15 gal/syd, depending on the texture and absorption rate of the existing asphalt. Random cracks should be filled with hot pour rubberized liquid asphalt crack filler (oil jacketed or direct fire). The cracks should be prepared for filling by removing vegetation, cleaning with a broom or a stream of compressed air, and the application of a soil sterilant if weed growth is anticipated. Larger cracks should be filled with a fine sand-asphalt hot mix.

### 3.02 APPLICATIONS

- A. Prime Coat:
1. Apply bituminous prime coat to base material surfaces at least 24 hours in advance, where asphaltic concrete paving will be constructed.
  2. Apply bituminous prime coat in accordance with state highway department specifications.
  3. Apply at minimum rate of 0.25 gal per sq. yd over compacted base material. Apply to penetrate and seal, but not flood surface.
  4. Take necessary precautions to protect adjacent areas from over spray.
  5. Cure and dry as long as necessary to attain penetration of compacted base and evaporation of volatile substances.
- B. Tack Coat:
1. Apply to contact surfaces of previously constructed asphaltic concrete base courses or portland cement concrete and surfaces abutting or projecting into asphaltic concrete or into asphaltic concrete pavement.
  2. Apply tack coat to asphaltic concrete base course or sand asphalt base course. Apply emulsified asphalt tack coat between each lift or layer of full depth asphaltic concrete and sand asphalt bases and on surface of bases where asphaltic concrete paving will be constructed.
  3. Apply emulsified asphalt tack coat in accordance with state highway department specifications.
  4. Apply at minimum rate of 0.05 gal per sq. yd of surface.
  5. Allow drying until at proper condition to receive paving.

### 3.03 ASPHALTIC CONCRETE PLACEMENT

- A. Place asphaltic concrete mixture on completed compacted subgrade surface, spread, and strike off. Spread mixture at following minimum temperatures:
1. Ambient temperature between 40 degrees Fahrenheit and 50 degrees Fahrenheit, mixture temp. = 285 degrees Fahrenheit
  2. Ambient temperature between 50 degrees Fahrenheit and 60 degrees Fahrenheit, mixture temp. = 280 degrees Fahrenheit
  3. Ambient temperature higher than 60 degrees Fahrenheit, mixture temp. = 275 degrees Fahrenheit
- B. Whenever possible, spread pavement by finishing machine; however, inaccessible or irregular areas may be placed by hand methods. Spread hot mixture uniformly to

required depth with hot shovels and rakes. After spreading, carefully smooth hot mixture to remove segregated course aggregate and rake marks. Rakes and lutes used for hand spreading shall be type designed for use on asphalt mixtures. Do not dump loads faster that they can be properly spread. Workers shall not stand on loose mixture while spreading.

- C. Paving Machine Placement: Apply successive lifts of asphaltic concrete in transverse directions with surface course placed parallel to flow of traffic. Place asphaltic paving in typical strips not less than 10'-0" wide. Where thickness of finished paving will be greater than 3 inches, spread in equal lifts of 3 inch maximum and 1 inch minimum. Where the thickness of finished paving will be 3 inches or less, spread in one layer.
- D. Joints: Make joints between old and new pavements, or between successive days and work in manner that will provide continuous bond between adjoining work. Construction joints shall have same texture, density, and smoothness as other sections of asphaltic concrete course. Clean contact surfaces of joints and apply tack coat.

### 3.04 ROLLING AND COMPACTION

- A. Mixture, after being spread, shall be thoroughly compacted by rolling as soon as it will bear the weight of rollers without undue displacement. Number, weight, types of rollers, and sequences of rolling operations shall be such that the required density and surface are consistently attained while the mixture is in workable condition.
- B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
- C. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling with hot material.
- D. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.
- E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.
- F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphaltic concrete. Compact by rolling to maximum surface density and smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked. Any masked or marred finish surfaces shall be repaired or smoothed.

### 3.05 JOINTS

- A. General

1. Place each asphaltic paving layer as continuous as possible to keep the number of joints to a minimum. Create joints between old and new pavement, between successive days' work, and where the mixture has become cold (less than 140 degrees F). Make these joints in such a manner as to create a continuous bond between the old and new pavement construction courses.
  2. When the pavement construction involves 2 or more courses, offset successive courses by at least 6 inches.
- B. Transverse Joints: If placing of material is discontinued or if material in place becomes cold, make a joint running perpendicular to the direction traveled by the paver. Before placement continues, trim the edge of the previously placed pavement to a straight line perpendicular to the paver and cut back to expose an even vertical surface for the full thickness of the course. When placement continues, position the paver on the transverse joint so that sufficient hot mixture will be spread in order to create a joint after rolling that conforms to the required smoothness. If the temperature of the previously placed pavement material drops below 140 degrees F before paving is resumed, give the exposed vertical face a thin coat of liquid asphalt just before paving is continued.
- C. Longitudinal Joints: Coat longitudinal joints that are not completed before the previously laid mixture has cooled to a temperature below 140 degrees F, with liquid asphalt just before paving is continued.

### 3.06 FIELD QUALITY CONTROL

- A. Asphaltic surface and base courses will be randomly cored at minimum rate of 1 core per 20,000 sq. ft of paving. However, a minimum of 3 cores in light duty areas and 3 cores in heavy-duty areas shall be obtained. Coring holes shall be immediately filled with full-depth asphaltic concrete. Asphaltic concrete pavement samples will be tested for conformance with mix design.
- B. Testing will be performed on finished surface of each asphalt concrete course for smoothness, using 10'-0" straightedge applied parallel with, and at right angles to centerline of paved area. Results of failed tests will be sent to Wal-Mart Construction Manager within 24 hours. . Surfaces will not be accepted if the following 10-foot straightedge tolerances for smoothness are exceeded:
- |                         |          |
|-------------------------|----------|
| Base Course Surface:    | 1/4-inch |
| Wearing Course Surface: | 1/8-inch |
- C. Thickness Test: The average thickness of the course or the combined courses shall be within 1/4 inch of the indicated thickness. Where the deficiency is greater than the specified tolerance, remove the pavement and replace it with new pavement.
- D. Field density test for in-place materials shall be performed by examination of field cores in accordance with one of following standards:
1. AASHTO Test Method T 245 (Percent of Laboratory Density)
    - a. Temperature equal to temperature at paving machine with reheating.
    - b. Compactive blows (35, 50, or 75) equal to mix design blows.
    - c. Minimum density = 96% of laboratory density.

2. AASHTO Test Method T 209 (Percent of Theoretical Maximum Density)
  - a. Minimum density = 92% of Theoretical Maximum Density.
- E. Rate of density testing shall be 1 core per 20,000 sq. ft of pavement, with minimum of 3 cores from heavy-duty areas and 3 cores from light duty areas. Cores shall be cut from areas representative of project.
- F. Areas of insufficient compaction, smoothness and thickness shall be delineated, removed, and replaced in compliance with Specifications at no additional expense to Owner.

**END OF SECTION 321216**

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## SECTION 321218 - BASE COURSE

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Construction of granular base for asphaltic concrete and portland cement concrete paving.
- B. Construction of sand/shell base for asphaltic concrete and portland cement concrete paving.
- C. Construction of hot-mix sand asphalt base for asphaltic concrete paving.

#### 1.02 RELATED SECTIONS

- A. Section 312100 - Aggregate Materials
- B. Section 321216 - Asphaltic Concrete Paving
- C. Section 321314 - Portland Cement Concrete Paving
- D. Section 321723 – Pavement Markings
- D. Section 321315 - Curbs and Sidewalks
- E. Construction Drawings

#### 1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM) latest edition
  - 1. C136 Method For Sieve Analysis of Fine and Coarse Aggregates
  - 1. D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN.m/m<sup>3</sup>))
  - 2. D1557 Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft lbf/ft<sup>3</sup> (2,700 Kn.m/m<sup>3</sup>))
  - 3. D 2216 Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
  - 4. D 2487 Classification of Soils for Engineering Purposes
  - 5. D 2922 Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)
  - 6. D 3017 Water Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth)
  - 7. D 4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- B. State Highway Department Standard Specifications

#### 1.04 QUALITY ASSURANCE



- A. An independent testing laboratory, selected and paid by Owner, will be retained to perform construction testing of in-place base course for compliance with requirements for thickness, compaction, density, and tolerances. Paving base course tolerances shall be verified by rod and level readings on not more than 50-foot centers to be not more than 0.05-feet above design elevation which will allow for paving thickness as shown on Construction Drawings. Contractor shall provide instruments and suitable benchmark.
- B. Do not place aggregate when base surface temperature is less than 40 degrees F, nor when air temperature is below 45 degrees F. Do not place aggregate when surface is wet or frozen. Do not place aggregate when weather conditions are unfavorable otherwise.

## **PART 2 PRODUCTS**

### **2.01 FILL MATERIALS**

- A. Submit materials certificate to the independent testing laboratory that is signed by materials producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein or on the Construction Drawings.
- B. Dense Graded Aggregate conforming to NJDOT Standard Specifications Section 901.08 or approved equal.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Contractor shall verify to the Owner in writing that the subgrade has been inspected, tested, and gradients and elevations are correct, dry, and properly prepared in accordance with Section 312000.

### **3.02 CONSTRUCTION**

- A. Perform base course construction in a manner that will drain the surface properly and prevent runoff from adjacent areas from draining onto base course construction.
- B. Compact base material to not less than 98 percent of optimum density as determined by ASTM D 698 (or 95 percent of optimum density, as determined by ASTM D 1557) unless otherwise indicated on Construction Drawings.
- C. Granular Base: Construct to thickness indicated on Construction Drawings. Apply in lifts or layers not exceeding 8-inches, measured loose.
- D. Sand/Shell Base: Construct to thickness indicated on Construction Drawings. Apply in lifts or layers not exceeding 4-inches, measured loose.
- E. Asphalt Institute Type VI, VII, or VIII Mixes for Hot-mix Sand Asphalt Bases: Construct to thickness indicated on Construction Drawings. Apply in lifts or layers not exceeding 3-inches, measured loose.

**3.03 FIELD QUALITY CONTROL**

- A. Field density tests for in-place materials shall be performed in accordance with the following standard:
  - 1. Nuclear Method: ASTM D 2922 (Method B-Direct Transmission)
- B. Base material thickness: Perform 1 test for each 20,000 sq. ft. of in-place base material area.
- C. Base material compaction: Perform 1 test in each lift for each 20,000 sq. ft. of in-place base material area.
- D. The independent testing laboratory will prepare reports that indicate test location, elevation data, and test results. Owner and Contractor shall be provided with copies of the reports within 96 hours of the time the test was performed. In the event that the test results show failure to meet any of the Specifications; Owner and Contractor will be notified immediately by the independent testing laboratory.
- E. The Contractor shall pay for retesting due to failures at no additional expense to Owner. Contractor shall provide free access to the site for testing activities.

**END OF SECTION 321218**

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## SECTION 321314 - PORTLAND CEMENT CONCRETE PAVING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Preparation and placement of portland cement concrete parking areas.
- B. Preparation and placement of portland cement concrete roads and entrances.

#### 1.02 RELATED SECTIONS

- A. Section 321218 - Base Course
- B. Section 321723 - Pavement Markings
- C. Section 321315 - Curbs and Sidewalks
- D. Construction Drawings

#### 1.03 REFERENCE STANDARDS

- A. American Concrete Institute (ACI) latest edition
  - 1. 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
  - 2. 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete
  - 3. 305R Hot Weather Concreting
  - 4. 306R Standard Specification for Cold Weather Concreting
  - 3. 308 Standard Practice for Curing Concrete
- B. American Society for Testing and Materials (ASTM) latest edition
  - 1. A185 Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
  - 2. A615 Deformed and Plain Billet-Steel for Concrete Reinforcement
  - 3. C33 Concrete Aggregates
  - 4. C78 Method for Flexural Strength Concrete (Using Simple Beam with Third-point Loading)
  - 5. C94 Ready-Mixed Concrete
  - 6. C143 Method for Slump of Hydraulic Cement Concrete
  - 7. C150 Portland Cement
  - 8. C171 Sheet Material for Curing Concrete
  - 9. C231 Air-Content of Freshly Mixed Concrete by the Pressure Method
  - 10. C260 Air-Entraining Admixtures for Concrete
  - 11. C309 Liquid Membrane-Forming Compounds for Curing Concrete
  - 12. C494 Chemical Admixtures for Concrete
  - 13. C920 Standard Specification for Elastomeric Joint Sealants
  - 14. D994 Preformed Expansion Joint Filler for Concrete (Bituminous)

- 15. D1751 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- 16. D2628 Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements

C. State Highway Department Standard Specifications

#### 1.04 QUALITY ASSURANCE

- A. Establish and maintain required lines and elevations.
- B. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by Owner.

#### 1.05 SUBMITTALS

- A. Submit materials certificate from materials producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein to the Engineering Consultant of Record and the independent testing laboratory for review and approval and within 7 calendar days after receipt of Notice-to-Proceed, submit for approval, certified laboratory test data or manufacturers certificates and data for the following items:
  - 1. Portland cement concrete mix
  - 2. Aggregate gradations
  - 3. Preformed expansion joint filler
  - 4. Field molded/poured sealant
  - 5. Dowel bars
  - 6. Expansion sleeves
  - 7. Tie bars
  - 8. Reinforcing steel bars
  - 9. Welded wire fabric
  - 10. Air entraining admixtures
  - 11. Water-reducing and set-retarding admixtures (if used)

#### 1.06 PROJECT CONDITIONS

- A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

### **PART 2 PRODUCTS**

#### 2.01 MATERIALS

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. Coat forms with nonstaining type of coating that will not discolor or deface surface of concrete.

- B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185. Furnish in flat sheets.
- C. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 60.
- D. Portland Cement: Shall conform to ASTM C150, Type I
- E. Joint Fillers: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D994, D1751, D2628; FS HH-F-341, Type II, Class A or approved equal.
- F. Joint Sealants: Conforming to ASTM C920, non-priming, pourable, self-leveling polyurethane. Acceptable sealants are Sonneborn "SL1", Sonneborn "SL2", Sonneborn "Sonomeric 1", Sonneborn "Sonomeric 2", Mameco "Vulkem 245", or Woodmont Products "Chem-Caulk" or approved equal.
- G. Aggregate: Shall conform to ASTM C33.
- H. Water: Shall be clean and potable
- I. Dowel Bars: Shall conform to ASTM A615, grade 60, and plain steel bars.
- J. Air Entraining Mixture: Shall conform to ASTM C260 (Sika AER by Sika Corporation, Air Mix by the Euclid Chemical Corporation or approved equal).
- K. Curing Compound: Shall conform to ASTM C309 (Hydrocide by Sonneborn of Rexnord Chemical Products, Inc., and Polyseal 4 in 1 by Chem Masters Corporation or approved equal.
- L. Joint Backup Rods: Shall be CCEVA Rod 100 by E-Poxy Industrials, Inc., Sealtight BACKER ROPE by W.R. Meadows, Inc. or approved equal.

## 2.02 MIX DESIGN AND TESTING

- A. Mix concrete and deliver in accordance with ASTM C94.
- B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce following properties:
  - 1. Compressive Strength: 3,500 psi, minimum at 28 days, unless otherwise indicated on Construction Drawings.
  - 2. Slump Range: 2"-4" for hand placed concrete, 1-1/4" to 3" for machine placed (slipform) concrete
  - 3. Air Entrainment: 5 to 8 percent

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Proofroll prepared base material surface to check for unstable areas. Paving work shall begin only after unsuitable areas have been corrected and are ready to receive paving.
- B. Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

### **3.02 INSTALLATION**

- A. Form Construction
  - 1. Set forms to required grades and lines, rigidly braced and secured.
  - 2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place minimum of 24 hours after concrete placement.
  - 3. Check completed formwork for grade and alignment to following tolerances:
    - a. Top of forms not more than 1/8-inch in 10'-0"
    - b. Vertical face on longitudinal axis, not more than 1/4-inch in 10'-0"
  - 4. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.
- B. Reinforcement: Fasten reinforcing bars or welded wire fabric (if required) accurately and securely in place with suitable supports and ties. Remove from reinforcement all dirt, oil, loose mill scale, rust, and other substances that will prevent proper bonding of the concrete to the reinforcement.
- C. Concrete Placement
  - 1. Concrete may be mixed and placed when the air temperature in the shade and away from artificial heat is a minimum of 35 degrees F and rising. Hot and cold weather concreting shall be in accordance with ACI 305R and 306R, respectively.
  - 2. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Concrete shall not be placed around manholes or other structures until they are at required finish elevation and alignment.
  - 3. Place concrete using methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
  - 4. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place construction joint.
- D. Joint Construction: Construct expansion, weakened-plane control (contraction), and construction joints straight with face perpendicular to concrete surface. Construct transverse joints perpendicular to centerline, unless otherwise detailed.

1. Weakened-Plane Control or Contraction Joints: Provide joints at spacing of 15'-0" on centers, maximum each way. Construct control joints for depth equal to at least 1/4 of the concrete thickness, as follows:
    - a. Form tooled joints in fresh concrete by grooving top with recommended tool and finishing edge with jointer.
    - b. Form sawed joints using powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into hardened concrete as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.
  2. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for period of more than 1/2 hour, except where such placements terminate at expansion joints. Construct joints using standard metal keyway-section forms.
  3. Transverse Expansion Joints: Locate expansion joints at maximum of 180'-0" on centers, maximum each way unless otherwise shown on the Construction Drawings. Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, sidewalks, and other fixed objects.
  4. Butt Joints: For joints against existing pavement, place 16" long dowels eight inches into holes drilled into center of existing slab. Epoxy dowels into holes with approved epoxy compound. Place dowels prior to concrete placement for new concrete. Dowel spacing to be 24" on center unless otherwise shown on Construction Drawings. Saw joint and fill with joint sealer.
- E. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2-inch or more than 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in 1-piece lengths for full width being placed, wherever possible. Where more than 1 length is required, lace or clip joint filler sections together.
- F. Joint Sealants: Joints shall be sealed with approved exterior pavement joint sealants and shall be installed in accordance with manufacturer's recommendations.

### 3.03 CONCRETE FINISHING

- A. After striking off and consolidating concrete, smooth surface by screeding and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10'-0" straightedge. Distribute concrete as required to remove surface irregularities and refloat repaired areas to provide continuous smooth finish.
- B. Work edges of slabs and formed joints with edging tool, rounding edge to 1/2-inch radius. Eliminate tool marks on concrete surface. After completion of floating and trowelling, when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:
  1. Inclined Slab Surfaces: Provide coarse, nonslip finish by scoring surface with stiff-bristled broom perpendicular to flow of traffic so as to produce regular corrugations not over 1/16 of an inch deep.
  2. Paving: Provide coarse, nonslip finish by scoring surface with stiff-bristled broom perpendicular to flow of traffic so as to produce regular corrugations not over 1/16 of an inch deep.

- C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Owner.
- D. Protect and cure finished concrete paving using acceptable moist-curing methods, more particularly described in "water-curing" section of ACI 308.

**3.04 CLEANING AND ADJUSTING**

- A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

**3.05 FIELD QUALITY CONTROL**

- A. The independent testing laboratory will randomly core pavement at minimum rate of 1 core per 20,000 sq. ft of pavement, with minimum of 3 cores from heavy-duty areas and 3 cores from light duty areas. Core will be tested for thickness and quality of aggregate distribution. Core holes shall be patched immediately with portland cement concrete and shall be finished to provide level surface as specified herein.

**END OF SECTION 321314**

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## SECTION 321315 - CURBS AND SIDEWALKS

### PART I GENERAL

#### 1.01 SECTION INCLUDES

- A. Preparation and placement of combination portland cement concrete curb and gutter.
- B. Preparation and placement of portland cement concrete curb.
- C. Preparation and placement of portland cement concrete sidewalk.

#### 1.02 RELATED SECTIONS

- A. Section 321218 - Base Course
- B. Section 321216 – Asphaltic Concrete Paving
- C. Section 321723 – Pavement Markings
- D. Construction Drawings

#### 1.03 REFERENCE STANDARDS

- A. American Concrete Institute (ACI) latest edition
  - 1. 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
  - 2. 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete
  - 3. 305R Hot Weather Concreting
  - 4. 306R Standard Specification for Cold Weather Concreting
  - 3. 308 Standard Practice for Curing Concrete
- B. American Standards for Testing and Materials (ASTM) latest edition
  - 1. A185 Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
  - 2. A615 Deformed and Plain Billet-Steel for Concrete Reinforcement
  - 3. C33 Concrete Aggregates
  - 4. C78 Method for Flexural Strength Concrete (Using Simple Beam with Third-point Loading)
  - 5. C94 Ready-Mixed Concrete
  - 6. C143 Method for Slump of Hydraulic Cement Concrete
  - 7. C150 Portland Cement
  - 8. C171 Sheet Material for Curing Concrete
  - 9. C231 Air-Content of Freshly Mixed Concrete by the Pressure Method
  - 10. C260 Air-Entraining Admixtures for Concrete
  - 11. C309 Liquid Membrane-Forming Compounds for Curing Concrete
  - 12. C494 Chemical Admixtures for Concrete
  - 13. D994 Preformed Expansion Joint Filler for Concrete (Bituminous)
  - 14. D1190 Concrete Joint Sealer, Hot Poured, Elastic Type

- 15. D1751 Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
- 16. D2628 Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements

C. State Highway Department Standard Specifications

1.04 QUALITY ASSURANCE

- A. Establish and maintain required lines and elevations.
- B. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable work as directed by Owner.

1.05 SUBMITTALS

- A. Submit materials certificate which materials producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein to the Engineering Consultant of Record and the independent testing laboratory for review and approval for the following items:

With 7 calendar days after receipt of Notice-to-Proceed, submit for approval, certified laboratory test data or manufacturers certificates and data for the following items:

- 1. Portland cement concrete mix
- 2. Aggregate gradations
- 3. Preformed expansion joint filler
- 4. Field molded/poured sealant
- 5. Dowel bars
- 6. Expansion sleeves
- 7. Tie bars
- 8. Reinforcing steel bars
- 9. Welded wire fabric
- 10. Air entraining admixtures
- 11. Water-reducing and set-retarding admixtures (if used)

1.06 PROJECT CONDITIONS

- A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

**PART 2 PRODUCTS**

2.01 MATERIALS

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. Forms shall be of depth equal to

depth of curbing or sidewalk, and so designed as to permit secure fastening together at tops. Coat forms with nonstaining type of coating that will not discolor or deface surface of concrete.

