WILLIAM PATERSON UNIVERSITY

SOCCER FIELD IMPROVEMENTS

TECHNICAL SPECIFICATIONS

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PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes general administrative and procedural requirements for all work. The administrative and procedural requirements included in this Section are to expand the requirements specified in Division 1.

1.2 SCOPE OF WORK

A. Provide all labor, material, equipment, and services necessary for and incidental to completion of all work as indicated on the Drawings and/or as specified herein. This includes all incidentals, equipment, appliances, services, hoisting, scaffolding, supports, sleeves, inserts, anchor bolts, tools, supervision, labor, consumable items, fees, licenses, etc., necessary to provide complete and workable systems.

1.3 DRAWING USE AND INTERPRETATION

A. Unless indicated by specific dimensions, drawings are meant to be diagrammatic. Exact equipment locations and routing of utilities shall be governed by field conditions and/or Owner's Representative's instructions.

B. All dimensions which relate to the building shall be taken as construction progresses. All errors incurred as result of the failure to check or verify dimensions, measurements, etc., shall be corrected.

C. The drawings show the general arrangement of utilities, equipment, and accessories. Drawings do not indicate all offsets, fittings, accessories, and changes in elevation, which may be necessary. Make all changes in equipment, locations, etc., to accommodate the work and to avoid obstacles at no increase in contract price. Provide offsets, fittings, and accessories as may be required to meet such conditions.

1.4 SPECIFICATION FORMAT AND CONTENT EXPLANATION

A. Specification Content: This Specification uses certain conventions regarding the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:

1. Abbreviated Language: Language used in Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpolated as the sense requires. Singular words will be interpreted as plural and plural words interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Streamlined Language: The Specifications generally use the imperative mood and streamlined language. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the Text, subjective language is used for clarity to describe responsibilities that must be fulfilled indirectly by the Contractor or by others when so noted.

a. The words "shall be" are implied where a colon (:) is used within a sentence or phrase.

1.5 DEFINITIONS

A. General: Basic Contract definitions are included in the conditions of the Contract.

B. Indicated: The term "indicated" refers to graphic representations, notes or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

D. Approved: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in the Conditions of the Contract.

E. Regulations: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

F. Furnish: The term "furnish" is used to mean "supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations."

G. Install: The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

H. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."

I. Installer: An "installer" is the Contractor or an entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

1. The term "experienced," when used with the term "installer," means having a minimum of five previous projects similar in size and scope to this Project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.
2. Trades: Use of titles such as "carpentry" is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades persons of the corresponding generic name.
3. Assignment of Specialists: Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in the operations to be performed. The specialists must be engaged for those activities, and assignments are requirements over which the Contractor has no choice or option. Nevertheless, the ultimate responsibility of fulfilling Contract requirement remains with the Contractor.
    a. This requirement shall not be interpreted to conflict with enforcement of building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.

J. The term "concealed": embedded in masonry or other construction, installed behind wall furring, within partitions or hung ceilings (permanent or removable), in trenches, or in crawl spaces.

K. The term "exposed": not installed underground or concealed. Equipment in rooms with exposed construction (i.e. mechanical rooms, electrical rooms, janitor's closets, etc.) are classified as exposed.

L. The term "piping": piping fittings, flanges, valves, controls, hangers, traps, drains, insulation and items necessary or required in connection with or relating thereto.

M. The "Project Site" is the space available to the contractor for performance of construction activities, either exclusively or in conjunction with other performing other work as part of the Project.

N. Testing Laboratories: A "testing laboratory" is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.6 COMPLETE SYSTEMS

A. General: Provide all materials as required for complete systems, including all parts obviously or reasonably incidental to a complete installation, whether specifically indicated or not. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation prior to Owner's acceptance.

B. Systems: The systems specified and/or shown on the Drawings are for complete and workable systems. Any deviation from these systems due to a particular manufacturer's requirements shall be made at no additional cost to the Owner.

1.7 CODES AND REGULATIONS

A. General: Comply with all governing federal, state, and local laws, ordinances, codes, rules, and regulations. Where the Contract Documents exceed these requirements, the Contract Documents shall govern. In no case shall work be installed contrary to or below minimum legal standards.

B. Utilities: Comply with all applicable rules, restrictions, and requirements of the utility companies serving the project site/facilities. Contractor shall be required to contact state regulated "call before you dig" service prior to any excavation work.

C. Non-Compliance: Should any work be performed which is found not to comply with any of the above codes and regulations, provide all work and pay all costs necessary to correct the deficiencies.