- B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185. Furnish in flat sheets.
- C. Reinforcing Steel: Deformed steel bars, ASTM A 615, Grade 60.
- D. Portland Cement: Shall conform to ASTM C150, Type I
- E. Joint Fillers: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D994, D1751, D2628; FS HH-F-341, Type II, Class A or approved equal.
- F. Joint Sealants: Conforming to ASTM D1190, non-priming, pourable, self-leveling polyurethane. Acceptable sealants are Sonneborn "Sonolastic Paving Joint Sealant", Sonneborn "Sonomeric CT 1 Sealant", Sonneborn "Sonomeric CT 2 Sealant", Mameco "Vulken 245", or Woodmont Products "Chem-Caulk" or approved equal.
- G. Aggregate: Shall conform to ASTM C33.
- H. Water: Shall be clean and potable
- I. Dowel Bars: Shall conform to ASTM A615, grade 60, and plain steel bars.
- J. Air Entraining Mixture: Shall conform to ASTM C260 (Sika AER by Sika Corporation, Air Mix by the Euclid Chemical Corporation or approved equal).
- K. Curing Compound: Shall conform to ASTM C309 (Hydrocide by Sonneborn or Rexnord Chemical Products, Inc., and Polyseal 4 in 1 by Chem Masters Corporation or approved equal.
- L. Joint Backup Rods: Shall be CCEVA Rod 100 by E-Poxy Industrials, Inc., Sealtight BACKER ROPE by W.R. Meadows, Inc. or approved equal.

## 2.02 MIX DESIGN AND TESTING

- A. Mix concrete and deliver in accordance with ASTM C94.
- B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce following:
  - 1. Compressive Strength: 4,000 psi, minimum at 28 days, unless otherwise indicated on Construction Drawings.
  - 2. Slump Range: 2"-3" for hand placed concrete, 1-1/4" to 3" for machine placed (slipform) concrete
  - 3. Air Entrainment: 5 to 7 percent

## **PART 3        EXECUTION**

### **3.01    PREPARATION**

- A.     Proofroll prepared base material surface to check for unstable areas. Begin paving work only after unsuitable areas have been corrected and are ready to receive paving.
- B.     Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

### **3.02    INSTALLATION**

- A.     Form Construction
  - 1.     Set forms to required grades and lines, rigidly braced and secured.
  - 2.     Install sufficient quantity of forms to allow continuance of work and so that forms remain in place minimum of 24 hours after concrete placement.
  - 3.     Check completed formwork for grade and alignment to following tolerances:
    - a.     Top of forms not more than 1/8-inch in 10'-0"
    - b.     Vertical face on longitudinal axis, not more than 1/4-inch in 10'-0"
  - 4.     Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.
- B.     Reinforcement: Fasten reinforcing bars or welded wire fabric (if required) accurately and securely in place with suitable supports and ties. Remove from reinforcement all dirt, oil, loose mill scale, rust, and other substances that will prevent proper bonding of the concrete to the reinforcement.
- C.     Concrete Placement
  - 1.     Concrete may be mixed and placed when the air temperature in the shade and away from artificial heat is a minimum of 35 degrees F and rising. Hot and cold weather concreting shall be in accordance with ACI 305R and 306R, respectively.
  - 2.     Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until set at required finish elevation and alignment.
  - 3.     Place concrete using methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
  - 4.     Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place construction joint. Automatic machine may be used for curb and gutter placement. Machine placement shall be at required cross section, line, grade, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified herein.
- D.     Joint Construction

1. Contraction Joints: Construct concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, in uniform sections of length specified on Construction Drawings. Form joints between sections either by steel templates, 1/8-inch in thickness, of length equal to width of curb and gutter, and with depth which will penetrate at least 2-inches below surface of curb and gutter; or with 3/4-inch thick performed expansion joint filler cut to exact cross section of curb and gutter; or by sawing to depth of at least 2-inches while concrete is between 4 and 24 hours old. If steel templates are used, they shall be left in place until concrete has set enough to hold it's shape, but shall be removed while forms are still in place.
  2. Longitudinal Construction Joints: Tie concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, to concrete pavement with 1/2-inch round deformed reinforcement bars of length and spacing shown on Construction Drawings.
  3. Transverse Expansion Joints: Concrete curb, combination concrete curb and gutter, or concrete sidewalk shall have filler cut to exact cross section of curb, gutter, or sidewalk. Joints shall be similar to type of expansion joint used in adjacent pavement.
- E. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2-inch or more than 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in 1-piece lengths for full width being placed, wherever possible. Where more than 1 length is required, lace or clip joint filler sections together.
- F. Joint Sealants: Seal joints with approved exterior pavement joint sealants. Install in accordance with manufacturer's recommendations.

### 3.03 CONCRETE FINISHING

- A. After striking off and consolidating concrete, smooth surface by screeding and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10'-0" straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.
- B. Work edges of sidewalks, gutters, back top edge of curb, and formed joints with edging tool, rounding edge to 1/2-inch radius. Eliminate tool marks on concrete surface. After completion of floating and trowelling, when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:
1. Curbs, gutters, and sidewalks: Broom finish by drawing fine-hair broom across surface perpendicular to flow of traffic. Repeat operation as necessary to produce fine line texture.
- C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up minor honeycombed areas. Remove and replace areas or sections with major defects, as directed Owner.
- D. Protect and cure finished concrete paving using acceptable moist-curing methods, more particularly described in "water-curing" section of ACI 308.

### 3.04 BACKFILL

- A. After concrete has set sufficiently, spaces on either side of concrete curb, combination concrete curb and gutter, or concrete sidewalk shall be refilled to required elevation with suitable material compacted in accordance with Section 312000.

**3.05 CLEANING AND ADJUSTING**

- A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

**END OF SECTION 321315**

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## **SECTION 321373 - CONCRETE PAVEMENT JOINT SEALANTS**

### **PART 1 – GENERAL**

#### **1.01 SCOPE OF WORK**

- A. Provide labor, materials, equipment and services, and perform operations required for installation of sealants/site and related work as indicated on the drawings or specified herein.
- B. Work Included: The work of this Section shall include, but not be limited to, the following:
  - 1. Exterior weather joints between similar and dissimilar materials.
  - 2. Exterior horizontal traffic joints.
- C. The words ‘caulking’ and ‘sealant’ shall be considered synonymous on the Contract Documents. It shall be understood that both words define materials for sealing joints or seams watertight.

#### **1.02 QUALITY ASSURANCE**

- A. Materials shall conform to the latest edition of reference specifications listed below, specified herein and to applicable codes and requirements of local authorities having jurisdiction. Work and installation shall conform to ASTM C962.
- B. Qualifications: Installer of sealants shall have a minimum of five (5) years of successful experience in the application of the type of materials specified in this section and only skilled workmen shall be used for the work.

#### **1.03 SUBMITTALS**

- A. Product Data: Copies of manufacturer’s latest published literature for all materials specified herein shall be submitted before materials are delivered to the site.
- B. Schedule of Sealant Usage: Submit a detailed schedule of all locations of sealant usage. List each sealant material, joint filler(s), color(s) and related data for each location of use.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to the site, in original unopened containers, clearly indicating manufacturer's name, brand name, and other identifying information.
- B. Materials shall be stored in a dry location, off the ground and in such a manner as to prevent freezing, damage and the intrusion of foreign matter.
- C. Materials which have become damaged or otherwise unfit for use during delivery, or storage, shall be replaced at the expense of the Contractor.

1.05 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with installation of joint sealers under the following conditions:
  - 1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturers.
  - 2. When joint substrates are wet due to rain, frost, condensation, or other causes.
- B. Joint Width Conditions: Do not proceed with installation of joint sealers where joint widths are less than allowed by the joint sealant manufacturer for the application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.
- D. Joint Design: Joint widths indicated within the Contract Documents are detailed at their "Designed Width", which is when the joint would be at the average air temperature of 70 degrees F. Installation shall take into account the ambient temperature range at the time of respective installation and operation.
  - 1. Joint materials shall perform over a ambient air temperature range of 120 degrees F. and a surface temperature range of 180 degrees F.

1.06 WARRANTY

- A. The Contractor shall execute and deliver to the Owner before final payment is made, a written warranty in a satisfactory form, stating that labor and materials furnished, and work performed by the Contractor are in accordance with the Contract Documents and authorized alterations and additions thereto; and that, should any defects develop during the warranty period, the Contractor shall upon written notice from the Architect or Owner, replace or satisfactorily repair such defects, including adjustments to adjacent work, as required; at the convenience of, and without expense to the Owner. Contractor shall warranty work for Five (5) years from date of final acceptance.



## **PART 2 – PRODUCTS**

### **2.01 SEALANT MATERIALS**

- A. General: Provide a complete system of cleaners, primers, fillers, tapes, backer rods and tapes and sealants in accordance with the manufacturer's requirements and the standards specified herein.
  - 1. Color of Sealants: For concealed joints provide manufacturer's standard color which has the best overall performance qualities for the application shown. For exposed joints the Architect will select colors from the manufacturer's standard colors or special colors as specified elsewhere.
- B. Elastomeric Compounds
  - 1. Multi-Component Polyurethane (Sealant Type 1): ASTM C920, class and use as best suited for the intended purpose. Products meeting these requirements are:
    - a. "DYmeric" by Tremco.
    - b. "Dynatrol II by Pecora Corp.
    - c. "Sonolastic NP II" by Sonneborn Building Products.
    - d. Or approved equal.
  - 2. Self-Leveling Traffic Bearing (Sealant Type 2): ASTM C920, self-leveling, two-part polyurethane compound, with a Shore A cured hardness of 35 plus or minus 5. Sealant shall have a joint movement capability of plus/minus 50 percent.
    - a. "Sonolastic 2C SL" by Sonneborn Building Products
    - b. "Sikaflex 12SL" by Sika Corp.
    - c. "Urexpan NR-20 1' by Pecora Corp.
    - d. Or approved equal.

### **2.02 JOINT FILLER MATERIALS**

- A. Compressible Rod (Filler Type 1): Types as shown, or as required for proper performance of the sealant in the specific joint, which is compatible with sealant, as recommended by sealant manufacturer. One of the following:
  - 1. Closed Cell Polyethylene Foam Rod: One of the following:
    - a. "Tremco Joint Backing" (Tremco).
    - b. "Green-Rod Polyethylene Backer Rod" (Nomaco, Inc.).

- c. “HBR Backer Rod” (Hercules, Inc.).
  - d. “Sonofoam Back Rod” (Sonneborn Building Products).
  - e. Or approved equal.
- 2. Open Cell Polyurethane Rod: “Denver Foam” as distributed by Pecora Chemical Corp. or Woodmont Products Inc.
- B. Preformed Sponge Rubber or Cork (Filler Type 2): ASTM D1752, Type I, II or III; type best suited for joint condition.
- C. Closed Cell Neoprene (Filler Type 3): ASTM D1056, Type S, Class SCE.
- D. Closed Cell Polyethylene (Filler Type 5): Not less than 3 psi for 25% compression resistance, highly resistant to petroleum oils and solvents, one of the following:
  - 1. “Expand-O-Foam” (Williams Products, Inc.).
  - 2. “Filler Foam Gasket FF4” (Progress Unlimited Inc.)
  - 3. “Tremco Joint Backing” (Tremco)
  - 4. Or approved equal.
- E. Select shape and size of joint filler in consultation with the manufacturer for proper performance in the specific condition of use in each case.

## 2.03 MISCELLANEOUS MATERIALS

- A. Joint Cleaner: Provide non-staining cleaner recommended by the manufacturer of the sealant for the specific joint surface and condition.
- B. Joint Primer and Sealer: Provide non-staining compounds recommended by the manufacturer of the sealant for the specific joint surface and condition. Primers and cleaners shall not damage applied metal finishes
- C. Bond Breaker Tape: Pressure sensitive polyethylene tape.
- D. Vent Tubes: Vent tubes (weep holes) shall be heat-bendable acrylic tubes.

## **PART 3 – EXECUTION**

### 3.01 EXAMINATION

- A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

### 3.02 PREPARATION

- A. Comply with the sealant manufacturers requirements for all preparations.
  - 1. Comply with conditions specified herein before in Paragraph “Project Conditions”.
- B. Clean out joints to receive sealant, backup material or preformed joint filler to comply with recommendations of approved manufacturer and as specified herein.
  - 1. Thoroughly clean joints, removing foreign matter such as dust, oil, grease, water, surface dirt and frost. Sealant must be applied to the base surface. Previously applied paint, film sealers, or coatings shall be entirely removed unless tested and approved by the sealant manufacturer for adhesion.
  - 2. Porous materials such as concrete and masonry shall be cleaned where necessary by grinding, water blast-cleaning, mechanical abrading, or combination of these methods as required to provide a clean, sound base surface for sealant adhesion.
    - a. Clean masonry surfaces with water and air; do not use any acid or other material which might stain surfaces.
    - b. Remove laitance and form release agents from concrete.
    - c. Remove loose particles present or resulting from grinding, abrading or blast-cleaning by blowing out joints with compressed air, oil free or vacuuming joints prior to application of primer or sealant.
  - 3. Clean and remove protective coatings on metallic surfaces as recommended by sealant manufacturer. Clean joint areas protected with masking tape or strippable films as above after removal of tape film.

### 3.03 INSTALLATION

- A. Comply with the sealant manufacturers requirements for all preparations.
  - 1. Comply with conditions specified herein before in Paragraph “Project Conditions
  - 2. Do not begin sealant operations if the work does not in comply with Contract Documents and the sealant manufacturer’s recommendations.
- B. Joint Fillers: Install joint fillers beneath all sealants.
  - 1. Perform work in strict accordance with manufacturer’s instructions.
  - 2. Employ mechanics skilled in this trade and proficient in the installation of specified sealant materials.
  - 3. Install joint filler materials when temperature is between 25 degrees F and 95 degrees F.
  - 4. For facade and traffic bearing conditions, foam sealant shall be at compression of 25 percent of uncompressed dimension. Depth of joint seal shall be in accordance

with manufacturer's requirements. Prior to installation, size of joint and sizing of seal shall be reviewed having regard to ambient temperature and expected thermal movement.

C. Sealants

1. Prime joint substrates where recommended by joint sealer manufacturer based upon the completion of a preconstruction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond, do not allow spillage or migration onto adjoining surfaces or exposed surfaces.
2. Use masking tape or other materials to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove as soon as possible after tooling sealant without disturbing joint seal.
3. In joints where depth of joint exceeds required depth of sealant, install joint backing (after primer is dry) in joints to provide backing and proper joint shape for sealant. Proper shape for sealant is a very slight concave curvature. Use special blunt T-shaped tool or roller to install joint backing to the proper and uniform depth required for the sealant. Joint backing shall be installed with approximately 30 percent compression. Do not stretch, twist, braid, puncture, or tear joint backing: Butt joint backing at intersections.
4. Install bond breaker smoothly over surfaces that would bond to sealant and at back of joints where joint backing is not required, so that sealant adheres only to the sides of the joint and not back surfaces nor backing.
5. It is recommended that sealant be installed when the average daily air temperature is 70 degrees F (plus/minus 5 degrees F), when joint should be at its Designed Width. When average daily temperature is lower or higher than this range Contractor shall perform work in strict accordance with sealant manufacturer's recommendations.
6. Apply sealant in accordance with the manufacturer's application manual and manufacturer's instructions, using hand guns or pressure equipment, on clean, dry, properly prepared substrates. Sealant application shall be such to ensure complete contact and adhesion to sides of joints. Temperature of sealant, as well as of substrates, at time of sealant application, shall be as recommended by sealant manufacturers. Refer to Paragraph "Job Conditions". Force sealant into joint in front of the tip of the "caulking gun" (not pulled over it) and force sealant against sides to make uniform contact with sides of joint and to prevent entrapped air or pulling of sealant off of sides. Fill sealant space solid with sealant.
7. Tool exposed joints to form smooth and uniform beds, with slightly concave surface. Finished joints shall be straight, uniform, smooth and neatly finished. Remove masking tape immediately after tooling of sealant and before sealant face starts to "skin" over. Neatly remove any excess sealant from adjacent surfaces of joint, leaving the work in a neat, clean condition.

**3.04 LOCATIONS OF USE**

- A. Sealants: Provide sealants in accordance with the following locations of use:
  - 1. Provide Sealant (Type 1) for all exterior weather seals and movement joints.
  - 2. Provide Sealant (Type 2) for all exterior paving joints.
- B. Joint Filler Materials: Provide joint fillers or tapes at all locations of sealant use as follows:
  - 1. Provide backer rods (Filler Type 1) at all joints to be sealed.
  - 2. Provide backer rods and joint fillers behind all horizontal joints and horizontal lengths of joints.
  - 3. Provide bond breaker tape at all joints indicated on the Drawings to have no backer rod and at joints as required by the sealant manufacturer.

**3.05 FIELD QUALITY CONTROL**

- A. Work under this section shall be subject to detailed inspection. Any sealants found out of plumb or cracking or backer rod or joint fillers found out of plumb or displaced by caulking operations or any work otherwise defective, or work not in accordance with specifications and details, shall be taken out and replaced to the complete satisfaction of the Architect, at no additional cost to the Owner.

**3.06 CLEANING AND PROTECTION**

- A. Upon completion of the work, unused materials, containers, equipment, masking tape or protective measures, etc., shall be removed from the site. Floors, walls and other adjacent surfaces, that are stained or damaged by work of this section, shall be repaired and adjacent surfaces shall be left in a clean and undamaged condition.
- B. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

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**END OF SECTION 321373**

## SECTION 321723 - PAVEMENT MARKINGS

### PART 1 GENERAL

#### 1.01 SCOPE OF WORK

This work shall consist of applying or removing white or yellow traffic paint and glass beads on bituminous concrete and Portland cement concrete pavement.

Removal of traffic stripes and markings consists of the removal of white or yellow stripes or solid areas, letters, arrows, and other symbols from bituminous concrete and Portland cement concrete surfaces.

- A. Pavement Stripes or Markings
- B. Surface Preparation
- C. Opening to Traffic
- D. Removal of Traffic Stripes or Traffic Paint

#### 1.02 RELATED SECTIONS AND DOCUMENTS

- A. Section 321724 – Traffic Control Signage

#### 1.03 REFERENCES

- A. Reference to the New Jersey Department of Transportation, Standard Specifications for Road and Bridges Construction 1996.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

All pavement striping and markings on temporary on-site roadway and parking areas shall be Latex Traffic Paint. All striping on permanent on-site roadway and parking areas shall be Epoxy Resin stripes. All pavement markings on permanent on-site roadway and parking areas shall be Thermoplastic markings.

- A. Pavement Stripes or Markings Paint
  - 1. Latex Traffic Paint. Latex traffic paint for traffic stripes or traffic marking shall be white or a yellow ready-mixed pigmented binder which is emulsified in water and capable of anchoring reflective glass beads which are separately applied. In addition the paint shall not contain any of the materials listed in the EPA code of regulations (CFR) 40, section 261.24 Table 1.

Manufactures of latex paint shall have produced, to the satisfaction of the Department's Bureau of Materials, a fast-drying traffic paint, which meets the following requirements:

- a. Composition

- b. Pigment
- c. Nonvolatile Vehicle
- d. Physical Properties
  - 1) Color
  - 2) Organic Volatile
  - 3) Volume of Solids
  - 4) Total Solid
  - 5) Liter Weight
  - 6) Grind
  - 7) Field No-Tracking Time
  - 8) Viscosity
  - 9) Flexibility
  - 10) Dry Opacity
  - 11) Daylight Reflectance
  - 12) Abrasion Resistance
  - 13) Water Resistance
  - 14) Freeze-Thaw Stability
  - 15) Heat Stability
  - 16) Dilution Test
  - 17) Dry Through (Early Washout)
  - 18) Color Appearance After Aging
  - 19) Shelf Life
  - 20) Packaging

2. Alkyd Traffic Paint. Alkyd traffic paint for traffic stripes or traffic markings shall be a white or a yellow ready-mixed pigmented binder which is a solvent-borne, high solid, lead free formulation capable of anchoring reflective glass beads which are separately applied. The paint shall not contain methylene chloride or 1,1,1-trichloroethane.

Manufacturers of alkyd paint shall have produce, to the satisfaction of the Department's Bureau of Materials, a fast-drying traffic paint, which meets the following requirements:

- a. Composition
- b. Pigment
- c. Vehicle
- d. Physical Properties
  - 1) Color
  - 2) Organic Volatile
  - 3) Total Solids
  - 4) Liter Weight
  - 5) Grind
  - 6) Drying Time
  - 7) Viscosity
  - 8) Flexibility
  - 9) Dry Opacity
  - 10) Daylight Reflectance
  - 11) Abrasion Resistance
  - 12) Water Resistance

- 13) Bleeding Resistance
- 14) Heat Stability
- 15) Color Appearance After Aging
- 16) Shelf Life
- 17) Packaging

B. Long-Life Epoxy Resin Traffic Stripes.

Epoxy resin compound shall be specifically formulated for use as a long-life pavement striping material and for hot-spray application at elevated temperature. Long-life epoxy resin traffic stripes placed on the project with material that fails to comply with the following requirements shall be removed and replaced according to Subsection 618.10:

2.02 EQUIPMENT

The epoxy striping until shall be so designed, equipped, maintained, and operated that the material is properly applied in variable widths at consistent temperature. The equipment for applying thermoplastic material shall be capable of providing continuous mixing and agitation of the material. All equipment for applying traffic stripes or traffic markings shall be equipped with glass bead dispensers of a type that will mechanically and automatically dispense beads uniformly on wet stripes or markings at the rates specified.

Equipment for removing the various types of traffic stripes or traffic markings shall be designed with a vacuum system to remove all millings from the pavement surface and prevent airborne residue from escaping into the atmosphere.

**PART 3 EXECUTION**

3.01 SURFACE PREPARATION

Contractor shall remove, immediately prior to striping or marking the pavement surface, all dirt, oil, grease, existing types of traffic stripes or traffic marking, and other foreign material, including curing compound on new Portland cement concrete, from the surface areas on which the various traffic stripes or traffic marking are to be placed. The pavement shall be cleaned 25 millimeters beyond the perimeter of where the stripe or marking is to be placed.

Contractor shall apply a primer-sealer conforming to NJDEP volatile organic content (VOC) requirements to the area of bituminous concrete surface, when recommended by the manufacture, and to the areas of Portland cement concrete surfaces where long-life thermoplastic traffic marking are to be placed.

3.02 APPLYING PAINT AND BEADS

Latex Traffic Paint. Contractor shall apply latex traffic stripes or traffic marking when the ambient and surface temperatures are above 7 degree C and rising. The Latex traffic paint shall be applied in a wet film thickness of  $150 \pm 25$  micrometers where traffic stripes are required for 14 days or less. The traffic paint shall be applied in a wet film thickness of  $380 \pm 25$  micrometers where traffic stripes or traffic stripes or marking are to be visible to traffic 15 days and beyond, or



when stripes or markings are to be placed on intermediate pavement layers to be opened to traffic due to stage construction.

Contractor shall apply glass beads, according to the gradation specified for latex traffic paint, to the wet paint in a uniform pattern and at the rate of for latex traffic paint, to the wet paint in a uniform pattern and at the rate of 1.4 kilograms per liter of paint.

When traffic stripes or traffic markings are required to remain visible beyond 14 days, Contractor shall apply, prior to acceptance and when directed, additional applications of latex traffic paint and glass beads. These applications shall be applied at least 15 days after the initial application and after any sawing or sealing of joints in the bituminous concrete overlay.

Alkyd Traffic Paint. Contractor shall apply alkyd traffic stripes or traffic marking when the ambient and surface temperatures are between 2 and 7 degree C and rising. The alkyd traffic paint shall be applied in a wet film thickness of  $150 \pm 25$  micrometers where traffic stripes are required for 14 days or less. The traffic paint shall be applied in a wet film thickness of  $280 \pm 25$  micrometers where traffic stripes or traffic stripes or marking are to be visible to traffic 15 days and beyond, or when stripes or markings are to be placed on intermediate pavement layers to be opened to traffic due to stage construction.

Contractor shall apply glass beads, according to the gradation specified for alkyd traffic paint, to the wet paint in a uniform pattern and at the rate of for alkyd traffic paint, to the wet paint in a uniform pattern and at the rate of 0.7 kilograms per liter of paint.

When traffic stripes or traffic markings are required to remain visible beyond 14 days, Contractor shall apply, prior to acceptance and when directed, additional applications of latex traffic paint and glass beads. These applications shall be applied at least 15 days after the initial application and after any sawing or sealing of joints in the bituminous concrete overlay.

Long-Life Epoxy Resin Traffic Stripes. Contractor shall mix epoxy resin material with an automatic proportioning and mixing machine and hot-spray the compound at a temperature between 38 and 55 degree C onto thoroughly dry surface. The material shall only be placed during anticipated dry weather when the ambient temperature is a minimum of 7 degree C and the surface temperature is a minimum of 10 degree C. The temperature of the sprayed mixture shall be adjusted as required for prevailing conditions, including the air and pavement surface temperatures, to achieve a no-track drying time of 30 minutes or less. The epoxy resin mixture shall be applied in a wet film thickness of  $500 \pm 25$  micrometers.

Immediately after, or in conjunction with the epoxy resin application, Contractor shall apply large glass beads and small glass beads to the wet compound. Each type of beads shall be applied in a uniform pattern and each at a rate of 1.4 kilograms per liter of epoxy resin material.

Contractor shall remove all epoxy resin material that has been tracked or spilled in areas outside the intended placement areas.

Long-Life Thermoplastic Traffic Marking. Contractor shall apply either performed or hot extruded thermoplastic traffic markings using equipment and procedures that produce markings that are straight and have sharp edges; that are the specified color, width, and thickness; that have uniform retroreflectivity; and that are properly bonded to the pavement. The thermoplastic material shall be applied as follows:

1. Preformed Thermoplastic. Contractor shall place preformed thermoplastic traffic marking tape on thoroughly dry surfaces and during anticipated dry weather. The preformed thermoplastic tape shall be melted using the flame from a propane-type torch, according to the manufacturer's recommendations, to bond the traffic marking permanently in position.

If required, Contractor shall apply additional glass beads to the hot-wet material in a uniform pattern, to attain the minimum initial retroreflectance value specified in subsection 618.10 for thermoplastic tape.

2. Extruded Thermoplastic. Contractor shall heat the thermoplastic material uniformly and apply the melted material at a temperature between 205 and 220 degree C, to thoroughly dry surface and during anticipated dry weather, when the ambient and surface temperature are a minimum of 10 degree C. The thermoplastic traffic marking shall be extruded on the bituminous or Portland cement concrete pavement in a thickness of 2.3 millimeters.

Immediately after, or in conjunction with the thermoplastic application, Contractor shall apply, by mechanical means, glass beads to the wet material in a uniform pattern and a minimum rate of 0.5 kilogram per square meter of marking. Hand throwing of the beads will not be allowed.

### 3.03 OPENING TO TRAFFIC

Contractor shall complete each application of all types of traffic stripes or traffic markings and allows them to thoroughly dry before opening to traffic.

Should ambient and surface temperatures be below the minimums specified for various material, with approval, traffic stripes or traffic markings may be placed at temperatures as low as 2 degree C in order to open the traveled way to traffic. Placement of long-life epoxy resin or thermoplastic may be delayed for up to four days after paving.

As a minimum, center lines on undivided roadways and broken lines between lanes shall be delineated before the traveled way is opened. Unless directed, temporary pavement markers shall be used for the interim delineation until permanent stripes and markings are applied. Engineer will determine when the traveled way is to be opened to traffic.

### 3.04 REMOVAL OF TRAFFIC STRIPES OR TRAFFIC PAINT

Contractor shall remove all types of traffic stripes or traffic markings by methods that do not damage the integrity of the underlying pavement or adjacent pavement areas, and that do not cause gouging, or create ridges or grooves in the pavement that may result in compromising vehicular control. Obliterating stripes or markings by painting over them will not be permitted.

Before starting removal operations, Contractor shall demonstrate the proposed method to accomplish the removal of approximately 95 percent of the stripe or marking without the removal of more than 2 milliliters of pavement thickness. Area of removal includes the area of the stripe or marking plus 25 milliliters on all sides. Removal operations will not be permitted until the method have been approved.

Contractor shall replace all existing pavement reflectors that have been damaged by removal operations, at no cost to the State.

Debris from the removal of traffic stripes and markings shall be disposed of in accordance with subsection 201.10.

**END OF SECTION 321723**

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## SECTION 323113 - CHAIN LINK FENCES AND GATES

### PART I GENERAL

#### 1.01 SECTION INCLUDES

- A. Installation of chain link fences and gates units provided by single source including erection accessories, fittings, and fastenings.
- B. Refer to architectural building plans for fencing attached to building.

#### 1.02 RELATED SECTIONS

- B. Construction Drawings

#### 1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition
  - 1. A 116 Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric
  - 2. A 120 Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless, for Ordinary Uses
  - 3. A 121 Zinc-Coated (Galvanized) Steel Barbed Wire
  - 4. A 123 Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
  - 5. A 153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  - 6. A 392 Zinc-Coated Steel Chain-Link Fence Fabric
  - 7. A 428 Weight of Coating on Aluminum-Coated Iron or Steel Articles
  - 8. A 491 Aluminum-Coated Steel Chain Link Fence Fabric
  - 9. A 569 Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled, Sheet and Strip Commercial Quality
  - 10. A 585 Aluminum Coated Steel Barbed Wire
  - 11. C 94 Ready-Mixed Concrete
  - 12. F 668 Polyvinyl Chloride (PVC) Coated Steel Chain Link Fence Fabric
  - 13. F 567 Installation of Chain-Link Fence
  - 14. F 573 Residential Zinc-Coated Steel Chain Link Fence Fabric
- B. Chain Link Fence Manufacturers Institute (CLFMI) latest edition Product Manual

#### 1.04 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of property perimeter posts relative to property lines and easements.

**2.01    ACCEPTABLE MANUFACTURERS**

- A.    Subject to compliance with requirements, provide products of one of following:
  - 1.    Allied Tube and Conduit Corp.
  - 2.    Anchor Fence, Inc.
  - 3.    United States Steel
  - 4.    Or approved equal.

**2.02    MATERIALS**

- A.    Fabric:
  - 1.    No. 9 gage, 0.148"  $\pm$  0.00", finished size galvanized steel wires, 2-inch mesh, top and bottom selvages twisted and barbed conforming to ASTM A392, A491, F668, or F573.
  - 2.    Furnish 1-piece fabric widths for fencing.
- B.    End, Corner, and Pull Posts: Galvanized steel, minimum sizes and weights conforming to ASTM A120 as follows:
  - 1.    Up to 6'-0" Fabric Height: 2.5" pipe (2.375-inch OD), 3.12-pounds per lineal foot, or 3.5-inch x 3.5-inch roll-formed section, 4.85-pounds per lineal foot.
  - 2.    Over 6'-0" Fabric Height: 3.0" pipe (2.875-inch OD), 4.85-pounds per lineal foot, or 3.5-inch x 3.5-inch roll-formed section, 4.85-pounds per lineal foot.
- C.    Line Posts: Galvanized steel, minimum sizes and weights conforming to ASTM A120 as follows:
  - 1.    Up to 6'-0" Fabric Height: 2.0" pipe (1.90-inch OD), 2.28pounds per lineal foot or 1.875-inch x 1.625-inch C-section, 2.28-pounds per lineal foot.
  - 2.    Over 6'-0" to 8'-0" Fabric Height: 2.5" pipe (2.375-inch OD), 3.12-pounds per lineal foot or 2.25-inch x 1.875-inch H-section, 2.64-pounds per lineal foot.
  - 3.    Over 8'-0" Fabric Height: 3.0" pipe (2.875-inch OD), 4.85-pounds per lineal foot or 2.25-inch x 1.875-inch H-section, 3.26-pounds per lineal foot.
- D.    Gate Posts: Galvanized steel posts for supporting single gate leaf or 1 leaf of double gate installation, for nominal gate widths conforming to ASTM A120 as follows:
  - 1.    Up to 6'-0": 3.0" pipe (2.875-inch OD), 4.85-pounds per lineal foot, or 3.5-inch x 3.5-inch roll-formed section, 4.85-pounds per lineal foot.
  - 2.    Over 6'-0" to 13'-0": 4.00-inch OD pipe, 9.11-pounds per lineal foot.
- E.    Top Rail: Rails: 10" (1.66-inch OD), 1.84-pounds per lineal foot or 1.625-inch x 1.25-inch roll-formed sections, 1.35 -pounds per lineal foot; galvanized steel, manufacturer's longest lengths conforming to ASTM A120.
- F.    Couplings: Expansion type, approximately 6-inches long, for each joint.
- G.    Attaching Devices: Provide means for attaching top rail securely to each gate corner, pull, and end post.
- H.    Sleeves: Galvanized steel pipe not less than 6-inches long with inside diameter not less than 1/2-inch greater than outside diameter of pipe. Provide steel plate closure welded to

bottom of sleeve of width and length not less than 1-inch greater than outside diameter of sleeve.

- I. Tension Wire: 7 gage galvanized steel, coated coil spring wire, located at bottom of fabric conforming to ASTM A116.
- J. Wire Ties: Class 1 galvanized steel, no less than 9 gage.
- K. Post Brace Assembly: Manufacturer's standard adjustable brace at end of gate posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for brace, and truss to line posts with 0.375-inch diameter rod and adjustable tightener.
- L. Post Tops: Galvanized steel, weather tight closure cap for each tubular post. Furnish caps with openings to permit passage of top rail.
- M. Stretcher Bars: Galvanized steel, 1 piece lengths equal to full height of fabric, with minimum cross-section of 3/16-inch x 3/4-inch. Provide 1 stretch bar for each gate and end post, and 2 for each corner and pull post.
- N. Stretch Bar Bands: Manufacturer's standard
- O. Gate Cross-bracing: 3/8-inch diameter galvanized steel adjustable length truss rods.
- P. Ready Mix Concrete: ASTM C94, mix design as follows:
  - 1. Mix concrete and deliver in accordance with ASTM C94.
  - 2. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce following:
    - a. Compressive Strength: 3,500 psi, minimum at 28 days, unless otherwise indicated on Construction Drawings.
    - b. Slump Range: 1 to 3-inches at time of placement
    - c. Air Entrainment: 5 to 8 percent
- Q. Water: Clean
- R. Swinging Gate Hardware:
  - 1. Hinges: Size and material to suit gate size, non-lift-off type, offset to permit full 180 degree gate opening. Provide a pair of 1 1/2-inch hinges for each leaf over 6'-0" nominal height.
  - 2. Latch: Forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch.
- S. Double Gates Hardware: Provide gate stops for double gates, consisting of mushroom type of flush plate with anchors set in concrete, to engage center drop rod or plunger bar. Include locking device and padlock eye as integral part of latch, using 1 padlock for locking both gate leaves.

- T. Sliding Gate Hardware: Provide manufacturer's standard heavy-duty track, ball-bearing hanger sheaves, overhead framing and supports, guides, stays, bracing, and accessories as required.

### **PART 3 EXECUTION**

#### **3.01 GATE FABRICATION**

- A. Fabricate swing gate perimeter frames of 1.90-inch OD pipe, galvanized steel. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware, and accessories. Space frame members maximum of 8'-0" apart.
- B. Assemble gate frames by welding or special fittings and rivets, for rigid connections. Install same fabric as for fence with stretcher bars at vertical edges. Install diagonal cross-bracing on gates as required ensuring rigid frame without sag or twist. Bars may be used at top and bottom edges. Attach stretchers to gate frame at 15-inches o.c. maximum.
- C. Attach hardware to provide security against removal or breakage.

#### **3.02 FINISH**

- A. Fabric Finish: Galvanized, ASTM A 392, Class I, with not less than 1.2 oz zinc/sq. ft of surface.
- B. Framing: Galvanized steel, ASTM A120 or A123, with not less than 1.8 oz zinc/sq. ft of surface.
- C. Hardware and Accessories: Galvanized, ASTM A153 with zinc weights in accordance with Table I.

#### **3.03 CONCRETE MIXING**

- A. Mix materials to obtain concrete with minimum 28-day compressive strength of 2,500 psi; 1-inch maximum size aggregate, maximum 3-inch slump, and 2 - 4 percent entrained air.

#### **3.04 INSTALLATION**

- A. Comply with recommended procedures and instructions of fencing manufacturer. Provide secure, aligned installation with line posts spaced at 10'-0" o.c. maximum.
- B. Grade Set Posts: Drill or hand excavate using posthole digger in firm undisturbed or compacted soil.
- C. Excavate hole for each post to minimum diameter recommended by fence manufacturer but not less than 4 times the largest cross-section of post. Excavate hole depths not less than 36-inches below finish grade surface.
- D. Center and align posts in holes with bottom of posts 3-inches above bottom of excavation.

- E. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations. Extend concrete footing 2-inches above grade and trowel crown to shed water.
- F. Sleeve Set Posts: Anchor posts by means of pipe sleeves preset and anchored into concrete. After posts have been inserted into sleeves, fill annular space between post and sleeve solid with nonshrink, non-metallic grout, mixed and placed to comply with grout manufacturer's directions.
- G. Top Rails: Run rail continuously, bending to form radius for curved runs. Provide expansion couplings as recommended by manufacturer.
- H. Center Rails: Provide center rails where indicated. Install in 1 piece between posts and flush with post on fabric side, using special offset fittings where necessary.
- I. Brace Assemblies: Install braces so posts are plumb when diagonal rod are under proper tension.
- J. Tension Wire: Install tension wires through post cap loops before stretching fabric and tie to each post cap with not less than 6 gauge galvanized wire. Fasten fabric to tension wire using 11 gauge galvanized steel hog rings spaced 24-inches o.c.
- K. Fabric: Leave approximately 2-in. between finish grade and bottom selvage. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released.
- L. Stretcher Bars: Secure at end, corner, pull, and gate posts by threading through or clamping to fabric at 4-inches o.c., and secure to posts with metal bands spaced at 15-inches o.c.
- M. Tie Wires:
  - 1. Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly when ends twisted at least 2 full turns. Bend ends of wire to minimize hazard to persons or clothing.
  - 2. Tie fabric to line posts with wire ties spaced 12-inches o.c. Tie fabric to rails and braces with wire ties spaced 24-inches o.c. Tie fabric to tension wires with hog rings spaced 24-inches o.c.
  - 3. Manufacturer's standard procedure will be accepted if of equal strength and durability.
- N. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
- O. Gates: Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubrication.

### 3.05 MISCELLANEOUS INSTALLATION

- A. Use U-shape tie wires, conforming to the diameters of pipe, that clasp the pipe and fabric firmly with ends twisted at least 2 full turns.
  - 1. Bend ends of exposed wires to minimize hazards to persons or clothing.



2. Install nuts for fasteners on tension bands and hardware bolts on the side of the fence opposite the fabric. The ends of bolts, once secure and checked for smooth operation, shall be peened to prevent removal of nuts.
3. Repair coatings damaged in the field with methods and techniques as recommended by the manufacturer.

**3.06 WARRANTY**

1. A guarantee shall be furnished for all materials, installation, and workmanship to be free of defects for a period of 1 year from date of acceptance unless noted otherwise in the contract documents. Any defect in installation or workmanship shall be repaired, and defective materials shall be replaced during the guarantee period without any cost to the Owner.

**END OF SECTION 323113**

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## SECTION 323201 - CAST-IN-PLACE CONCRETE WALLS

### PART 1 - GENERAL

- A. The work covered in this Chapter shall include the construction of reinforced concrete retaining walls, only in the case that this wall type is selected for construction from the list of deduct/alternates.

#### 1.02 RELATED SECTIONS

- A. 31116.13 – Concrete Form Liners for Exterior Improvements
- B. 320523 – Cast In Place Concrete for Exterior Improvements
- C. 320522 – Concrete Reinforcing for Exterior Improvements

#### 1.03 REFERENCE STANDARDS

- A. ASTM C 90-75- Standard Specification for Loadbearing Concrete Masonry Units.
- B. ASTM C 140-75 - Standard Specification for Sampling and Testing Concrete Masonry Unit and Related Units
- C. ASTM D 638 - Standard Test Method for Tensile Properties of Plastic.
- D. ASTM D 1248 - Standard Specifications for Polyethylene Plastics Molding and Extrusion Materials, for Wire and Cable.

#### 1.04 REINFORCEMENT

- A. Reinforcement steel shall be free from excess rust, scale or other substances and shall be protected at all times from damage. All reinforcements shall be placed in the exact position shown in the plans, and shall be held securely in position by suitable means so they will not displace during the process of depositing or consolidating the concrete.

#### 1.05 FORMS

- A. Forms shall be of suitable material and of a type, size, shape, quality, and strength to insure construction as designed. The forms shall be true to line and grade, mortar tight, and sufficiently rigid to resist deflection during placing of the concrete. The responsibility for their adequacy shall rest with the Contractor. All dirt, chips, sawdust, nails, and other foreign matter shall be removed completely from forms before any concrete is deposited therein. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes that would deface the finished surfaces. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being reused. Before concrete is placed in forms, all inside surfaces of the forms shall be thoroughly treated with an approved releasing agent which will leave no objectionable film on the surface of the forms that can be absorbed by the concrete. Care shall be exercised that no releasing agent is deposited on previously placed concrete.

#### 1.06 RELATED SECTIONS

- A. Section 320521 - Concrete Forming for Exterior Improvements
- B. Section 320522 - Concrete Reinforcing for Exterior Improvements
- C. Section 320523 - Cast-In-Place Concrete For Exterior Improvements
- D. Section 320524 - Portland Cement Concrete For Exterior Improvements.

## **PART 2 - EXECUTION**

### **2.01 CONCRETE PLACEMENT**

- A. Before placing any concrete, all dirt and other debris shall be removed from the forms. Concrete shall be handled by methods which will prevent the separation or loss of ingredients and the formation of laitance. Concrete free fall distance shall not exceed 5 feet. This includes free fall in a discharge pipe when using a conveyor system for placement. Pumped concrete is not considered in free fall until the concrete exits the pumper hose. The concrete shall be placed in its final position, as nearly as possible, to avoid re-handling. The concrete shall be placed and thoroughly consolidated in level layers not exceeding 12 inches in thickness. Suitable means shall be provided to permit concrete to be placed in a manner which will avoid accumulations of dry or hardened concrete on the forms or reinforcement.

### **2.02 VIBRATING**

- A. All concrete shall be thoroughly consolidated by means of approved mechanical vibrators. The vibrator shall consolidate the full depth and width of the concrete to a uniform mass without segregation. Care must be exercised to insure the coating of all surfaces of the reinforcement with concrete and the thorough consolidation of concrete around the reinforcement. Equal care shall be taken to insure that all concrete is consolidated against the face of the forms.

### **2.03 SURFACE FINISH**

- A. All concrete knee and seat walls shall be finished with a broom finish on exposed surfaces.

### **2.04 JOINTS**

- A. Joints shall be square and normal to the forms unless otherwise provided. Bulkheads shall be provided for all except horizontal joints. When shown in the plans or specified in the Special Provisions, joints shall be sealed.

### **2.05 CONSTRUCTION JOINTS**

- A. Construction joints shall consist of the joints in which no provision is made for movement of abutting surfaces. All construction joints shall be keyed and shall be made only where located in the plans, unless otherwise provided in these Specifications and approved by the Owner's Representative. When not detailed in the plans, or in case of emergency, construction joints shall be placed as directed by the Owner's Representative.

### **2.06 CURING AND PROTECTION**

- A. As soon after the completion of the specified finishing operation as the condition of the concrete will permit without danger of consequent damage thereto, all exposed surface shall be cured by the water method, the form-in-place method, or by the membrane curing compound method.
- B. Form-In-Place Method
- C. Formed surfaces of concrete may be cured by retaining the forms in place. The forms shall remain in place for a minimum period of seven (72) hours after the concrete has been placed.

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**END OF SECTION 323201**

## SECTION 323300 - SITE FURNISHINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Related Sections include the following:
  - 1. Division 32 Section 321314 "Portland Cement Concrete Paving"
  - 2. Division 32 Section 321315 "Curbs and Sidewalks"
  - 3. Division 32 Section 321373 "Concrete Pavement Joint Sealants"

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Benches and Seats

#### 1.3 ACTION SUBMITTALS

- A. Product Data: Submit for each type of product indicated.
- B. Samples for Initial Selection: For units with factory-applied color finishes.
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
  - 1. Size: Not less than 6-inch- (152-mm-) long linear components and 4-inch- (102-mm-) square sheet components.
- D. Product Schedule: For site furnishings. Use same designations indicated on Drawings.
- E. Material Certificates: For site furnishings, signed by manufacturers.
- F. Wood Preservative Treatment: Include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
- G. Sustainably Harvested Wood: Include certification by manufacturer and from sources that participate in sustained yield programs.
- H. Maintenance Data: For site furnishings to include in maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of site furnishing(s) through one source from a single manufacturer.

#### 1.5 EXTRA MATERIALS (ATTIC STOCK)

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Bench and Seating Replacement Slats: No fewer than two full-size units for each size indicated.
  - 2. Touch-up Paint: 1 quart supplied by the site furnishings manufacturer for each paint color utilized.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes and complying with the following:
  - 1. Rolled or Cold-Finished Bars, Rods, and Wire: ASTM B 211.
  - 2. Extruded Bars, Rods, Wire, Profiles, and Tubes: ASTM B 221.
  - 3. Structural Pipe and Tube: ASTM B 429/B 429M.
  - 4. Sheet and Plate: ASTM B 209.
  - 5. Castings: ASTM B 26/B 26M.
- B. Steel and iron: Free of surface blemishes and complying with the following:
  - 1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
  - 2. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53, or electric-resistance-welded pipe complying with ASTM A 135.
  - 3. Tubing: Cold-formed steel tubing complying with ASTM A 500.
  - 4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513, or steel tubing fabricated from steel complying with ASTM A 1011/A 1011M and complying with dimensional tolerances in ASTM A 500; zinc coated internally and externally.
  - 5. Sheet: Commercial steel sheet complying with ASTM A 1011/A 1011M.
  - 6. Malleable-Iron Castings: ASTM A 47/A 47M, grade as recommended by fabricator for type of use intended.
  - 7. Cast Gray Iron: ASTM A823-99(2003).
  - 8. Hot-dip galvanized steel.
- C. Stainless steel: Free of surface blemishes and complying with the following:
  - 1. Sheet, Strip, Plate, and Flat Bars: ASTM A 666.
  - 2. Pipe: Schedule 40 steel pipe complying with ASTM A 312/A 312M.

3. Tubing: ASTM A 554.
- D. Wood: Surfaced smooth on four sides with eased edges; kiln dried, free of knots, solid stock of species indicated.
  1. Comply with materials, standards and instruction as specified in Section 06 2013 "Exterior Finish Carpentry".
- E. Fiberglass: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and with manufacturer's standard finish.
- F. Plastic: Color impregnated, color and UV-light stabilized, and mold resistant.
  1. Polyethylene: Fabricated from virgin plastic HDPE resin.
- G. Anchors, Fasteners, Fittings, and Hardware: Stainless steel, Galvanized steel, manufacturer's standard, corrosion-resistant-coated or non-corrodible materials; commercial quality, tamperproof, vandal and theft resistant, concealed, recessed, and capped or plugged.
- H. Non-shrink, Nonmetallic Grout: Premixed, factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107; recommended in writing by manufacturer, for exterior applications.
- I. Erosion-Resistant Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.
- J. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:
  1. Zinc-Coated Tubing: External, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, polymer film. Internal, same as external or consisting of 81 percent zinc pigmented coating, not less than 0.3 mil (0.0076 mm) thick.
  2. Hot-Dip Galvanizing: According to ASTM A 123/A 123M, ASTM A 153/A 153M, or ASTM A 924/A 924M.

## 2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment: Pressure-treat wood according to AWPA U1 and the following:
  1. Use preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
  2. Kiln-dry lumber and plywood after treatment to a maximum moisture content, respectively, of 19 and 15 percent. Do not use materials that are warped or do not comply with requirements for untreated materials.

## 2.3 FABRICATION

- A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.
- B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
- C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
- D. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWWA M4 to cut surfaces.
- E. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
- F. Factory Assembly: Assemble components in the factory to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

## 2.4 ALUMINUM FINISHES

- A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

## 2.5 STEEL AND GALVANIZED-STEEL FINISHES

- A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.
- B. PVC Finish: Manufacturer's standard, UV-light stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added; complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness.

## 2.6 IRON FINISHES

- A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

## 2.7 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.



1. Run directional finishes with long dimension of each piece.
2. Directional Satin Finish: No 4.
3. Dull Satin Finish: No. 6.

## 2.8 SITE FURNISHINGS

- A. Refer to contract Drawings.
- B. Subject to compliance with the requirements, provide products manufactured by the manufacturer listed below, or approved equal.
  1. Landscape Forms, Inc.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.
  1. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Coordinate installation of all site furnishings with final approved shop drawings.
- B. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
  1. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
  2. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.
  3. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
  4. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

5. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with non-shrink grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

### **3.3 CLEANING**

- A. After completing site furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

### **END OF SECTION 323300**

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## SECTION 329100 - PLANTING

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Preparation and excavation of planting beds.
- B. Planting of trees, shrubs, sod, seed, and associated materials.
- C. Provide and execute Maintenance Contract.

#### 1.02 RELATED SECTIONS

- A. Section 312000 - Earthwork
- B. Section 312200 - Erosion Control and Sedimentation
- C. Section 329113 - Planting Soil Mixing
- D. Construction Drawings

#### 1.03 REFERENCE STANDARDS

- A. American National Standard Institute (ANSI)
  - 1. Z60.1 American Standard for Nursery Stock
- B. American Sod Producer Association (ASPA)
- C. American Nursery and Landscape Association (ANLA)

#### 1.04 QUALITY ASSURANCE

- A. No error or discrepancy in Construction Drawings or Specifications shall cause defective or inappropriate materials to be used or poor workmanship to be allowed. All work completed and materials furnished and installed shall be of the best quality and shall be in strict accordance with the intention of the Drawings, Specifications and samples.
- B. Work must be carried out only during weather conditions favorable to landscape construction and to the health and welfare of plants.
- C. Before commencing work, all trees and shrubs which are to be saved must be protected from damage by the placement of fencing flagged for visibility or some other suitable protective procedure approved by Construction Manager and Engineer. No Work may begin until this requirement is fulfilled.

- D. In order to avoid damage to roots, bark or lower branches, no truck or other equipment shall be driven or parked within the drip line of any tree, unless the tree overspreads a paved way.
- E. The Contractor shall use any and all precautionary measures when performing Work walks, pavements, utilities, and any other features either existing or previously installed under this Contract.
- F. The Contractor shall adjust depth of earthwork and planting soiling when working immediately adjacent to any of the aforementioned features in order to prevent disturbing tree roots, undermining walks and pavements, and damage in general to any existing or newly incorporated item.
- G. Plants transported to the Project in open vehicles shall be covered with tarpaulins or other suitable covers securely fastened to the body of the vehicle to prevent injury to the plants. Closed vehicles shall be adequately ventilated to prevent overheating of the plants. Evidence of inadequate protection following digging, carelessness while in transit, or improper handling or storage shall be cause for rejection. All plants shall be kept moist, fresh, and protected. Such protection shall encompass the entire period during which the plants are in transit, being handled, or are in temporary storage.
- H. Measure plants when branches are in their normal position.
- I. Trees and shrubs shall meet requirements for spread, height, or container size stated in Construction Drawings.
  - 1. Measurements are to be taken from ground level to average height of shrub and not to longest branch.
  - 2. Height and spread dimensions specified herein refer to main body of trees measured from crown of roots to tip of top branch.
- J. Caliper measurements shall be taken at point on tree trunk 6-inches above natural ground line for trees up to 4-inches in caliper, and at point 12-inches above natural ground line for trees exceeding 4-inches in caliper.
- K. If range of sizes is given, no plant shall be less than minimum size, and at least 50 percent of plants shall be as large as upper half of range specified.
- L. Measurements specified are minimum size acceptable and, where pruning is required, are measurements after pruning.
- M. Condition of new plant materials is the responsibility of the Contractor and shall be approved by the Owner. Landscape Architect and/or Owner reserves the right to inspect and reject plants at any time and at any place, and reserves the right to inspect plants at the growing nursery.
- N. Landscape Architect and/or Owner shall have the final approval for acceptance of the landscape planting work.

## **1.05 SUBMITTALS**

- A. Before ordering or purchasing materials, provide samples of those materials to Owner for approval, if so requested.
- B. Submit certification tags from trees, shrubs, sod, and seed verifying type and purity.
- C. Unless otherwise authorized by Owner, notify Owner at least 48 hours in advance of anticipated delivery date of plant materials. Legible copy of invoice, showing kinds and sizes of materials included for each shipment, shall be furnished to Owner.
- D. Inform Owner of date when planting shall commence.

#### **1.06 PROJECT CONDITIONS**

- A. Work must be carried out only during weather conditions favorable to landscape construction and to health and welfare of plants. Owner shall determine suitability of such weather conditions.

#### **1.07 MAINTENANCE OPERATIONS BEFORE APPROVAL**

- A. Plant care shall begin immediately after each plant is satisfactorily installed and shall continue throughout the life of the Contract until final acceptance of the Project by the Authority.
- B. Care shall include, but not be limited to, replacing mulch that has been displaced by erosion or other means, repairing and reshaping water rings or saucers, watering when needed or directed, and performing any other Work required to keep the plants in a healthy condition.
- C. Contractor shall remove and replace all dead, defective and/or rejected plants as required before final acceptance by Authority.

#### **1.08 NOTIFICATION OF DELIVERY**

- A. Unless otherwise authorized by Engineer, the Contractor shall notify Construction Manager at least 48 hours in advance of the anticipated delivery date of any plant materials for immediate forwarding to the Engineer. A legible copy of the invoice, showing kinds and sizes of materials included for each shipment shall be furnished to the Construction Manager for the review of the Engineer.

#### **1.09 GUARANTEE**

- A. Care shall include, but not be limited to, replacing mulch that has been displaced by erosion. Contractor shall guarantee all plant material for a period of two years from the date of acceptance by the Authority. All plant material either dead or in decline shall be replaced at no additional cost to the Authority.
- B. The condition of all new plant materials is the responsibility of the Contractor and shall be approved by Engineer.
- C. Until final approval from the Engineer and acceptance by the Authority, any replacement of plant materials that may be necessary shall be at the expense of the Contractor.

- D. In addition to other standard provisions, the Contractor's bid amount shall also provide for the following:
- a. Maintenance necessary during Establishment Period, through final acceptance by the Authority.
  - b. Replacement in kind, or with a plant of similar species and size acceptable to Engineer, of all plant materials not in a healthy growing condition or that has died back to the crown or beyond normal pruning limits.
  - c. The Contractor shall also be responsible for any damage caused by his operations and shall dispose of all rubbish and excess soil as directed by the Construction Manager.

## **PART 2      PRODUCTS**

### **2.01    PLANT MATERIALS**

- A. Plant material (trees and shrubs) shall conform to requirements of ANSI Z60.1 of rules and grading upgraded to meet the following:
1. Plants shall be of selected specimen quality, exceptionally heavy, symmetrical, tightly knit, so trained or favored in their development and appearance as to be superior in form, number of branches, compactness and symmetry. Plants shall have normal habit or sound, healthy, vigorous plants with well developed root system.
  2. Plants shall be free of disease, insect pests, eggs, or larvae.
  3. Plants shall not be pruned before delivery.
  4. Trees with abrasion of bark, sunscalds, disfiguring knots, or fresh cuts of limbs over 1 1/4-inch, which have not completely calloused, shall be rejected.
  5. Plants shall be typical of their species or variety and shall have normal habit of growth and be legibly tagged with proper name. Plants shall have been grown under climatic conditions similar to those of site or have been acclimated to such condition for at least 2 years.
  6. Root system of each plant shall be well provided with fibrous roots. Parts shall be sound, healthy, vigorous, well-branched, and densely foliated when in leaf.
  7. Plants designated ball and burlap must be moved with root systems as solid units with balls of earth firmly wrapped with burlap and comply with the following:
    - a. Diameter and depth of balls of earth must be sufficient to encompass fibrous root feeding systems necessary for healthy development of plant.
    - b. No plant shall be accepted when ball of earth surrounding its roots has been badly cracked or broken preparatory to or during process of planting. Balls shall remain intact during all operations.
    - c. Plants that cannot be planted at once must be heeled-in by setting in ground and covering balls with soil or mulch and then watering.
    - d. Hemp burlap and twine is preferable to treated. If treated burlap is used, twine is to be cut from around trunk and burlap is to be removed.
  8. Trunk of each tree shall be single trunk growing from single unmutated crown of roots. No part of trunk shall be conspicuously crooked as compared with normal trees of same variety.
  9. Thickness of each shrub shall correspond to trade classification "No.1". Single stemmed or thin plants shall not be accepted. Side branches must be generous, well-twigged, and plant as whole well-branched to ground. Plants must be in moist condition, free from dead wood, bruises, or other root or branch injuries.

2.02 SOD

- A. Sod shall be species ASPA certified. Sod to be strongly rooted, weed, disease, pest free and uniform in thickness.

2.03 TOPSOIL

- A. Refer to Specification 329113 - Planting Soil Mixing.
- B. Refer to Planting Soil Specifications on the Drawings.

2.04 FERTILIZER

- A. Deliver fertilizer, mixed as specified, in original unopened standard size bags showing weight, analysis and name of manufacturer. Containers shall bear manufacturer's guaranteed statement of analysis, or manufacturer's certificate of compliance covering analysis shall be furnished to Owner. Store fertilizer in such manner that it shall be kept dry.
- B. Base percentages of nitrogen, phosphorus, and potash on laboratory test recommendations as approved by Owner. For bidding assume 10 percent nitrogen, 6 percent phosphorus, and 4 percent potash by weight. At least 50 percent of total nitrogen shall contain no less than 3 percent water-insoluble nitrogen. At least 60 percent of nitrogen content shall be derived from super-phosphate containing not less than 18 percent phosphoric acid or bone meal containing 25 - 30 percent phosphoric acid and 2 - 3 percent nitrogen. Potash shall be derived from muriate of potash containing 55 - 60 percent potash.

2.05 PEAT MOSS

- A. Peat moss shall be Michigan peat moss or approved equal in color and consistency.
- B. Peat moss shall be moss peat, finely shredded to pass 1/2-inch mesh and shall be no less than 90 percent organic material by weight, with ash content by ignition of no more than 10 percent.
- C. Material shall contain 35 - 66 percent moisture by weight, but shall have water-holding capacity of 150 - 200 percent.
- C. Material shall have pH value of 4 to 5.
- D. Material may be imported supplied in bales or domestic furnished in bulk. If furnished in bulk, material and its source must be acceptable to Owner.
- E. Peat moss may NOT be used as an organic matter amendment to Planting Soil.

2.06 SHREDDED HARDWOOD BARK MULCH

- A. Mulch shall be of sufficient character as not to be easily displaced by wind or water runoff.

**2.07 STAKING MATERIAL**

- A. Stakes shall be 8-ft steel tee posts. Three stakes shall be used for each tree.
- B. Wire used for tree staking shall be pliable No. 12 galvanized soft steel wire.
- C. Hose shall be 2-ply fibred-bearing rubber garden hose, not less than 1/2-inches inside diameter, black or green, and of suitable length.

**2.08 WATER**

- A. Potable water, on-site water shall be furnished by Owner. Contractor shall furnish hose and other watering equipment.

**2.09 WEED MAT**

- A. Weed mat shall be "Dewitt Weed Barrier" or approved equal.

**2.10 STEEL EDGING**

- A. Steel edging shall be 1/8-inch x 4-inch interlocking steel edge, staked with metal stakes sufficiently to hold in place.

**2.11 STONE MULCH**

- A. Size and color of stone mulch should be as shown on Construction Drawings.

**2.13 EROSION CONTROL BLANKET**

- A. Blankets, biodegradable, enclosed in a photodegradable plastic mesh, including steel wire staples, 6 inches long.
- B. Provide and install where indicated on Construction Drawings "Curlex" blankets by American Excelsior Company, "Polyjute" Style 465 GT by Synthetic Industries, or approved equal.

**2.14 ANTI-DESICCANT SPRAY**

- A. Spray shall be an emulsion which will provide a protection fill over plant surfaces. It shall be permeable enough to permit transpiration. It shall be delivered in the manufacturer's containers and mixed according to the manufacturer's instructions.

**PART 3 EXECUTION**

**3.01 PLANTING COORDINATION**

- A. The Contractor shall inform Engineer through the Construction Manager of the date when the planting shall commence and of the anticipated delivery date of the material.



- B. Failure to notify Engineer through Construction Manager in advance of order to arrange proper scheduling may result in loss of time or rejection of a plant or plants not installed as specified or directed.

### 3.02 PREPARATION

- A. If project completion date prohibits in-season planting, prepare for out-of-season seeding or sodding so that lawns shall be completed and ready for acceptance at time of project completion, without additional cost to Owner.
- B. Provide sufficient tools and equipment required to carry out planting operation.
- C. Locations containing unsuitable subsoil shall be treated by one or more of the following:
  - 1. Where unsuitability is deemed by Owner to be due to excessive compaction caused by heavy equipment and where natural subsoil is other than AASHTO classification of A6 or 7, loosen such areas with spikes, disking, or other means to loosen soil to condition acceptable to Owner. Loosen soil to minimum depth of 12-inches with additional loosening as required to obtain adequate drainage. Contractor may introduce peat moss, sand, or organic matter into the subsoil to obtain adequate drainage. Such remedial measures shall be considered as incidental, without additional cost to Owner.
  - 2. Where unsuitability is deemed by Owner to be due to presence of boards, mortar, concrete, or other construction materials in sub-grade and where natural subsoil is other than AASHTO classification of A6 or 7, remove debris and objectionable material. Such remedial measures shall be considered as incidental, without additional cost to Owner.
  - 3. Where unsuitability is deemed by Owner to be because natural subsoil falls into AASHTO classification of A6 or 7 and contains moisture in excess of 30 percent, then installation of sub-drainage system or other means described elsewhere in Specifications shall be used. Where such conditions have not been known or revealed prior to planting time and they have not been recognized in preparation of Construction Drawings and Specifications, then Owner shall issue pricing order to install proper remedial measures.
- D. Perform planting operations at steady rate of work unless weather conditions make it impossible to work. No plant material shall be planted in frozen ground.
- E. Disk, drag, harrow, or hand rake subgrade to depth of 6-inches and removed stones larger than 1-1/2 inches to provide bond for topsoil. Topsoil, which must be transported across finished sidewalks, shall be delivered in such manner that no damage will be done to sidewalks. Contractor shall be responsible for repair of such damage.
- F. Do not place topsoil until subgrade has been approved in accordance with Section 312000. Before placing topsoil, rake subsoil surface clear of stones, debris, and roots. Compact topsoil to form layer with minimum depth of 6-inches in lawn areas and 12-inches in shrub beds. Place topsoil so that after final settlement there will be positive drainage conforming to elevations shown on Construction Drawings.
- G. Tree and Shrub Preparation

1. Dig bare rooted shrubs with adequate fibrous roots. Cover roots of these plants with uniformly thick coating of mud by being puddled immediately after they are dug, or packed in moist straw or moss.
  2. Dig ball and burlap plants with firm natural balls of earth of diameter and depth to include fibrous roots.
  3. Protect roots or balls of plants at all times from sun and drying winds.
  4. Ball and burlap plants which cannot be planted immediately upon delivery shall be set on ground and protected with soil, wet moss, or other acceptable material. Heel-in bare rooted plants that cannot be planted immediately upon delivery. All shall be kept moist.
  5. Open bundles of plants and separate before roots are covered. Take care to prevent air pockets among roots. During planting operations, cover bare roots with canvas, hay, or other suitable material. No plant shall be bound with wire or rope at any time so as to damage bark or break branches.
- H. Sod Bed Preparation: Grade areas to finish grade, filling as needed or removing surplus dirt, stones, debris, etc. and floating areas to smooth, uniform grade as indicated on Construction Drawings. Lawn areas are to slope to drain.
- I. Grass or sodded areas shall have fertilizer applied in two (2) applications with a thorough watering as specified in section 4.02 B immediately following each application. The first application shall be one (1) week prior to seeding/sodding at the rate of 25 pounds per 1000 square feet and barrowed into the top two (2) inches of topsoil. The second application shall be at the rate of 10 pounds per 1000 square feet immediately following the second mowing.
- J. Adjustments in locations of planting beds and bed lines shall be made as directed by the Engineer. In the event that pits or areas for planting are prepared and backfilled with planting soil to grade prior to commencement of lawn operations, they shall be so marked that when the Work of planting proceeds, they can be readily located. In case underground obstructions such as ledges or utilities are encountered, location shall be changed under the direction of Engineer without charge to the Authority.
- K. Holes for trees shall conform to the planting details and all plans shall sit at the same elevation as grown in the nursery.
- L. Ground limestone shall be added to the planting soil for backfilling tree holes and shrub beds as the progress of the Work permits if soil tests indicate it is needed, and commercial fertilizer at the rate of three (3) pounds for tree up to three inches (3") in caliper, one (1) pound per one inch (1") in caliper for larger trees, six (6) ounces for small shrubs and eight (8) ounces for each shrub four feet (4') or over. Ground limestone shall be omitted in the case of acid soil plants. The limestone and fertilizer shall be thoroughly mixed with the planting soil in the planting operation.
- M. The plants shall be planted in the center of the holes and at the same elevation as they grew in the nursery. Planting soil shall be backfilled in layers of not more than eight inches (8") and each layer watered sufficiently to settle before the next layer is put in place. Planting soil shall be tamped under edges of balled plants. Enough planting soil shall be used to bring the surfaces to finish grade when settled.
- a. A saucer shall be provided around each plant as shown on the Drawings.

- b. Plants shall be soaked with water twice within the first twenty-four (24) hours of time of planting. Water shall be applied with low pressure so as to soak in thoroughly without dislodging the planting soil.
- c. A three inch (3") layer (after settlement) of mulch or approved equal shall be applied to the outside edge of each tree pit saucer or planting bed.

### 3.03 PROTECTION

- A. Before commencing work, trees and shrubs that are to be saved shall be protected from damage by placement of fencing flagged for visibility or some other suitable protective procedure approved by Owner. No work may begin until this requirement is fulfilled.
- B. In order to avoid damage to roots, bark, or lower branches, no truck or other equipment shall be driven or parked within drip line of any tree, unless tree overspreads paved area.
- C. Use precautionary measures when performing work around trees, sidewalks, pavements, utilities, and other features either existing or previously installed.
- D. Adjust depth of earthwork and topsoil when working immediately adjacent to aforementioned features in order to prevent disturbing tree roots, undermining sidewalks and pavements, and damage in general to other features either existing or previously installed.
- E. Cover plants transported to project in open vehicles with tarpaulins or other suitable covers securely fastened to body of vehicle to prevent injury to plants. Closed vehicles shall be adequately ventilated to prevent overheating of plants. Evidence of inadequate protection following digging, carelessness while in transit, or improper handling or storage shall be cause for rejection. Plants shall be kept moist, fresh, and protected. Such protection shall encompass entire period during which plants are in transit, being handled, or are in temporary storage.
- F. Where excavating, fill, or grading is required within drip line of trees that are to remain, work shall be performed as follows:
  - 1. Trenching: When trenching occurs around trees to remain, tree roots shall not be cut but trench shall be tunneled under or around roots by careful hand digging without injury to roots.
  - 2. Raising Grades:
    - a. Where fill not exceeding 16-inches is required, clean, washed gravel graded from 1-inch to 2-inch in size shall be placed directly around tree trunk. Extend gravel out from trunk on all sides minimum of 18-inches and finish approximately 2-inches above finished grade at tree. Install gravel before any earth fill is placed. New earth fill shall not be left in contact with trunks of trees requiring fill.
    - b. Where fill exceeding 16-inches is required, construct dry laid tree well around trunk of tree. Tree well shall extend out from trunk on all sides minimum of 3-feet and to 3-inches above finish grade. Place coarse grade rock directly around tree well extending out to drip line of tree. Place clean, washed gravel graded from 1-inch. to 2-inch. in size directly

over coarse rock to depth of 3-inches. Place approved backfill material directly over washed gravel to desired finish grade.

3. Lowering Grades: Existing trees in areas where new finish grade is to be lowered shall have regrading work done by hand to elevation indicated on Construction Drawings. Roots as required shall be cut cleanly 3-inches below finished grade and scars covered with tree paint.
4. Trees marked for preservation that are more than 6-inches above proposed grades shall stand on broad rounded mounds and be graded smoothly into lower level. Trees located more than 16-inches above proposed grades shall have dry laid stone wall or other retaining structure as detailed on Construction Drawings constructed minimum of 5-feet from trunk. Exposed or broken roots shall be cut clean and covered with topsoil.

### 3.04 TREE AND SHRUB PLANTING

- A. Plants too large for 2 men to lift in and out of holes shall be placed with sling. Do not rock trees in holes to raise.
- B. If rock or other underground obstruction is encountered, Owner may require plant pits to be relocated, pits enlarged, or plants deleted from project.
- C. Make adjustments in locations as directed. In event that pits or areas for planting are prepared and backfilled with topsoil to grade prior to commencement of lawn operations, they shall be so marked that when planting proceeds, they can be readily located. In case underground obstructions such as ledges or utilities are encountered, change location under direction of Owner without charge.
- D. Holes for trees shall be at least 2-feet greater in diameter than spread of root system and at least 6-in. deeper than root ball. Holes for shrubs and vines shall be at least 12-inches greater in diameter than spread of root system and at least 2-feet deep.
- E. During backfilling of tree holes and shrub beds with topsoil, manure, ground limestone (if soil tests indicate it is needed), and commercial fertilizer at rate of 3-pounds for trees up to 3-inches in caliper, 1-pound per inch caliper for larger trees, 6-ounces for small shrubs and 8-ounces for each shrub 4-feet or over shall be added as progress of work permits. Omit ground limestone and manure in case of acid soil plants. Manure, limestone, and fertilizer shall be thoroughly mixed with topsoil in planting operation; care being taken that manure does not come in immediate contact with roots.
- F. Plants shall be planted in center of holes and at same depth as they previously grew. Backfill topsoil in layers of not more than 8-inches and each layer watered sufficiently to settle before next layer is put in place. Tamp loam under edges of balled plants. Use enough topsoil to bring surfaces to finish grade when settled.
  1. Provide saucer around each plant as shown on Construction Drawings.
  2. Soak plants with water twice within first 24 hours after time of planting. Apply water with low pressure so as to soak in thoroughly without dislodging topsoil.
  - 3.

### 3.05 MISCELLANEOUS INSTALLATIONS

- A. Shredded Hardwood Bark Mulch
  - 1. Use 3-inches of shredded hardwood bark mulch or approved equal as top dressing in planting beds. Mulch single trees or shrubs to outside edge of saucer.
- B. Use peat moss for planting soil mixture only and not be used as mulch, except on ground cover.
- C. Apply fertilizer to grass or sodded areas in 2 applications with thorough watering immediately following. First application shall be 1 week before seeding at rate of 35-pounds per 1,000 square feet harrowed into top 2-inches of seedbed. Second application shall be done at rate of 25-pounds per 1,000 square feet, immediately following second mowing.
- D. Peg sodded slopes greater than 3:1 to hold in place.
- E. Areas to be covered with erosion control blankets shall be properly prepared, fertilized, and seeded before blanket is applied. When blanket is unrolled, netting shall be on top and fibers in contact with soil. In ditches, apply blanket in direction of flow of water. On slopes, apply blankets vertically on slope. Butt ends and sides snugly and stapled. Staple to manufacturer's recommendations.

### 3.06 SOD

- A. Cut and lay sod on same day. Only healthy vigorous growing sod is to be laid.
- B. Always lay sod across slope and tightly together so as to make solid area.
- C. Roll or firmly but lightly tamp with suitable wooden or metal tamper new sod sufficiently to set or press sod into under laying soil.
- D. After sodding has been completed, clean up and thoroughly moisten newly sodded areas.

### 3.07 MAINTENANCE DURING CONSTRUCTION

- A. Begin maintenance immediately after planting. Plants shall be watered, mulched, weeded, pruned, sprayed, fertilized, cultivated, and otherwise maintained and protected until acceptance. Settled plants shall be reset to proper grade and position, planting saucer restored, and dead material removed. Tighten and repair stakes and wires. Correct defective work as soon as possible after it becomes apparent and weather and season permit.
- B. If a substantial number of plants are in decline or dead at the time of inspection, acceptance shall not be granted and the Contractor's responsibility for maintenance of all plants shall be extended until replacements are made or existing plants are deemed acceptable by Landscape Architect.
- C. All replacements shall be plants of the same kind and size specified in the Plant schedule as shown on landscape plant schedule. They shall be furnished and planted as specified above. The cost shall be borne by the Contractor. After Substantial Completion

replacements resulting from removal, loss, or damage due to vandalism, physical damage by animals or vehicles shall be approved and paid for by the Authority.

- D. Plants shall be guaranteed for a period of two (2) years after inspection and acceptance.
- E. At the end of the Establishment Period, inspection shall be made again. Any plant required under this Contract that is dead or unsatisfactory to Engineer or Authority shall be removed from the Site. These shall be replaced by Contractor during the normal planting season at no additional cost to the Authority.
- F. Maintain lawns for at least 30 days after sodding, or as long as is necessary to establish uniform stand of the specified grasses, or until substantial completion of project, or until acceptance of lawns, whichever is later.
- G. In event that lawn operations are completed too late in Fall for adequate growth, maintenance shall continue into following growing season or until uniform stand of specified grasses has been established.
- H. Make weekly inspections to determine moisture content of soil and adjust watering schedule established by irrigation system installer to fit conditions.
- I. After grass growth has started, areas that fail to show uniform stand of grass for any reason whatsoever shall be reseeded in accordance with Construction Drawings and as specified herein. Such areas shall be reseeded repeatedly until areas are covered with satisfactory growth of grass at no additional cost to Owner.
- J. Watering shall be done in such manner and as frequently as is deemed necessary by Owner to assure continued growth of healthy grass. Water areas of site in such way as to prevent erosion due to excessive quantities applied over small areas and to avoid damage to finished surface due to watering equipment.
- K. Water for execution and maintenance will be provided by Owner at no expense to Contractor. Contractor shall furnish portable tanks, pumps, hose, pipe, connections, nozzles, and any other equipment required to transport water from available outlets and apply it to seeded areas in approved manner.
- L. Initiate mowing of seeded areas when grass has attained height of 1 1/2-inches to 2-inches. Maintain grass height at 1-inch to 1 1/2-inches at subsequent cuttings depending on time of year. Not more than 1/3 of grass leaf shall be removed at any cutting and cutting shall not occur closer than 10 days apart.
- M. Heavy cuttings shall be removed to prevent destruction of underlying turf. If weeds or other undesirable vegetation threaten to smother planted species, such vegetation shall be mowed or, in case of rank growths, shall be uprooted, raked and removed from area by methods approved by Owner.
- N. Protect sodded area from trespassing while grass is rooting. Furnish and install fences, signs, barriers, or other necessary temporary protective devices. Contractor shall repair damage resulting from trespass, erosion, washout, settlement, or other causes at his expense.

- O. Remove fences, signs, barriers, or other temporary protective devices after final acceptance.
- P. If substantial number of plants are sickly or dead at time of inspection, acceptance will not be granted and Contractor's responsibility for maintenance of plants shall be extended until replacements are made.
- Q. Replacements shall be plants of same kind and size specified on Construction Drawings. Furnish and plant as specified herein. Cost shall be borne by Contractor. Replacements resulting from removal, loss, or damage due to occupancy of project in any part, vandalism, physical damage by animals, vehicles, etc., and losses due to curtailment of water by local authorities will be approved and paid for by Owner.
- R. Remove and replace dead, defective and/or rejected plants as required before final acceptance. Replacement of plant materials that may be necessary shall be at expense of Contractor.
- S. Grassed areas damaged during process of work shall be responsibility of Contractor, who shall restore disturbed areas to condition satisfactory to Owner. This may include filling to grade, fertilizing, seeding, and mulching.
- T. Guarantee plants for period of 2 years after inspection and acceptance.
- U. At end of Establishment Period, inspection shall be made again. Remove from site any plant that is dead or unsatisfactory to Owner. Replace plants during normal planting season.

### 3.08 MAINTENANCE

#### A. GENERAL LANDSCAPING

- 1. Provide Owner with 3 written proposals due before possession date for landscape maintenance from experienced local nursery businesses capable of performing work specified herein. Accepted proposal and maintenance contract will be for period of 2 years and renewable in 1-year increments. Maintenance will begin immediately after final acceptance of landscaping by Owner. During the first year warranty period, the Contractor shall be responsible for insuring that the maintenance contract is being followed.
- 2. Landscape maintenance shall include necessary watering, cultivation, weeding, pruning, wound dressing, disease and insect pest control, protective spraying, labor for replacement of dead plant material, straightening plants which lean or sag, adjustments of plants which settle or are planted too low, mowing, replacement of mulch that has been displaced, repairing and reshaping of saucers, and reseeding or replanting of those areas affected. Remove rubbish, waste, tools, and equipment used at end of each workday. Other procedures consistent with good horticultural practice necessary to insure vigorous, healthy growth of plant material are also part of Maintenance Contract.
- 3. During first year of Maintenance Contract, replacement of plant material shall be responsibility of Contractor with exceptions as listed herein.

4. Landscape maintenance contractor shall purchase and maintain Contractor's general liability insurance in amount of \$1,000,000 for protection from Contractor's operations under Maintenance Contract. Certification of such insurance shall be filed with Owner prior to commencement of work.
- B. Watering
1. The irrigation system, if installed on the Site, shall be used by the landscape maintenance Contractor for the watering program, but any failure of the system does not eliminate the landscape maintenance Contractor's responsibility for maintaining the desired level of moisture necessary to maintain vigorous, healthy growth.
  2. It shall be the contractor's responsibility of maintaining desired level of moisture necessary to maintain vigorous, healthy growth.
  3. Water shall be applied each time sufficient to penetrate soil to minimum depth of 8-inches in shrub beds and 6-inches in turf areas at rate that will prevent saturation of soil.
  4. On-site water shall be furnished by Owner. Contractor shall furnish hose and other watering equipment.
- C. Weeding: Landscape maintenance contractor shall keep areas free from weeds and undesirable grasses by a method and by materials approved by the American Association of Nurserymen (A.A.N.).
- D. Disease and insect pest control: Inspect plant material at least once each month to locate any disease or insect pest infestations. Upon discovery of infestation, nature or species of infestation shall be identified. Control in accordance with industry standards shall be immediately implemented.
- E. Fertilizing: Landscape maintenance contractor is to fertilize on regularly scheduled program to fit requirements of plant material to maintain vigorous, healthy growth.
- F. Pruning and repair: Amount of pruning shall be limited to minimum necessary to remove dead or injured branches, to compensate for loss of roots as result of transplanting operations, and to maintain safety in traveled areas. Pruning shall be done to not change the natural habit or shape of plant. Cuts shall be made flush, leaving no stubs.
- G. Mowing: Mow grass areas at regular intervals to keep grass height from exceeding 3-inches. Mow in such manner as to prevent clippings from blowing onto paved areas and sidewalks. Cleanup after mowing shall include sweeping or blowing to clear mowing debris.
- H. Clean up: During course of maintenance, excess and waste materials shall be continuously and promptly removed at end of each workday.



- I. Maintenance report and schedule of activities: Landscape maintenance contractor shall provide schedule and report to Owner that details planned maintenance activities including names of any subcontractors.
- J. Maintenance Contract: These terms and conditions herein outlined shall be attached and made a part of a maintenance contract with the Owner.

**3.09 TERMINATION OF THE MAINTENANCE CONTRACT**

- A. If the landscape Maintenance Contractor defaults or persistently fails or neglects to carry out the required Site landscape maintenance work, the Authority, after twelve (12) days' written notice to the landscape maintenance Contractor, and without prejudice to any other remedy they may have, may make good such deficiencies and receive a credit from the landscape maintenance Contractor for such costs.

**END OF SECTION 329100**

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## SECTION 329113 - PLANTING SOIL MIXING

### PART 1 - GENERAL

#### 1.01 SCOPE OF WORK

- A. Furnishing materials from approved off-site source(s) as a base component for planting soil mixes and furnishing other soil amendment materials.
- B. Blending and preparing planting soils for plant areas.
- C. Delivering, placing, and fine grading pre-mixed light weight structural soils and planting soil material of the type(s) indicated for plant areas.
- D. Protecting all plant mix installations with snow fencing, filter fabric, or other approved means, over the surface area plant bed installations, until substantial completion.
- E. Protection of finished paving, light poles utility or other finished work by means of wooden protection boards, or other approved means, over the area of construction concurrent with any and all construction operations.

#### 1.02 RELATED SECTIONS

- A. Section 329100 – Planting
- B. Construction Drawings

#### 1.03 SUBMITTALS

- A. Product Data: Submit technical descriptive data for each manufactured or packaged product of this Section. Include manufacturer's product testing and analysis and installation instructions for manufactured or processed items and materials.
- B. Locations: Submit locations of material sources. Submit location of mixing sites.
- C. Certificates:
  - 1. Submit certified analysis for each soil treatment, amendment, and fertilizer material specified and as used. Include guaranteed analysis and weight for packaged materials.
- D. Test Reports; Submit written reports of each sample tested. Each report shall include the following as a minimum and such other information required specific to material tested:
  - 1. Date issued.
  - 2. Project Title and names of Contractor and supplier.
  - 3. Testing laboratory name, address and telephone number, and name(s), as applicable, of each field and laboratory inspector.
  - 4. Date, place, and time of sampling or test, with record of temperature and weather conditions.
  - 5. Location of material source.

6. Type of test.
  7. Results of tests including identification of deviations from acceptable ranges. Identify any toxic substance(s) harmful to plant growth or life.
- E. Samples:
1. Compost, each source, 5 lb. packaged.
  2. Base material, each source, 5 lb. packaged.
  3. Each mix type specified, 5 lb. packaged.
  4. Filter fabric or woven geomembrane, 12" x 12".
- F. Statement(s) of Qualifications: Submit within 45 days of notice to proceed to confirm qualifications as specified in Article 1.04, herein.
- G. Schedule and Protection Plan: Submit a detailed plan for scheduling and sequencing of all contract work and for protection of soil mixes and other completed work including coordination with contractors requiring access through the site. Indicate with schedules and plans the utilization of soil mix and subsoil protection measures (filter fabric and snow fencing) over the surface area of plant bed installations, until substantial completion. Indicate with schedules and plans the utilization of finished work protection measures (wooden protection boards or other approved methods) over the work area of construction operations concurrent with all construction operations until substantial completion.

#### 1.04 QUALITY ASSURANCE

1. Qualifications:
  - a. Installation and maintenance foreman on the job shall be competent English-speaking supervisor(s), experienced in landscape installation and maintenance.
  - b. Perform work with personnel totally familiar with planting soil preparation and planting installations under the supervision of a foreman experienced with landscape work.
  - c. Soil Scientist or Agricultural Chemist: Experienced person or persons employed by public or private soils testing laboratory, qualified and capable of performing tests, making soil recommendations, and issuing reports as specified. Testing Laboratory and Agricultural Chemist shall be as approved by the Landscape Architect.
2. References:
  - a. Association of Official Agricultural Chemists.
  - b. American Society for Testing and Materials (ASTM) using test criteria as specified or required by other references.
  - c. American Society of Agronomy and Soil Science Society of America, Methods of Soil Analyses, Volumes I and II

- d. U.S. Composting Council Test Method for the Examination of Composting and Compost (TMECC)
  - e. Pre-installation Conferences: Person(s) responsible for soil preparation and mixes of this Section shall attend Pre-installation Conference(s) to coordinate with work of other sections.
3. Inspections and Testing:
- a. Soil, compost, and other material testing and soil mix testing required in this Section or additionally required by Owner's Representative shall be furnished and paid for by Contractor.
  - b. Owner's Representative or Landscape Architect reserve the right to take and analyze at any time such additional samples of materials as deemed necessary for verification of conformance to specification requirements. Contractor shall furnish samples for this purpose upon request and shall perform testing as requested.
  - c. The following testing facilities have been pre-approved for testing of planting soil components and blended planting soil mixes. Testing agencies not listed below shall be approved by the GRG Representative.
  - d. Soil Physical Parameters and Nutrient/Micronutrient Testing:
    - i) Rutgers Soil Testing Laboratory, 20 Indyk-Engel Way, North Brunswick Township, NJ 08902, or approved equal
  - e. Compost Testing:
    - i) Woods End Research Laboratory, 290 Belgrade Road, Mt Vernon ME 04352, Phone: 207-293-2457, Fax: 207-293-2488, [www.woodsend.org](http://www.woodsend.org), or approved equal
  - f. Biological Testing:
    - i) Soil Foodweb Inc, 1645 Washington Avenue Bohemia, NY, 11716, tel: 631.750.1553 [www.soilfoodweb.com](http://www.soilfoodweb.com)
    - ii) Earthfort Laboratory, 635 SW Western Blvd, Corvallis, OR 97333, (541) 257-2612

#### 1.05 REGULATORY REQUIREMENTS

- A. Comply with all rules, regulations, laws and ordinances of focal, state and federal authorities having jurisdiction. Provide labor, materials, equipment and services necessary to make work comply with such requirements without additional cost to Owner.
- B. Procure and pay for permits and licenses required for work of this section. Comply with the requirement of the Remedial Action Work Plan for the project.

#### 1.06 PROJECT/SITE CONDITIONS

- A. Acquaintance With Existing Site Conditions

1. Through study of all Contract Documents and by careful examination of the site, become informed as to the nature and location of the Work, the nature of surface and subsurface soil conditions, the character, quality and quantity of the materials to be encountered, the character of equipment and facilities needed preliminary to and during the prosecution of the Work, the general and local conditions, and all other matters which can in any way affect the Work.
2. Investigate the conditions to public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to, ingress and egress of this work site. Conform to all governmental regulations in regard to the transportation of materials to, from, and at the job site, and secure in advance such permits as may be necessary.
3. Should the Contractor, in the course of Work, find any discrepancies between Contract Drawings and physical conditions or any omissions or errors in Drawings, or in layout as furnished by the Owner, it will be Contractor's duty to inform the Landscape Architect immediately in writing for clarification. Work done after such discovery, unless authorized by the Landscape Architect, shall be done at the Contractor's risk.
4. Contractor shall be familiar with the Remedial Action Work Plan for the project and be experienced in working on sites with historic fill.

**B. Environmental Requirements:**

1. Perform both off-site mixing and on-site soil work only during suitable weather conditions. Do not disc, rototill, or work soil when frozen, excessively wet, or in otherwise unsatisfactory condition.
2. Soil mixes shall not be handled, hauled, or placed during rain or wet weather or when wet near or above field capacity.

**C. Sequencing and Scheduling: Adjust, relate together, and otherwise coordinate work of this Section with work of Project and all other Sections of Project Specifications.**

**1.07 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. **Packaged Materials:** Deliver packaged materials to the location where soils are to be mixed, in unopened bags or containers, each bearing the name, guarantee, and trademark of the producer, material composition, manufacturers' certified analysis, and the weight of the materials. Retain packages for the Construction Manager or Owner's Representative.
- B. Soil or amendment materials stored on site temporarily in stockpiles prior to placement shall be protected from intrusion of contaminants and erosion. All temporary storage means and methods shall be approved by Owner's Representative.
- C. Blending of soil materials will be sequenced to occur no more than four (4) to six (6) weeks before delivery and placement at the project site.
- D. After blending, soil materials shall be stockpiled in a location free from contamination. Stockpiles will be left uncovered during dry periods, and covered with a tarpaulin during precipitation.

**1.08 BASE COMPONENT MATERIALS**

**A. General:**

1. Contractor is responsible to provide and install planting soil mixes on rooftop structure as indicated on the drawings.
2. All planting soil mix materials shall fulfill the requirements for new planting soil mixes as specified.
3. Samples of individual components of plant mixes and also blended plant mixes shall be submitted by the Contractor for testing and analysis to the approved testing laboratory. Include verification testing of on-site sub-soils. Comply with specific material requirements specified.
  - a. No base component material for plant mix shall be used until certified test reports by a soil scientist or agricultural chemist have been received and approved by Landscape Architect.
  - b. As necessary, make any and all soil mix amendments and resubmit test reports indicating amendments until approved.
4. Owner's Representative may request additional testing by Contractor for confirmation of Mix quality at any time until completion. See Article 1.04, herein for additional requirements.

**B. Base Component Materials**

1. Base Component Soil shall be sandy loam soil from a single source capable of supplying a consistent quantity of the specified soil material meeting the requirements of this specification. Base Component Soil shall not be site salvaged unless approved by Landscape Architect.
2. Sand shall be used as the base component material for structural soils and drainage layers. Sand will be obtained from a single, consistent source.
3. Test Base Component Materials, both individual components and mixed materials, for compliance with material specifications. These test criteria and results, when approved, shall establish the standard to which all subsequent Base Component Material tests must conform.
4. Prior to blending Base Component Material with organic matter (compost), have one (1) composite sample tested from each 500 c.y. of Base Component Material intended for use in soil mixes of lawn and planting work.
  - a. Base Component Material shall meet specified requirements. The only allowable amendments to the Base Component Material will be for adjustment of nutrient levels and then only by means established by these specifications.
  - b. Perform the following tests and submit test reports. Failure to include any of the criteria stated below will be sufficient cause for rejection of the test reports.

5. Particle size analysis/distribution by sieve analysis as defined below as well as with a hydrometer method.
6. Fertility analysis - pH, soluble salts, nitrate, phosphate, potassium, calcium and magnesium.
7. Organic matter content (% oven dry weight of soil).
8. Toxic substance content.
9. Material drainage rate.

C. Material Requirements, Sand:

1. Physical Analysis (Soil Texture):

<u>Sieve Size</u>	<u>% Passing</u>	<u>% Retained</u>	<u>Dimension Class</u>
1"	100.0	0.0	Gravel
1/4"	100.0	0.0	Fine Gravel
# 10	95 - 100	0 - 5	Very Coarse Sand
# 20	80 - 90	5 - 20	Coarse Sand
# 40	35 - 45	35 - 55	Coarse Sand
# 60	15 - 25	10 - 30	Medium Sand
# 80	5 - 15	0 - 20	Fine Sand
#100	0 - 5	0 - 10	Very Fine Sand
#200	< 2	< 2	Very Fine Sand
Pan	<1		Silt/Clay

Test results must be submitted for per-cent (%) retained as well as for per-cent (%) passing for all sieve sizes. Failure to include any of the aforementioned criteria will be cause for rejection of the test report.

2. Chemical Analysis:

- a. Organic matter content (% oven-dry weight of soil as determined by loss on ignition). Organic matter content shall be less than 1%.
- b. Soil reaction (pH) - 6.0 ( $\pm 0.5$ )

- c. Soluble salt content (conductivity) - Less than 0.5 mm hos/cm for a 1:2 soil to water ratio.
- d. Toxic substance content harmful to plant growth.
  - i) Material Drainage at a rate of 55 to 70% of the total volume of water within 3 minutes. Soil should be saturated prior to conducting test.

D. Material Requirements, Sandy Loam

1. Physical Analysis (soil texture):

<u>Sieve Size</u>	<u>% Passing</u>	<u>Retained</u>	<u>Dimension Class</u>
1"	100.0	0.0	Gravel
1/4"	100.0	0.0	Fine Gravel
# 10	98 - 100	0 - 2	Very Coarse Sand
#20	85 - 98	10 - 15	Coarse Sand
# 40	63 - 75	10 - 35	Coarse Sand
#60	40 - 55	12 - 35	Medium Sand
#80	25 - 35	15 - 30	Fine Sand
#200	20 - 30	5 - 15	Very Fine Sand
Pan		20 - 30	Silt/Clay

Test results must be submitted for percent (%) retained as well as for percent (%) passing for all sieve sizes. Failure to include any of the aforementioned criteria will be cause for rejection of the test report.

2. Chemical Analysis:

- a. Organic matter content (% oven dry weight of soil)
- b. Total content shall be within the range of 3 to 4%.
- c. Soil reaction (pH) - 6.0 ( $\pm 0.5$ )
- d. Soluble salt content (conductivity) - Less than 3.1 mm hos/cm for a 1:2 soil to water ratio.
- e. Toxic substance content harmful to plant growth.
  - i) Hydrometer Testing:
    - i. Sand – 70 - 80%



ii. Silt – 10 - 20%

iii. Clay – 5 - 15%

Note: Silt and clay percentages combined must be at least 15%, and silt cannot be more than 2x the clay content of the soil

E. Before Base Component Soil is used for mixing with amendments, handle and stockpile Base Component Soil in the following manner:

1. Homogenize to make a uniform mix, free of subsoil lenses and other irregularities.
2. Aerate the base material to make a friable planting medium.
3. Separate out and remove all clay lumps, stones, stocks, roots, and other debris.
4. No. 8 Pea Gravel

a. Pea gravel will be washed, rounded rock of 1/4" to 3/8" diameter. Pea Gravel shall conform to the following:

Sieve Size	Percent Passing by Weight
12.5 mm	100%
10 mm	90 - 100%
5 mm	0 - 10%
2 mm	0 - 1%

\* This material shall be clean naturally occurring rock

F. Material Requirements: Compost

1. Compost shall be a stable, humus-like material produced from the aerobic decomposition and curing of organic vegetative residues derived from feedstock consisting of woody stems, leaves, grass cuttings, and livestock manure (up to 10 percent of the compost mix by volume). The compost shall be a dark brown to black color and be capable of supporting plant growth with appropriate management practices with no visible free water or dust, with no unpleasant odor.

a. Chemical Properties: Compost shall conform to the following values:

Item	Units	Range
Total nitrogen	ppm	2000 - 8000
Extractable nitrate	ppm	20 -200
Total phosphorus	ppm	5 - 2000
Available phosphorus	ppm	5 - 200
pH	Std U	5.5 – 8.0
Salt concentration	dS.m-1	<6

2. The ratio of carbon to nitrogen (C:N) shall range between 10:1 to 25:1.
3. Organic matter content of compost shall be at least 40 percent (dry weight). One hundred percent of the material shall pass a 1/2-inch (or smaller) screen. Debris such as metal, glass, plastic, wood (other than residual chips), asphalt or masonry shall not be visible and shall not exceed one percent dry weight.
4. The compost shall be screened to 1/2 inch maximum particle size and shall contain no more than 3 percent material finer than 1.0mm (No. 18 sieve) as determined by sieve analysis.
5. Additional tests defined in Part I as Chemical Properties shall be performed and the results will be utilized to evaluate amendments to the planting soil mixes that may be required.
  - a. Maturity:
    - i) CO<sub>2</sub> test: Compost respiration shall be no more than 6 mg CO<sub>2</sub>-C/gBVS day.
    - ii) Reheating test: The maximum heat rise shall be no greater than 9 degree C above room temperature (20 to 25 degrees C).
    - iii) Solvita test: The compost must achieve a maturity index of 6 or more.
  - b. Biological Values:
    - i) Active bacteria and fungi are not to be higher than 10 percent of total bacteria and fungi respectfully.
    - ii) Total bacteria to be a minimum of 500 ug/g
    - iii) Total fungi to be a minimum of 400 ug/g
    - iv) Protozoa to be 100,000 (amoeba and flagellates with no more 3000 ciliates)
    - v) Nematodes minimum of 10 beneficial, no root feeders
  - c. Pathogens/Metals/Vector Attraction reduction shall meet 40 CFR Part 503 rule, Table 3, page 9392, Vol. 58 No. 32.
  - d. Heavy metal content not to exceed the following amounts:

Element	Acetate Extract	HCL Extract
Iron	0.5 ppm	3.1 ppm
Manganese	0.5 ppm	15.4 ppm
Molybdenum	0.4 ppm	0.8 ppm
Zinc	0.2 ppm	4.4 ppm
Aluminum	0.2 ppm	1.2 ppm
Boron	1.1 ppm	1.7 ppm
Copper	None	0.01 ppm
Lead	0.1 ppm	0.4 ppm
Selenium	None	0.4 ppm
Mercury	None	None
Chromium	None	None
Cadmium	None	0.02 ppm
Nickel	None	0.04 ppm
Cobalt	None	0.05 ppm

None = none detected = below detection limits of 0.01 ppm.

- e. Total available N from biological cycling: 150 lbs per acre.
- f. Test compost for compliance with material specifications including organic matter, pH, and heavy metal content. Have one (1) composite sample tested for each new source of supply, each variable pile within each source of supply, and each 500 c.y. of material or as directed by Owner's Representative.

G. Material Requirements: Expanded Shale/Clay

- 1. Expanded shale or clay is a lightweight, porous ceramic material produced by expanding and vitrifying select shale in a rotary kiln, free of organic matter and fines. Expanded shale or clay (3/4x No. 4) is a planting soil mix component.
  - a. Expanded shale/clay properties include the following:

Analysis	Units	Result	FLL Guidelines for Extensive Sites <sup>1</sup>

<i>Particle Size Distribution</i>	mass %	>	0.9	< 10
< 0.05 mm ( <i>Fll reference value based on &lt; 0.06 mm</i> )	g/cm3	>	0.82	
	lb/ft3			
<i>Density Measurements</i>	g/cm3			
Bulk Density (dry weight basis)	lb/ft3			
Bulk Density (at max. water-holding capacity)	mass %			
Bulk Density (dry weight basis)	Vol. %			
Bulk Density (at max. water-holding capacity)	Vol. %			
<i>Water/Air Measurements</i>				
Moisture	Vol. %			
Total Pore Volume <sup>2</sup>	cm/s			
Maximum water-holding Capacity	in/min			
Air-Filled Porosity (at max water-holding capacity)	mmhos/cm			
Water permeability (Ksat)	(KCl)/L			
Water permeability (Ksat)	mass %			
<i>pH and Salt Content</i>	g/L			
pH (CaCl <sub>2</sub> )				
Soluble salts (water, 1:10, m:v)				
Soluble salts (water, 1:10, m:v)				
<i>Organic Measurements</i>				
Organic matter content				
				1.09 -15.8
				1.

<p><i>2 Total pore volume determined using measured particle density instead of assumed particle density as specified in FLL 2008. Guidelines for the Planning Execution and Upkeep of Green-Roof Sites</i></p>			

B. Mixing Procedures

1. Saturate the lightweight aggregate with water to ensure proper soil component distribution.
2. Mechanically mix appropriate proportions of remaining ingredients with the saturated aggregate until a uniform distribution is achieved.
3. When stockpiling the finished mix, cover the pile with a waterproof tarp to prevent drying out or separation of soil components from rain.
4. Material Requirements: Geofibers
  - a. Geofibers shall be discrete, fibrillated polypropylene fibers for turf soil reinforcement.
  - b. Geofibers shall conform to the following:

Property	Test Method	Requirement
Polypropylene	ASTM D4101	99% minimum
Fiber Length	Measured	2 inches

Color		Black
Specific Gravity	ASTM D792	0.91 gm/cc
Carbon Black Content	ASTM D1603	0.6%, minimum
Tensile Strength	ASTM D2256	40,000 psi
Tensile Elongation	ASTM D2256	15%, maximum
Young's Module	ASTM D3822	600,000 psi

- c. Geofibers will be packaged in sealed, waterproof 50lb bales or other approved packaging. Each bale or bag will be labeled as to its contents, including
5. Product Brand Name and Style Number
6. Name and address of manufacturer and supplier
7. Proper notifications of trademarks and/or patents
8. Net weight contents of each bag or bale
9. Material Requirements: Woven Geotextile/Filter Fabric
  - a. Filter fabric shall be a woven drainage geotextile, non-biodegradable.
  - b. The permeability of the drainage fabric shall be a minimum of 110 gal/min/sq. ft.
  - c. Filter fabric shall meet the following Minimum Average Roll Value (MARV) specifications across the weave:
10. Weight (Typical): 5.6 oz./yd<sup>2</sup>, according to ASTM D-5261
11. Grab Tensile Strength: 370 x 200 lbs., according to ASTM D-4632
12. Grab Elongation: 15% Max, according to ASTM D-4632
13. Trapezoidal Tear Strength: 115 x 75 lbs., according to ASTM D-4533
14. Puncture Resistance: 675 lbs., according to ASTM D-4833
15. Water Flow: 145 sec-1, according to ASTM 4491
16. Permittivity: 2.1 gpm / ft<sup>2</sup>, according to ASTM 4491
17. A.O.S: 40 U.S. Sieve, according to ASTM D4751
18. Percent Open Area: 10 oz./yd<sup>2</sup>, according to D4751
19. UV Resistance: 70% / 500 hours, according to ASTM D4355

#### 1.10 SOIL AMENDMENT MATERIAL

- A. Ground Limestone: Ground Limestone as a soil amendment material will only be used pending results of analysis.
1. Provide a Ground Agricultural Limestone with a minimum of 88% of calcium and magnesium carbonates.
  2. Ground Limestone material shall have a total 100% passing the 10 mesh sieve, minimum of 90% passing the 20 mesh sieve, and a minimum of 60% passing the 100 mesh sieve.

#### 1.11 HERBICIDES

- A. Herbicides: May be required for possible use if there is seed germination after sub-grade placement and prior to planting mix installation or after subsequent plant mix installation. Under no circumstances are materials to be applied without specific instruction from the Landscape Architect, or Owner's Representative.
1. Pre-Emergent and Post-Emergent Herbicides shall be approved before use for type and rate of application by the Landscape Architect and by local and state agencies with jurisdiction.

#### 1.12 PLANTING SOIL MIXES

- A. Soil Mix Types: Provide the following planting soil mix types at the locations indicated. Adequate quantities of mixed planting and light weight soil materials shall be provided to attain, after compaction and natural settlement, all design finish grades.
1. Refer to the drawings for planting mix types.
  2. Provide synthetic reinforcing fibers for plant soil mix for all turf areas.
- B. Planting Soil Blending
1. Planting soils shall consist of base sandy loam soil blended with compost in the ratios presented in the following chart. Mix ratios are approximate and shall be adjusted as required to meet the specific requirements of the planting soil mixes.

Planting Soil Mix	Soil Blending Ratios by Volume			
	Sandy Loam	Compost	Expanded Shale/Clay	Sand
Sub Soil Mix	2	0	1	0
Lawn Soil Mix	3	1	0	0
Tree/Shrub Soil	5	2	0	0
Base Sand	0	0	0	1

2. Uniformly mix ingredients as specified for each Planting Soil Mix Type (Loamy Sand, compost, and/or expanded shale/clay, and possible other materials deemed to be necessary as a result of testing) by wind rowing/tilling on an approved, clean hard surface area. *Sandy loam and compost must be blended to a uniform, homogenous mix prior to mixing with expanded shale/clay.* Compost shall be maintained moist, not wet, during mixing. Other amendments shall not be added unless approved to extent and quantity by Landscape Architect and Owner's Representative and additional tests have been conducted to verify type and quantity of amendment is acceptable.
  3. Hammer mills or blending knives are not permitted in preparation of the planting soil mixes as these processes reduce soil structural stability.
  4. When stockpiling the finished mix, cover the pile with a waterproof tarp to prevent drying out or separation of soil components from rain.
- C. On-Going Sampling and Testing of Planting Soil Mixes (Production Runs)
1. Sampling: During soil blending operations, samples shall be collected for quality assurance. Collect samples in accordance with this Specification. Each sample shall be labeled with the planting soil mix, batch number, and date of sample. Collect samples of each 500 cubic yards of planting soil mix produced immediately upon completion of each production run or as required by Owner's Representative intended for use in each type of lawn and plant mix to include the following:
    - a. Nutrient Analysis:
      2. Have nutrient levels (nitrate, nitrogen, phosphate, potassium, magnesium, calcium, ammonium, iron, and manganese) tested, and request testing laboratory recommendations for additional fertilizer requirements at both lawn and all plant areas if nutrient levels are below average.
      3. Nutrient deficiencies in soils of plant areas shall be corrected at time of installation.
      4. Nutrient deficiencies in soils of lawn areas shall be corrected both at time of lawn installations and during maintenance period as specified.
        - a. Test organic matter, pH, soluble salts.
    5. Sampling Methods: All samples shall be composite samples that are assembled from a minimum of 6 subsamples taken from the stockpiled material. Blend samples together and submit for testing the quantity required by the testing agency.
    6. Sample and perform soil tests to demonstrate that materials meet the specifications.
      - a. No planting soil mix shall be used until certified test reports by an approved Testing Agency have been approved by the Landscape Architect.



- b. The Landscape Architect may request additional testing by the Soil Blending Contractor for confirmation of mix quality and/or soil mix amendments at any time until delivery to the site.
  - c. If, at any time during the project, the planting soil components, base loam or planting soil mixes require adjustment to meet the specifications and/or performance criteria then the Soil Blending Contractor shall submit the adjusted soil components and/or mixes for testing as specified herein.
  - d. Additional testing for re-approval shall be required should any of the material sources change after initial approval.
- D. Stockpiling and Plant Mixes
  - 1. General: Stockpiling and Plant Mixes utilized for planting soil on-site, off-site and at source should be restricted to no more than the needs of what can be used in a 24-hr. period.
  - 2. Stockpiles should be no more than 6 feet in height to prevent anaerobic conditions within the pile(s). Stockpiles shall be sheltered from weather to prevent excessive water absorption and blowing by winds as approved by Owner's Representative.
  - 3. Soils shall not be stockpiled on or within the construction areas.

## **PART 3 - EXECUTION**

### **3.01 VERIFICATIONS**

- A. Prior to construction and soil placement operations at planting areas, ascertain the location of all electric cables, conduits, underdrainage systems and utility lines. Take proper precautions so as not to disturb or damage sub-surface elements. Contractor failing to take these precautions shall be responsible for making requisite repairs to damaged utilities at Contractor's own expense.
- B. Verify that required underground utilities are available, in proper location, and ready for use. Coordinate with other trades.
- C. Verify that all work requiring access through or adjacent to areas where plant mixes are to be placed has been completed and no further access will be required. In the event that access will be required, this must be coordinated with the Owner's Representative.

### **3.02 PLANTING MIXTURES**

- A. Planting soil mixes shall be of the type(s) indicated in accordance with the planting details, and shall be pre-mixed and placed as specified.
  - 1. Bring to pH levels of 6.5 +/- 0.5 standard units. pH-shall be verified by testing.

2. Lower pH by using ammonium sulfate product. Peat moss or copper sulfate may not be used to lower pH. Consult with soil scientist to determine appropriate application rates.
- B. All amendments shall be thoroughly incorporated into the mixture to assure uniform distribution. Delay mixing of fertilizers if planting will not follow within a few days.

### 3.03 PLACING PLANTING SOIL

- A. Remove all large clods, lumps, brush, roots, stumps, litter, and other foreign material and stones three-quarters inch (3/4") in diameter or larger. Dispose of removed material legally offsite.
- B. Do not place a muddy or wet soil mix.
- C. Planting soil mixes shall be placed carefully to avoid damage or displacement of other materials such as walls, paving, drainage components, filter fabric, or roofing membrane. Refer to Soil Profile Plan Sheet notes for soil placement details.
- D. Planting soil mixes soil shall be placed to within 1 inch greater than final grade or to a depth of no greater than 8 inches and compacted as described in Point c. below. For final grades less than 8 inches only one round of compaction shall be performed and remaining soil loosely placed prior to wetting (see Point e. below). For final grades greater than 8 inches, place soil at no greater than 6 inches and repeat procedure until soil has been compacted within 1 inch of final grade. The remaining soil shall be loosely placed at 1 inch greater than final grade and wetted.
- E. Compaction shall be performed with a 200 – 300 lb. landscape roller or lightly compacted with a hand held mechanical compactor to achieve a 75 - 80% compaction as determined by ASTM D1557. Dry soil density shall not exceed 1.35 g/cm<sup>3</sup> (85 lbs/cf)
- F. After compaction remaining soil shall be placed and thoroughly watered or jetted over entire area. Fill settled low areas with additional soil and re-wet to achieve uniform prescribed final grade.
- G. Placement of Geocells: For geogrid that is installed between the tree planting soil and the porous surface material, the Contractor shall ensure the geocells remains level relative to its position.

### 3.04 TESTING

- A. After installation, perform in-situ soil density and double-ring infiltrometer tests in conformance with Part 1 of this specification. Remediate any areas that exceed the specified compaction rate or that fail to drain within the specified rate. Remediation shall include de-compaction, aeration, or full replacement of the affected soil areas.
  - a. Standard Proctor Density Test: Conforming to ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
    - i) Density Tests (Compaction):

2. Nuclear Method: ASTM D6938 - 10 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
  - a. Infiltration Test: Double ring infiltrometer, falling head, conforming to ASTM D3385-09
    - i) Infiltration rate shall be minimum 1.5"/hr.

**END OF SECTION 329113**

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## **SECTION 330510 - OTHER UTILITIES**

### **PART 1 GENERAL**

#### **1.1 SCOPE OF WORK**

Work under this Section shall consist of providing all labor, plant facilities, materials and equipment necessary and required to install the gas, electric, telephone and cable television facilities in accordance with the Contract Documents. This Work shall include but not be limited to:

- A. Installation of on-site utilities consisting of pipe, conduit and all necessary and required accessory items and operations associated with said installation.
- B. Coordinate with the utility companies regarding the installation of utilities within the right-of-way and on-site as required, including connections to existing facilities.

#### **1.2 RELATED SECTIONS**

- A. Section 011100 - General Requirements, as related to As-Built Requirements
- B. Section 312000 - Earthwork
- C. Local Utility Companies and Governing Agencies
- D. Contract Documents

#### **1.3 COORDINATION**

- A. All work under this Section shall be coordinated with the gas, electric and telephone utility company and shall comply with all requirements, details, regulations, etc. of said utility company. The Contractor shall coordinate with each utility to define where his limit of work exists before submitting a bid price for this Section.
- B. Work shall be coordinated with the electrical and/or mechanical contractors responsible for building and light standard connections.

### **PART 2 PRODUCTS**

#### **2.1 GENERAL**

- A. When available, those materials specified by the appropriate utility company shall be used in lieu of those materials specified in this Section.

#### **2.2 GAS PIPING**

- A. All gas pipe, fittings, joints and valves shall comply with all requirements, regulations, specifications and recommendations of the gas company.

#### **2.3 ELECTRIC, TELEPHONE AND CABLE DUCTBANK**

- A. Concrete ductbank shall comply with all requirements of applicable utility companies.

2.4 MANHOLE/PULL PITS

- A. All manholes and pull pits required by the utility company shall comply with all requirements, regulations, specifications, details, and recommendations of said utility company.

**PART 3 EXECUTION**

3.1 CONSTRUCTION

- A. General:

The Contractor shall install all pipe, conduit and ductbank in the locations as shown on the Drawings and/or as approved by the Owner's Engineer and utility company. Pipe and conduit shall be of the type and sizes specified and shall be laid accurately to line and grade. Any necessary structures shall be accurately located and properly oriented.

- B. Excavation and Backfill:

1. When available, those requirements, specifications and procedures, for excavation and backfill, specified by the appropriate utility company shall be used in lieu of these specifications. When such specifications are not available from said utility company, the requirements of this specification shall apply.
2. The provisions of Section 312000 entitled "Earthwork" shall govern Work under this Section.

- C. Storage and Handling of Conduit and Pipe:

All pipe and conduit shall be protected against impact, shock and free fall, and only equipment of sufficient capacity and proper design shall be used in handling. Storage of pipe and conduit on the job shall be in accordance with manufacturer's recommendations, subject to the approval of the Owner's Engineer.

- D. Damage to Pipe and Conduit:

Pipe or conduit which is defective from any cause, including damage caused by handling, and determined by the Owner's Engineer as unrepairable, shall be unacceptable for installation and shall be replaced at no cost to the Owner as directed by the Owner's Engineer.

Pipe or conduit that is damaged or disturbed through any cause prior to acceptance of the Work shall be repaired, realigned or replaced as directed by the Owner's Engineer, at the Contractor's expense.

- E. Pipe Installation:

1. All piping and conduit shall be laid in accordance with the requirements and procedures specified by the appropriate utility company. When such requirements are not available from said utility company, the requirements of this specification

shall apply.

2. Each length of pipe and conduit shall be laid with firm, full and even bearing throughout its entire length, in a trench prepared and maintained in accordance with Section 312000. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. The interior of the pipe and the jointing seal shall be free from sand, dirt and trash before installing the line. Minimum cover over the top of the pipe or conduit shall comply with the utility specifications and shall never be less than 2-ft.
3. Bedding and Backfilling: The type of materials to be used in bedding and backfilling and the method of placement shall comply with the requirements and procedures specified by the appropriate utility company. When such requirements are not available, the type of materials to be used in bedding and backfilling and the method of placement shall conform to the requirements of these specifications and as shown on the Details of the Drawings.
4. Protection During Construction: The Contractor shall protect the installation at all times during construction, and movement of construction equipment, vehicles and loads over and adjacent to any pipe shall be performed at the Contractor's risk.

At all times when pipe laying is not in progress, all open ends of pipes shall be closed by temporary watertight plugs. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been pumped dry and all danger of water entering the pipe has passed.

F. Pipe/Conduit Joints:

1. When available, those specifications and requirements specified by the appropriate utility shall be used in lieu of these specifications. Where such specifications are not available from said utility company, the requirements of this specification shall apply.
2. All joints are to be made watertight in accordance with the requirements specified herein. Pipe shall be jointed in strict accordance with the Pipe manufacturer's instruction. Jointing of all pipe shall be done entirely in the trench. Assembly of PVC conduit shall be with a solvent type adhesive as recommended by the conduit manufacturer.

G. Manholes/Pull Pits:

Any manholes or pull pits required by the appropriate utility shall be fabricated, bedded, located and backfilled in accordance with said utility requirements and recommendations. Final location(s) shall be approved by the Owner's Engineer.

H. Connection to Existing Facilities:

1. General: The Contractor shall make all required connections of the proposed gas lines into existing gas facilities, where and as shown on the Contract Documents and/or as approved by the gas company.

The Contractor shall terminate the upstream end of the electric and telephone conduit at a location specified by the electric and telephone companies.

2. Compliance with Requirements of Owner of Facility: Connections into existing facilities shall be performed in accordance with the requirements of the owner of the facility. The Contractor shall be required to comply with all such requirements, including securing of all required permits, and paying the costs thereof. The cost of making the connections in accordance with the requirements of the Owner of the existing facility shall be included in the Contract Sum.
3. Cable pulling and connection of wire and cable to the existing facilities is not covered under this specification and will be done by others.

I. Construction within the Public Right-Of-Way:

Construction within the public right-of-way shall conform to all requirements of the Borough of North Haledon Representative Engineer and any other agencies having jurisdiction.

J. Service Lines:

1. The Contractor shall install gas piping and electric/telephone conduit to points located 5-ft outside the proposed building lines as shown on the Drawings. All pipes and conduit shall be properly sealed with watertight plugs and shall be clearly marked from above.
2. The Contractor will be required to coordinate his work with the work of the Building Contractor to determine the exact location and elevation of the point of entry into the building. If the Building Contractor has installed his portion of the service lines, Work under this Contract shall also include final connections of the service lines 5-ft outside the building line to the building service line at no additional cost to the Owner.

3.2 . INSPECTION AND TESTING

- A. The Contractor shall perform all inspection and testing of these installations as required by the appropriate utility company and shall bear all costs arising therefrom.

3.3 FINAL INSPECTION

- A. Upon completion of the Work and before final acceptance by the Owner, these installations may be subjected to a final inspection in the presence of the Owner's Engineer, a Borough of North Haledon Representative Engineer or a representative of the utility company. The Work shall not be considered as completed until all requirements for line, grade, cleanliness, tests and workmanship have been met.

**END OF SECTION 330510**

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## **SECTION 331000 - PROTECTION OF EXISTING UTILITIES**

### **PART 1 GENERAL**

#### **1.01 SCOPE OF WORK**

- A. Identification and field mark out of all on-site utility lines to remain in operation during construction.
- B. Identification and field markout of all off-site utility lines within construction work areas.
- C. Submission of procedures to be used to ensure the safety of the utility.
- D. Conduct test pit excavation at all proposed utility crossings prior to construction.
- E. Repair of any damage during construction operations.
- F. Relocate utilities that are indicated as such.

#### **1.02 RELATED SECTIONS AND DOCUMENTS**

- A. Section 311000 – Site Preparation
- B. Section 024119.1 – Site Demolition
- C. Section 312000 – Earthwork
- C. Contract Drawings

#### **1.03 PROJECT RECORD DOCUMENTS**

- A. Accurately record actual locations of capped utilities and utility lines encountered during construction.
- B. Accurately record actual locations and elevations of existing utilities at proposed utility crossings prior to utility and storm sewer construction. Submit recorded data to Owner's Engineer for verification of proposed design.

#### **1.04 REGULATORY REQUIREMENTS**

- A. Contractor shall notify all affected utility companies, agencies, authorities, owners, etc. at least 48 hours prior to the commencement of work or as required by each agency and shall comply with their requirements.
- B. Contractor shall contact the "New Jersey One Call System", 811 or (800) 272-1000, service for an official utility mark out.

### **PART 2 PRODUCTS**

NOT APPLICABLE



## **PART 3        EXECUTION**

### **3.01    IDENTIFICATION**

- A.     Locate all existing utilities which are to remain in service and/or require relocating during construction as shown on the Contract Drawings.

### **3.02    PROTECTION**

- A.     Flag, barricade or suitably protect existing utilities during construction operations and equipment movement. Install shoring and bracing as required.
- B.     Prevent interruption of existing utility service to occupied or used facilities, except when authorized in writing by authorities having jurisdiction.

### **3.03    LATERAL DISCONNECTION**

- A.     Where a utility line is to be disconnected from portions to remain, the lateral pipes shall be cut and suitably plugged/capped in accordance with the Contract Drawings and applicable utility or agency requirements.

### **3.04    REPAIRS**

- A.     Any damage to existing, operational utilities by the Contractor or his subcontractors during the on-going construction operation shall be immediately repaired to operational standards at the Contractor's expense. If the repairs are not immediately addressed by the Contractor, the utility owner and/or the Owner shall have the right to contract for the repair at the Contractor's expense.

### **3.05    RELOCATIONS**

- A.     Where utility lines are designated to be relocated, construct new utilities as shown and in accordance with these specifications and then remove former service to minimize disruption to the best extent practical. This operation shall be coordinated with the appropriate Authorities, as necessary.

## **END OF SECTION 331000**

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## SECTION 332200 - WATER DISTRIBUTION SYSTEMS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Site water piping and fittings including domestic potable waterline and fire protection system supply waterline, valves, and fire hydrants.
- B. Connection of site water system to municipal water systems.

#### 1.02 RELATED SECTIONS

- A. Section 312000 - Earthwork
- B. Construction Drawings

#### 1.03 REFERENCE STANDARDS

- A. American Society of Mechanical Engineers (ASME) latest edition
  - 1. B 16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- B. American Society for Testing and Materials (ASTM) latest edition
  - 1. B 88 Seamless Copper Water Tube
  - 2. D 1784 Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
  - 3. D 2241 Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)
  - 4. D 2564 Poly (Vinyl Chloride) (PVC) solvent cement
  - 5. D 2672 Poly (Vinyl Chloride) (PVC) integrally molded bell ends for solvent - cemented pipe joints.
  - 6. D 2855 Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
  - 7. D 3139 Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals
  - 8. F 477 Elastomeric gaskets and lubricant
  - 9. F 656 Poly (vinyl chloride) (PVC) cement Primer
- C. American National Standards Institute (ANSI) latest edition
  - 1. A21.8
- D. American Water Works Association (AWWA) latest edition
  - 1. C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
  - 2. C105 Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
  - 3. C110 Ductile-Iron and Gray-Iron Fittings, 3 Inches Through 48 Inches, for Water and Other Liquids
  - 4. C111 Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
  - 5. C151 Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

6. C200 Steel Water Pipe 6 Inches and Larger
7. C500 Gate Valves for Water and Sewage Systems
8. C502 Dry-Barrel Fire Hydrants
9. C504 Rubber-Seated Butterfly Valves
10. C600 Installation of Ductile-Iron Water Mains and Appurtenances
11. C606 Grooved and Shouldered Joints
12. C651 Disinfecting Water Mains
13. C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water Distribution

- E. National Fire Protection Associations (NFPA)
1. NFPA 13 Installation of Sprinkler Systems
  2. NFPA 24 Installation of Private Fire Service Mains and Their Appurtenances

#### **1.04 QUALITY ASSURANCE**

- A. Products, where marked for compliance with code or test standards, shall also mark specific standard as required in the Contract Documents.
- B. Perform installation in accordance with utility company and municipality requirements.
- C. Valves: Manufacturer's name and pressure rating marked on valve body.
- D. Perform disinfection of potable lines in accordance with AWWA C651.

#### **1.05 SUBMITTALS**

- A. Product Data: Provide Engineer with data on pipe materials, pipe fittings, hydrants, valves, and accessories.
- B. Manufacturer's Certificate: Certify that products meet or exceed state or local requirements.
- C. Furnish 1 copy of results of meter test and hydrostatic pressure test to Owner and utility company upon completion of water distribution backfilling operations.

#### **1.06 PROJECT CONDITIONS**

- A. Coordinate work with connection of water/sewer/storm sewer service outside building to maintain water service to affected parties, including the operating store. Contractor to notify affected parties 48 hours prior to interruption of any services.

### **PART 2 PRODUCTS**

#### **2.01 PIPE AND FITTINGS**

- A. Pipe sizes 3-inches and smaller for installation below grade and outside building shall comply with one or combination of following:
  - 1. Seamless Copper Tubing: Type "K" soft copper, ASTM B88.
    - a. Fittings: Wrought copper (95-5 Tin Antimony solder joint), ASME B 16.22.
  - 2. Polyvinyl Chloride (PVC) Water Pipe: Pipe, ASTM D 2241, with SDR 21 rating, continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D1784 material classification.
    - a. Pipe joints: Integrally molded bell ends, ASTM D2672.
    - b. Cement primer: ASTM F656.
    - c. Solvent cement: ASTM D2564.
- B. Pipe sizes 4 to 16 inches for installation below grade and outside building shall comply with one or combination of following:
  - 1. Ductile Iron Water Pipe: AWWA C151, Pressure class 350 (4-12") Pressure Class 250 (14-16").
    - a. Fittings: Either mechanical joint or push-on joint, AWWA C153, and shall be coated with a 6-8 mil nominal thickness fusion bonded epoxy conforming to the requirements of AWWA C550 and C116, or cement mortar lined in accordance with AWWA C104.
    - b. Elastomeric gaskets and lubricant: ASTM F477.
  - 2. Polyvinyl Chloride (PVC) Water Pipe: Pipe, AWWA C900, rated DR 18 (Class 150), continually marked as required.
    - a. Elastomeric gaskets and lubricant: ASTM F477 for smaller pipes.
    - b. Pipe joints: Integrally molded bell ends, ASTM D3139.

## 2.02 GATE VALVES - 2-Inches and Larger

- A. Manufacturer and Model: Mueller Resilient Wedge Gate Valves or approved equal.
- B. AWWA C509, iron body, non-rising stem with square nut, single wedge, resilient seat, flanged or mechanical joint ends, control rod, post indicator where indicated on Construction Drawings, extension box and valve key.

## 2.03 BALL VALVES - 2-Inches and Smaller

- A. Manufacturers: Mueller Oriseal or approved equal.
- B. Brass body, teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA compression inlet end, compression outlet with electrical ground connector, with control rod, extension box and valve key.

## 2.04 BUTTERFLY VALVES - from 2-Inches to 24-Inches

- A. AWWA C504, Iron body, bronze disc, resilient replaceable seat, water or lug ends, infinite position lever handle.

## 2.05 CHECK VALVES, POST INDICATOR VALVES, and BACKFLOW PREVENTORS

- A. Refer to Fire Suppression in Architectural/Building Specifications

## 2.06 FIRE HYDRANTS ASSEMBLIES

- A. Fire Hydrants: Type as required by utility company/Local Fire Department and as shown on Construction Drawings.
- B. Hydrant Extensions: Fabricate in multiples of 6-inches with rod and coupling to increase barrel length.
- C. Hose and Steamer Connections: Match sizes with utility company, with two hose nozzles, one pumper nozzle.
- D. Finish: Apply primer and 2 coats of enamel or special coating to color as required by utility company.

## 2.07 ACCESSORIES

- A. Thrust Blocking: Place 3000 psi concrete to provide sufficient bearing area to transmit unbalanced thrust from bends, tees, caps, or plugs to undisturbed soil without loading undisturbed soil in excess of 2,500 pounds per square foot when water main pressure is 200 psi. In addition to thrust blocks the contractor shall use restrain mechanical joints at all fittings

HORIZONTAL THRUST BLOCKS							
(BLOCKING HEIGHT GREATER THAN PIPE O.D.)							
(BLOCKING WIDTH BETWEEN 1 AND 2 TIMES HEIGHT)							
REQUIRED SQ. FT. OF UNDISTURBED EARTH WALL FOR REACTION BACKING							
TYPE OF FITTINGS							
PIPE DIAMETER	TEES SQ. FT.	90° BEND SQ. FT.	45° BEND SQ. FT.	22 <sup>1</sup> / <sub>2</sub> ° BEND SQ. FT.	11 <sup>1</sup> / <sub>4</sub> ° BEND SQ. FT.	5 <sup>5</sup> / <sub>8</sub> ° BEND SQ. FT.	CAP/PLUG SQ. FT.
3"	2.0	2.0	2.0	2.0	2.0	2.0	2.0
4"	2.0	2.0	2.0	2.0	2.0	2.0	2.0
6"	5.0	5.0	3.0	2.0	1.0	1.0	5.0
8"	9.0	9.0	5.0	2.5	1.5	1.0	9.0
10"	12.0	12.0	7.0	4.0	2.0	1.0	12.0
12"	18.0	18.0	10.0	5.0	2.5	1.5	12.0
14"	25.0	25.0	16.0	8.0	4.0	2.0	25.0
16"	40.0	40.0	20.0	10.5	5.5	4.0	40.0
18"	45.0	45.0	25.0	12.0	6.0	4.0	45.0

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that building service connection and municipal utility water main size, location, and depth are as indicated on Construction Drawings.

**3.02 PREPARATION**

- A. Ream pipe and tube ends and remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare pipe for connections to equipment with flanges or unions.
- D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

**3.03 BEDDING**

- A. Excavate pipe trench and place bedding material in accordance with Section 312000

**3.04 INSTALLATION - PIPE, FITTINGS AND VALVES**

- A. Maintain separation of water main from sanitary and storm sewer piping in accordance with state or local codes.
- B. Install pipe and fittings in accordance with AWWA C600.
- C. Install pipe to allow for expansion and contraction without stressing pipe or joints or as specified by pipe manufacturer.
- D. Install water pipe, fittings and valves in conformance with AWWA C600.
- E. Connections with Existing Private Pipelines: Where connections are made between new work and existing private piping, make connection using suitable fittings for conditions encountered. Make each connection with existing pipe at time and under conditions with least interference with operation of existing pipeline and in compliance with local utility company.
- F. Form and place concrete for thrust blocks or other specified methods of retainage at each change of direction or end of pipe main.
- G. Establish elevations of buried piping in accordance with Section 312000.
- H. Install trace wire continuous over top of non-metal pipe. Bury a minimum of 6 inches below finish grade, and above pipeline.

**3.05 DISINFECTION, TESTING, FLUSHING AND SAMPLING OF DOMESTIC WATER PIPING SYSTEM**

- A. Disinfect distribution system with chlorine before acceptance for domestic operation. Chlorine dosage shall be not less than 50 parts per million. Flush lines before introduction of chlorinating materials and after contact period of not less than 24 hours. Flush with clean water after contact period until residual chlorine content is not greater than 1.0 part per million. Flush water discharged from water supply lines or hydrants shall not be allowed to discharge directly onto exposed soil or turf which could result in erosion of soil. If potential

for erosion exists at discharge point, measures shall be taken to prevent erosion. Open and close valves in lines being disinfected several times during contact period. After disinfection, take water sample and bacteriological test in accordance with AWWA C651. Do not place distribution system in service until approval is obtained from local governing authorities.

- B. Contractor shall provide a means of neutralizing the super chlorinated water before releasing into the environment. This may be accomplished by either a method of dechlorinization, direct release into a detention area or any method acceptable to federal, state, and local codes. Direct release to open ground shall not be allowed, unless contained within an on-site detention facility with 6" permanent storage. In this case, the Contractor shall time the release to assure that no rainstorms are imminent. The intent of this condition is to allow the majority of the chlorine to evaporate into the atmosphere before a rainstorm has the opportunity to wash the residual downstream. Contractor shall not release super chlorinated water directly into the sanitary sewer system, private or public, nor any storm drain system not directly discharging into the detention facility.

**END SECTION 332200**

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## **SECTION 332334 – EXCAVATION, BACKFILL AND COMPACTION FOR PAVEMENT**

### **PART 1 - GENERAL**

#### **1.01 SUMMARY**

- A. Excavation to line, grade, and configuration as shown on Construction Drawings for proposed and future pavement areas.
- B. Fill to line, grade, and configuration as shown on Construction Drawings for proposed and future pavement areas.
- C. Compacting fill materials in acceptable manner as specified herein.

#### **1.02 RELATED SECTIONS**

- A. Section 312200 – Earthwork
- B. Section 321123 - Aggregate Materials
- C. Section 321124 - Base Course
- D. Section 321216 - Asphaltic Concrete Paving
- E. Section 321000 - Curbs and Sidewalks
- F. Construction Drawings

#### **1.03 REFERENCE STANDARDS**

- A. See Section 312200

#### **1.04 QUALITY ASSURANCE**

- A. Independent Testing Laboratory, selected and paid by Owner, will be retained to perform construction testing on filling operations and subgrade analysis as specified in Section 312200 and as specified herein.
- B. Testing shall be in accordance with Part 3, Section 3.07, “Field Quality Control”.

#### **1.05 SUBMITTALS**

- A. Shop drawings or details pertaining to excavating and filling for pavement are not required unless otherwise shown on Construction Drawings or if contrary procedures to Construction Documents are proposed.
- B. Submit 30-pound sample of each type of off-site fill material that is to be used in backfilling in air-tight container to independent testing laboratory or submit gradation and certification of aggregate material that is to be used to independent testing laboratory for review.



## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Fill material from off-site as specified in Section 310100 and approved by Owner.
- B. Aggregate material as specified in Section 321123.

### 2.02 EQUIPMENT

- A. Transport off-site materials to project using well-maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping.

## PART 3 - EXECUTION

### 3.01 PREPARATION

- A. Identify lines, elevations, and grades necessary to construct pavements, curb, curb and gutter, bases, sidewalk, and roadways as shown on Construction Drawings.
- B. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.
- C. Locate and identify site utilities that have previously been installed and protect from damage.
- D. Locate and identify existing utilities that are to remain and protect from damage.
- E. Over excavate and properly prepare areas of subgrade that are not capable of supporting proposed systems. Stabilize these areas by using acceptable geotextile fabrics or aggregate material.

### 3.02 EXCAVATION

- A. Excavate roadway and pavement areas to line and grade as shown on Construction Drawings.
- B. Place suitable material into project fill areas as specified in Section 310100.
- C. Unsuitable excavated material is to be disposed of in manner and location that is acceptable to Owner and local governing agencies.
- D. Perform excavation using capable, well-maintained equipment and methods acceptable to Owner and local governing agencies.

### 3.03 FILLING AND SUBGRADE PREPARATION

- A. Areas exposed by excavation or stripping and on which subgrade preparations for paving are to be performed, including future pavement areas, shall be scarified to minimum depth of 8-inches and compacted to minimum of 98 percent of optimum density, in accordance with ASTM D 698 (or 95 percent of optimum density, in accordance with ASTM D 1557) at moisture content of not less than 1 percent below and not more than 3 percent above optimum moisture content. Proofroll these areas to detect areas of insufficient compaction. Accomplish proofrolling by making minimum of 2 complete passes with fully-loaded tandem-axle dump truck with a maximum loaded weight of 20 tons, or approved equal, in each of 2 perpendicular directions under supervision and direction of the independent testing laboratory. Excavate and recompact areas of failure as specified herein.
- B. Place fill materials used in preparation of the subgrade in lifts or layers not to exceed 8-inches loose measure and compacted to minimum density of 98 percent of optimum density, in accordance with ASTM D 698, (or 95 percent of optimum density, in accordance with ASTM D 1557) at moisture content of not less than 1 percent below and not more than 3 percent above optimum moisture content.
- C. Following table stipulates maximum allowable values for plasticity index (PI) and liquid limit (LL) of suitable fill materials to be used in specified areas, unless specifically stated otherwise on Construction Drawings:

	<u>PI</u>	<u>LL</u>
*Paving Area, below upper two feet	20	50
*Paving Area, upper two feet	15	40

(\*References to depth are to proposed subgrade elevations)

- D. Fill material imported from off-site or fill material removed from onsite cut areas shall have CBR or LBR value equal to or greater than pavement design subgrade CBR or LBR value indicated on Construction Drawings.

### 3.04 COMPACTION

- A. Maintain optimum moisture content of fill materials as specified herein to attain required compaction density.
- B. Test materials in accordance with Section 312200.
- C. Corrective measures for non-complying compaction: Remove and recompact deficient areas until proper compaction is obtained at no additional expense to Owner.

### 3.05 MAINTENANCE OF SUBGRADE

- A. Verify finished subgrades to ensure proper elevation and conditions for construction above subgrade.

- B. Protect subgrade from excessive wheel loading during construction including concrete trucks, dump trucks, and other construction equipment.
- C. Remove areas of finished subgrade found to have insufficient compaction density to depth necessary and replace in manner that will comply with compaction requirements by use of material equal to or better than best subgrade material on site. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section.

### 3.06 FINISH GRADING

- A. Finish grading shall be in accordance with Section 312200 and as specified herein.
- B. Check grading of paving areas by string line from grade stakes (blue tops) set at not more than 50-foot centers. Tolerances of 0.10-foot, more or less, will be permitted. Contractor is to provide engineering and field staking necessary for verification of lines, grades, and elevations.

### 3.07 FIELD QUALITY CONTROL

- A. See Section 312200, 3.24, "Field Quality Control".

## PART 4 - MEASUREMENT AND PAYMENT

### 4.01 MEASUREMENT AND PAYMENT

The price bid for all excavation, backfill, compaction and testing as described in Section 332334 Excavation, Backfill, and Compaction for Pavement shall be included in the respective Items that require excavation, backfill and compaction in order to properly complete all Contract work.

### END OF SECTION

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## SECTION 334100 - STORM DRAINAGE

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Site storm sewer drainage piping, fittings, accessories, and bedding.
- B. Connection of building and site storm water drainage system to municipal storm sewers.
- C. Catch basins, paved area drainage, site surface drainage, and stormwater detention facilities.

#### 1.02 RELATED REQUIREMENTS

- A. Section 312000 - Earthwork
- B. Section 312200 – Erosion and Sedimentation Control
- C. Section 334300 - Sewer Manholes, Frames, and Covers
- D. Construction Drawings

#### 1.03 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials (AASHTO) latest edition
  - 1. M36 Zinc Coated (Galvanized) Corrugated Iron or Steel Culverts and Under Drains
  - 2. M190 Bituminous Coated Corrugated Metal Culvert Pipe and Arches
  - 3. M252 Corrugated Polyethylene Drainage Tubing, 3 to 10 Inch Diameter
  - 4. M294 Corrugated Polyethylene Drainage Tubing, 12 to 36 Inch Diameter
- B. American Society for Testing and Materials (ASTM) latest edition
  - 1. A74 Cast Iron Soil Pipe and Fittings
  - 2. A185 Steel welded Wire Fabric, Plain, for Concrete Reinforcement
  - 3. A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
  - 4. A746 Ductile Iron Gravity Sewer Pipe
  - 5. C 76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
  - 6. C150 Portland Cement
  - 7. C206 Finished Hydrated Lime
  - 8. C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
  - 9. C478 Precast Reinforced Concrete Manhole Sections
  - 10. C564 Rubber Gasket for Cast Iron Soil Pipe and Fittings
  - 11. C969 Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

- 12. D 3034 Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
- 13. D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Electrometric Seals
- 14. D3350 Polyethylene Plastic Pipe and Fitting Materials
- 15. F477 Electrometric Seals (Gaskets) for Joining Plastic Pipe

- C. American Concrete Institute (ACI)
  - 1. ACI 301 Structural Concrete for Buildings

#### 1.04 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, and accessories. Provide shop drawings for precast inlets, catch basins and junction boxes.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified local requirements.
- C. Contractor shall submit shop drawings in conformance with Section 011100.

#### 1.05 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of pipe runs, connections, catch basins, cleanouts, and invert elevations.
- B. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

#### 1.06 PROJECT CONDITIONS

- A. Coordinate work with termination of storm sewer connection outside building including connection to municipal storm sewer system.

## **PART 2 PRODUCTS**

#### 2.01 SEWER PIPE MATERIALS AND FITTINGS

- A. Reinforced Concrete Pipe (RCP): ASTM C 76, Class III, wall B (Class V under Railroads) except as noted on Construction Drawings, installed with flexible plastic, bitumen gaskets at joints.
  - 1. Gaskets: Joint material for RCP shall be rubber gasket conforming to the requirements of ASTM C443 or "tongue and groove" type filled with cement mortar.
  - 2. Flared end sections shall be class 1
- B. Polyvinyl Chloride (PVC) Pipe: ASTM D 3034, rated SDR 35, continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034 classification. Only permitted when specifically indicated on Construction Drawings.

1. Pipe joints: Joints for PVC shall conform to ASTM 3212 using restrained gasket conforming to ASTM F477.
- C. High Density Polyethylene Pipe (HDPE) Smooth Interior: AASHTO Designation M252 and M294, maximum diameter of 60-inches. Only permitted when specifically indicated on Construction Drawings. Pipe shall be installed in accordance with pipe manufacturer's installation Guidelines for Culvert Storm Drainage Applications.
  1. Pipe Joints and fittings shall conform to AASHTO M252 and M294.
  2. Acceptable manufacturers: Advanced Drainage Systems, Inc. "ADS N-12", HANCOR, INC. "Hi-Q", or approved equal.
  3. Gaskets are not required unless specifically called out on the Construction Documents.
- D. Ductile Iron Pipe (DIP): shall conform to ASTM A746
  1. Fittings shall be cast iron conforming to ASTM A74
  2. Joint material for DIP shall be a rubber gasket conforming to the requirements of ASTM C564 for compression joints.
- E. Subdrains: shall be perforated, PVC or Flexible corrugated plastic pipe as specified herein of the size indicated on the construction drawings.

## 2.02 INLETS, CATCH BASINS AND JUNCTION BOXES

- A. Lid and frame per details shown on Construction Drawings.
- B. Structure construction in accordance with details shown on Construction Drawings and as per the Structural Engineer.
- C. Cast-In-Place concrete for drainage structures including: manholes, inlets, catch basins, collars, support blocks, headwalls and paved ditches shall conform to ACI 301 and applicable reference specification therein and the following:
  1. Compressive Strength – 3000 psi at 28 days.
  2. Reinforcement – ASTM A615, grade 40 or 60 deformed reinforcing bars. Or A185 for wire fabric
- D. Cement Mortar used for paving inverts, filling lift holes, joints, patching and anchoring castings shall consist of one part portland cement, type I, ASTM C150, 1/4 part hydrated lime, ASTM C206 and 2-1/2 parts clean, well-graded sand and water free of suspended matter, alkali, and containing no industrial or domestic waste.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Construction Drawings.

### 3.02 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with bedding material.
- B. Remove large stones or other hard matter that could damage piping or impede consistent backfilling or compaction.
- C. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

### 3.03 BEDDING

- A. Excavate pipe trench and place bedding material in accordance with Section 312000.

### 3.04 INSTALLATION - PIPE

- A. The pipe shall be inspected for defects and cracks before being carefully lowered into the trench, piece by piece. Any defective, damaged or unsound pipe or any pipe that has had its grade disturbed after laying shall be taken up and replaced. Open ends shall be protected with a stopper to prevent earth or other material from entering the pipe during construction. The interior of the pipe shall be free from dirt, excess water and other foreign materials as the pipe laying progresses, and left clean at the completion of the installation.
- B. Installation shall commence at the lowest point for each segment of the route. RCP shall be laid with the groove or bell end upstream. Riveted CSP shall be placed with the inside circumferential laps pointing downstream. Applying bituminous material conforming to AASHTO M190 shall repair damaged bituminous coating on CSP.
- C. Lay pipe to the required line and slope gradients with the necessary fittings, bends, manhole, risers and other appurtenances placed at the required location as noted on Construction Drawings.
- D. Do not displace or damage pipe when compacting.
- E. No pipe shall be laid in water or when trench conditions are unsuitable for such work.
- F. Joints:
  - 1. Joints shall be constructed as described herein with the intent that they be made watertight.
  - 2. For RCP, the joint surface shall be cleaned and washed with water, if necessary, before the joints are made. For tongue and groove joints in smaller sizes, butting the inside of the bell with a cement mortar before joining shall make the joints. The inside joint can be wiped clean of excess mortar by brush or a squeegee drawn through the pipe as the laying operations progress. In the larger diameters, which permit the entry of a man, an annular space is provided between pipe

sections which shall be completely filled with mortar and finished off smooth with the inside surface of the pipe.

### 3.05 INSTALLATION - CATCH BASINS, INLETS, AND JUNCTION BOXES

- A. Precast Sections:
  - 1. Precast section with bases shall be installed in accordance with Section 312000 and 334300 or as shown on construction drawings.
  - 2. Pipe openings shall be aligned to that of the pipe entering and leaving the manhole, etc. Pipe shall be properly aligned with connections to manholes, etc. as shown on the construction drawings.
- B. Cast-In-Place sections shall be as shown on the drawings and in accordance with Section 312000.
- C. Invert channels shall be smooth and accurately shaped to a semicircular bottom conforming to the inside of the adjacent sewer section. Invert channels and structure bottoms shall be shaped with cement mortar. Changes in size and grade of invert shall be made gradually and evenly. Changes in direction of the sewer entering branch or branches shall have a true curve of as large a radius as the manhole will permit.
- D. Frames and Covers:
  - 1. Frames and covers shall be set to the proper elevation. The frames shall be firmly embedded in mortar approximately 1 inch thick and aligned to fit the top section of the structure.
  - 2. Bricks set in mortar used to adjust the frame to finished grade shall be limited to no more than four courses.
  - 3. Adjustment rings used to make adjustments in grade shall be made with the initial ring embedded in mortar and the exterior of the rings parged with mortar not less than 1/2 inch thick. No adjustment made in this manner shall exceed 8 inches.
- E. Concrete cradles shall be constructed as shown on the construction drawings and as needed when crossing over and under sewer pipe or utility lines. Concrete is to be 3000 psi mix with a minimum thickness of 6 inches.

### 3.06 SUBDRAINS

- A. Subdrains shall be installed in accordance with the details and at the locations shown on the construction drawings

### 3.07 INSPECTION AND TESTING

- A. General
  - 1. Storm sewer systems and culverts, upon completion or at such time as directed, shall be cleaned, inspected and tested. The system or culvert shall have a true grade and line. Actual elevations shall be within 0.08 feet of the elevations given on the construction drawings.
  - 2. After completion of the Work, or any part thereof, the job shall be tested to determine that it has been installed in accordance with the construction drawings



and specifications. In general, the Work shall prove to be in good condition, installed in accordance with the construction drawings and specifications and ready for use.

**B. Cleaning and Testing**

1. The contractor is to visibly inspect and remove all debris and obstructions from storm pipe. All storm pie is to be tested for infiltration and exfiltration by hydrostatic testing per ASTM C969. All manholes and pipe shall meet ASTM C969 leakage criteria.

**C. Alignment Test**

1. After backfill has been placed and compacted to a depth not less than one foot above top of pipe, a visual inspection shall be made by flashing a light between manholes. Any displacement or misalignment of invert shall be corrected.

**END OF SECTION 334100**

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## SECTION 334200 - SANITARY SEWAGE SYSTEMS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Sanitary sewer drainage piping, fittings, accessories, cleanouts, and bedding.
- B. Connection of site sanitary sewer system to municipal sanitary sewer systems.

#### 1.02 RELATED REQUIREMENTS

- A. Section 312000 - Earthwork
- B. Section 334300 - Sewer Manholes, Frames, and Covers
- C. Construction Drawings

#### 1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition
  - 1. D1784 Rigid Vinyl Compounds
  - 2. D1785 PVC Plastic Pipe, Schedule 40, 80, and 120
  - 3. D2466 PVC Plastic Fittings, Schedule 40
  - 4. D2564 Solvent Cements for PVC Pipe and Fittings
  - 5. F1668 Procedures for Buried Plastic Pipe
  - 6. A74 Cast Iron Soil Pipe and Fittings
  - 7. A746 Ductile Iron Gravity Sewer Pipe
  - 8. C12 Practice for Installing Vitrified Clay Pipe Lines
  - 9. C150 Portland Cement
  - 10. C207 Hydrated Lime for Masonry Purposes
  - 11. C425 Compression Joints for Vitrified Clay Pipe and Fittings
  - 12. C478 Precast Reinforced Concrete Manhole Sections
  - 13. C564 Rubber Gaskets for Cast Iron Soil Pipe and Fittings
  - 14. C700 Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
  - 15. C828 Recommended Practice for Low-Pressure Air Test of Vitrified Clay Pipe Lines
  - 16. D2141 Poly (vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
  - 17. D2657 Heat-Joining Polyolefin pipe and Fittings
  - 18. D3034 Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
  - 19. D3035 Polyethylene (PE) Plastic Pipe Using Flexible Electrometric Seals
  - 20. D3139 Joints for Plastic Pressure Pipe Using Flexible Electrometric Seals
  - 21. D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Electrometric Seals
  - 22. D3261 Butt heat fusion Polyethylene (PE) Plastic Fittings for Polyethylene Plastic pipe and Tubing
  - 23. F477 Electrometric Seals (Gaskets) for Joining Plastic Pipe

- C. American Water Works Association (AWWA) latest edition
  - 1. C111 Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
  - 2. C600 Ductile-Iron Water mains and Their Appurtenances
  - 3. C900 Polyvinyl Chloride (PVC) Pressure pipe, 4 in. Through 12 in,  
for Water Distribution (NOT APPLICABLE FOR THIS PROJECT)
  - 4. C901 Polyethylene (PE) Pressure pipe, Tubing and Fittings  
1/2 inch through 3 inches, for Water Distribution (NOT APPLICABLE FOR THIS PROJECT)
  - 5. C906 Polyethylene (PE) Pressure Pipe and Fittings, 4 inch through 63  
inch, for Water Distribution (NOT APPLICABLE FOR THIS PROJECT)

#### 1.04 QUALITY ASSURANCE

- A. An independent testing laboratory or consultant selected and paid by the Contractor, will be retained to perform construction testing on site under observation of the Engineer.

#### 1.05 SUBMITTALS

- A. Product Data: Provide data of pipe materials, pipe fittings, and accessories per Section 011100.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified local requirements.

#### 1.06 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of pipe runs, connections, cleanouts, and invert elevations and provide As-Built drawings signed and sealed by a NJ licensed surveyor.
- B. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

#### 1.07 PROJECT CONDITIONS

- A. Coordinate work with termination of sanitary sewer connection outside building and connection to municipal sewer utility service.

## **PART 2 PRODUCTS**

#### 2.01 SEWER PIPE, FITTINGS, AND JOINTS (Exterior to Building except as noted)

- A. Polyvinyl Chloride Pipe (PVC): ASTM D 1785, rated Schedule 40 unless otherwise specified by the utility company. Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, schedule rating, and ASTM D 1785 classification.

1. Pipe fittings shall conform to ASTM D 2466.
  2. Trace Wire: Magnetic detectable conductor (#12 copper), brightly colored plastic covering, imprinted with "Sanitary Sewer Service" in large letters.
- B. Ductile Iron Pipe (DIP): ASTM A746, Class 52, inside nominal diameter as specified on Construction Drawings, bell and spigot end.
1. Ductile Iron Pipe Joint Device: AWWA C111, rubber gasket joint devices.

## **2.02 PIPE ACCESSORIES**

- A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene-ribbed gasket for positive seal.
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps, etc.

## **2.03 CLEANOUTS AND MANHOLES**

- A. Precast concrete manholes section shall conform to Section 334300.
- B. Lid and Frame: Provide traffic grade and rated covers and frames where cleanouts and manholes are within pavement, with letter in accordance with the municipal and or sewer treatment authority, where applicable, cast into the cover.
- B. Shaft Construction: Cast Iron shaft of internal diameter as specified on Construction Drawings with 3500 psi concrete collar for cleanouts.

# **PART 3 EXECUTION**

## **3.01 EXAMINATION**

- A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Construction Drawings.

## **3.02 PREPARATION**

- A. Hand trim excavations to required elevations. Correct over excavation with bedding material.
- B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

## **3.03 BEDDING**

- A. Excavate trench and place bedding material in accordance with Section 312000.

## **3.04 INSTALLATION - PIPE**

- A. The type and class of pipe used shall be as shown on the construction plans. Pipes shall be laid and maintained to the required line and grade with necessary fittings, bends, manholes risers, cleanouts and other appurtenances placed at the required locations. The pipe shall be installed with uniform bearing under the full length of the barrel of the pipe. The pipe shall be inspected for defects and cracks before carefully being lowered into the trench. Any defective, damaged or unsound pipe, or any pipe that has had its grade disturbed after laying shall be taken up and replaced. Commence installation at lowest point with the bell end upgrades.
- B. No pipe shall be laid in water or when trench conditions are unsuitable for work.
- C. Pipe connecting to manholes or other structures shall terminate flush inside of the structure wall.
- D. Joints for PVC and CISP shall be thoroughly lubricated with an approved lubricant before pipe sections are slipped together. Open ends shall be fully protected with a stopper to prevent earth or other material from entering the pipe during construction. Carefully free interior of the pipe from dirt, cement and other deleterious material as the work progresses.
- E. Maintain separation of potable water main for sewer piping (10 foot horizontal and 18 inches vertical minimum) or as directed by the Engineer. Provide concrete encasement where less than minimum separation vertical is available per construction drawings.
- F. Route pipe in straight line parallel to roads, buildings and adjacent utilities and as shown on construction drawings.
- G. Establish elevations of buried piping with sufficient cover as recommended by pipe manufacturer to ensure not less than 3 feet of cover, except as noted on drawings.
- H. Form and place concrete for thrust blocks at each elbow of pipe force main. See construction drawing for details of construction.
- I. Backfill trench in accordance with Section 312000.
- J. Install trace wire continuous over top of non-metal pipe. Bury 6 inches minimum below finish grade, above pipeline.

### 3.05 INSTALLATION – CLEANOUTS AND MANHOLES

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. For cleanouts form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe to be installed to proper elevations.
- C. For manholes construct inverts according to the following guidelines:
  - 1. Invert channel shall be smooth and accurately shaped to a semicircular bottom to match with the inside of the adjacent sewer section.
  - 2. Invert channels and structure bottoms shall be shaped with mortar and lean concrete.

3. Changes in size and grade of invert shall be made gradually and evenly.
4. Changes in the direction of the sewer entering branch or branches shall have a true curve of as large a radius as the manhole will permit.

- D. For manholes provide manhole rings, frame and cover as shown on the construction drawings.

### 3.06 FIELD QUALITY CONTROL

- A. Pipes and joints shall not be completely backfilled until after inspection, testing, and approval by the Owner.
- B. Prior to testing for leakage, the pipe trench shall be backfilled to at least the spring line of the pipe. If required to prevent pipe movement during testing, additional backfill shall be added leaving the pipe joints uncovered to permit inspection.
- C. Exfiltration Test
1. Each section of sewer line between successive manholes shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole, using stoppers.
  2. Fill the manhole and pipe with water to a point which produces a maximum of 3 feet of head above the invert of the sewer at the center of the upper manhole; or if ground water is present, 3 feet of head above the average adjacent ground water level.
  3. The allowable leakage shall be:
    - a. 50 gal/inch of pipe diameter/mile/day
- D. Infiltration Test
1. If excessive ground water is encountered in the construction of a section of the sewer, the exfiltration test shall not be used.
  2. The upper and lower ends of the sewer to be tested shall be closed sufficiently to prevent the entrance of water.
  3. Pumping of ground water shall be discontinued for at least 3 days; then infiltration shall be tested.
  4. Infiltration into each section of sewer between adjoining manholes shall not exceed that allowed for the exfiltration test.
- E. Provide measuring devices, meters, water, materials, and labor for making the required tests.
- F. Gravity systems shall be air tested between manholes at 3.5 psi for 5 minutes per ASTM F 1417 for plastic pipes. The Infiltration Test may be limited to the manholes only when the authority having jurisdiction does not require the test and the construction manager waives the test. The Infiltration Test will always be required when excessive ground water is encountered in addition to the air test.

- G. Tests shall be conducted in the presence of the Owner or his designee. Test data shall be submitted to the Engineer for review and approval.
- H. All force main piping shall be hydrostatically tested at 150 psi in accordance with AWWA C 600.
- I. If deflection test is to be run using a rigid ball or mandrel. It shall have a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices.
  - 1. Allowable Deflection: Maximum allowable pipe deflection shall not exceed 5 percent of nominal inside diameter.
  - 2. Mandrel: Mandrel, go/no-go, device shall be cylindrical in shape and constructed with either 9 or 16 evenly spaced arms or prongs. Mandrels with fewer arms will be rejected as not sufficiently accurate. Contact length of mandrel's arms shall equal or exceed nominal inside diameter of sewer to be inspected. Critical mandrel dimensions shall carry tolerance of 0.01-inch maximum. Contractor shall provide mandrel and necessary equipment for mandrel test.
  - 3. Procedure: Mandrel shall be hand-pulled through flexible pipe sewer lines no earlier than 30 days after trench has been completely backfilled. Sections of sewer not passing mandrel shall be uncovered and rebedded, rerounded, or replaced to satisfaction of Owner or governing agency at no cost to Owner. Repaired section shall be retested.

**END OF SECTION 334200**

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## SECTION 334300 - SEWER MANHOLES, FRAMES, AND COVERS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Monolithic concrete manhole barrel with either monolithic concrete or masonry transition to lid frame.
- B. Modular precast concrete manhole barrel with tongue-and-groove joints with either precast concrete or masonry transition to lid frame.
- C. Precast polyethylene manhole assemblies.
- D. Preparation and installation of lid frame, covers, anchorage, and accessories.

#### 1.02 RELATED SECTIONS

- A. Section 312000 - Earthwork
- B. Section 334200 - Sanitary Sewer Systems
- C. Section 334100 - Storm Drainage
- D. Construction Drawings

#### 1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition
  - 1. A 48 Gray Iron Castings
  - 2. C 55 Concrete Building Brick
  - 3. C 478 Precast Reinforced Concrete Manhole Sections and Steps
  - 4. C 923 Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes
  - 5. D 1248 Polyethylene Plastics Molding and Extrusion Materials
- B. International Masonry Industry All-Weather Council (IMIAC) latest edition
  - 1. Recommended Practices and Guide Specification for Cold Weather Masonry Construction
- C. State Department of Transportation (DOT), Construction and Material Specifications, Latest Edition

#### 1.04 SUBMITTALS

- A. Shop Drawings: Indicate reference to Construction Drawings of manhole locations, elevations, piping with sizes, locations, and elevations of penetrations.



- B. Product Data: Provide data for manhole covers, manhole steps, component construction, features, configuration, and dimensions.
- C. Contractor shall submit shop drawings for the Engineer's approval as per Section 2000 1.08.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Manhole Barrel: Reinforced precast concrete in accordance with ASTM C 478 with gaskets in accordance with ASTM C 923.
  - 1. Construct manholes of precast concrete sections as required by Construction Drawings to size, shape, and depth indicated, but never less than 4'-0" inside diameter.
- B. Concrete Brick Units: ASTM C 55, Grade N Type I-moisture controlled, normal weight, of same grade, type and weight as block units, nominal modular size of 3 5/8-inches x 7 5/8-inches x 2 1/4-inches
- C. Manhole Barrel: Precast polyethylene in accordance with ASTM D 1248. Manholes shall be manufactured with factory-molded steps. Nominal cylinder internal diameter shall be 48-inches and shall be designed to accept concrete filled polyethylene manhole lids and standard cast iron frames with lid or grate. Manholes shall have compressive strength that meets ASTM D 2412 standards. Acceptable Manufacturers: Advanced Drainage Systems (ADS) or approved equal.
- D. Mortar and Grout: Mortar for finishing and sealing shall be Class "C". Honeycombing less than 2-inches deep shall be repaired using Class "D" mortar.
- E. Brick Transition Reinforcement: Formed steel 8-gauge wire with galvanized finish.

### **2.02 COMPONENTS**

- A. Lid and Frame: ASTM A 48, Class 30B heavy duty cast iron construction, machined flat bearing surface, removable lid, open as indicated on Construction Drawings, sealing gasket, minimum total weight of 475 pounds manufactured by Campbell Foundry, Neenah Foundry Company, East Jordan Iron Works, or approved equal.
- B. Manhole Steps: Shall be formed aluminum rung (3/4 inch minimum diameter) or steel reinforced polypropylene, 12 inches wide, 12 inches on center vertically (maximum) set in manhole wall.

### **2.03 CONFIGURATION**

- A. Barrel Construction: Concentric with eccentric cone top section.
- B. Shape: Cylindrical
- C. Clear Inside Dimensions: 48-inches diameter minimum or as indicated on Construction Drawings.

- D. Design Depth: As indicated on Construction Drawings.
- E. Clear Lid Opening: 24-inches minimum
- F. Pipe Entry: Provide openings as indicated on Construction Drawings
- G. Main and Lateral Pipes: Neatly cut off main and lateral pipes flush with inside of manhole or inlet where they enter structure walls. Point up irregularities and rough edges with non-shrink grout. All pipe penetrations shall utilize A-LOK gaskets as manufactured by Atlantic Concrete Products, or equal. **DO NOT MORTAR EXTERIOR OR TOP HALF OF PIPE.**
- H. Inverts: Shape inverts for smooth flow across structure floor as indicated on Construction Drawings. Use concrete and mortar to obtain proper grade and contour. Finish surface with fine textured wood float.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify items specified by other Sections are properly sized and located.
- B. Verify that built-in items are in proper location and ready for roughing into work.
- C. Verify that the excavation for manholes is correct.

#### **3.02 PREPARATION**

- A. Coordinate placement of inlet and outlet pipe or duct sleeves as indicated on Construction Drawings.

#### **3.03 PLACING PRECAST MANHOLE BARREL SECTIONS**

- A. Place base pad to proper elevation and location and trowel top surface level for placement of manhole barrel.
- B. Place manhole barrel plumb and level to correct elevations and anchor to base pad.
  - 1. After completion of slab foundation, lower first joint of manhole barrel into position, grooved end first, and set level and plumb on concrete base. Align and adjust to proper grade prior to placing and forming invert. Pour invert immediately after setting of first section of manhole barrel.
  - 2. Prior to setting subsequent manhole barrel sections, apply primer to tongue and groove ends and allow to set in accordance with manufacturer's recommendations. Place "Ram-nek", or equivalent, plastic rope on tongue end. Lower next section into position, and remove excess material from interior of structure. Add additional material on exterior of joint, if necessary, for completely watertight joint.

- C. Set cover frames and lids level without tipping, to correct elevations. Utilizing pre-cast rings, or brick and mortar may achieve final rim elevation. Maximum limit, 4 courses.

**END OF SECTION 334300**

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