1.8 REFERENCE STANDARDS

A. All published standards of the following associations/organizations, as mandated by specific state standards, shall be followed and applied as a minimum.
   1. AABC, Associated Air Balance Council
   2. ACI, American Concrete Institute
   3. AGA, American Gas Assoc.
   4. AIA, The American Institute of Architects
   5. AISC, American Institute of Steel Construction
   6. ANSI, American National Standards Institute
   7. API, American Petroleum Institute
   8. ASME, American Society of Mechanical Engineers
   9. ASPE, American Society of Plumbing Engineers
   10. ASSE, American Society of Sanitary Engineering
   11. ASTM, American Society for Testing and Materials
   12. AWS, American Welding Society
   13. AWWA, American Water Works Assoc.

14. CAGI, Compressed Air and Gas Institute
15. CGA, Compressed Gas Assoc.
16. CISPI, Cast Iron Soil Pipe Institute
17. DIPRA, Ductile Iron Pipe Research Assoc.
18. ETL, ETL SEMKO a Division of Intertek Group
19. FMG, Factory Mutual Global
20. HEI, Heat Exchange Institute
21. HI, Hydronics Institute
22. ISA, Instrument Society of America
23. MSS, Manufacturers Standardization Society
24. NACE, National Association of Corrosion Engineers International
25. NEC, National Electrical Code (from NFPA)
26. NEMA, National Electrical Manufacturers Assoc.
27. NFPA, National Fire Protection Assoc.
28. NSF, National Sanitation Foundation
29. PDI, Plumbing and Drainage Institute
30. SSPMA, Sump and Sewage Pump Manufacturers Assoc.
31. STI, Steel Tank Institute
32. SWPA, Submersible Wastewater Pump Assoc.
33. UL, Underwriters Laboratories Inc.
34. WSC, Water Systems Council

B. Federal Government Agencies: Names and titles of federal government standard- or Specification-producing agencies are often abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard- or Specification-producing agencies of the federal government. Names are subject to change and are believed, but are not assured, to be accurate and up-to-date as of the date of the Contract Documents.

1. CE, Corps of Engineers (U.S. Department of the Army)
2. EPA, Environmental Protection Agency
3. UFC, United Facilities Criteria
4. MIL, Military Standardization Documents (U.S. Department of Defense)
5. NIST, National Institute of Standards and Technology (U.S. Department of Commerce)
6. OSHA, Occupational Safety and Health Administration (U.S. Department of Labor)

C. Applicability of Standards: Except where 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. Such standards are made a part of the Contract Documents by reference.

D. Copies of Standards: Each entity engaged in construction on the project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents. Where copies of standards are needed for performance of a required construction activity, the contractor shall obtain copies directly from the publication source.

1.9 QUALITY ASSURANCE

A. Manufacturers' Qualifications: Not less than five years experience in the actual production of the specified products.

B. Installers' Qualifications:

1. Firm with not less than five years experience in the installation of mechanical systems and equipment similar in scope and complexity to those required for this Project, and having successfully completed at least ten comparable scale projects.
2. Painting, patching, carpentry and the like related to or required for Division 22 work shall be performed by craftsman skilled in the appropriate trade.
3. All welding shall be performed by ASME certified welders.

1.10 INSPECTIONS

A. General: During and upon completion of the work, arrange and pay all associated costs for inspections of all work installed under this Contract, in accordance with the Conditions of the Contract.

B. Inspections Required: As per the laws and regulations of the local and/or state agencies having jurisdiction at the project site.

C. Inspection Agency: Approved by the local and/or state agencies having jurisdiction at the project site.

PART 2 – PRODUCTS

2.1 GENERAL

A. Where Specified: Materials and equipment shall be as specified in subsequent sections of the Project Manual and/or as indicated on the Drawings.

B. General: All materials and equipment to be new, clean, undamaged, and free of defects and corrosion.

C. Acceptable Products: The product will be acceptable only when that product complies with all requirements of the Contract Documents as determined by the Engineer.

D. Common Items: Where more than one of any specific item is required, all shall be of the same type and manufacturer.

E. Listing: All materials and equipment shall be Underwriters' Laboratories (UL) or ETL SEMKO (ETL) listed and labeled, where UL or ETL standards and listings exist for the specified materials or equipment.

F. Special Tools: Provide all special tools needed for proper operation, adjustment and maintenance of equipment.

PART 3 – EXECUTION

3.1 GENERAL

A. The installation of all mechanical work shall be in accordance with the letter and intent of the Contract Documents, as determined by the Engineer.

B. Installation Requirements: All materials and equipment shall be installed as recommended by the respective manufacturers, by mechanics experienced and skilled in their particular trade, in a neat and workmanlike manner, in accordance with the standards of the trade, and so as not to void any warranty, UL or ETL listing.

3.2 DELIVERY STORAGE AND HANDLING

A. Packing and Shipping: Deliver products in original, unopened packaging, properly identified with manufacturer's identification, and compliance labels.

B. Storage and Protection: Comply with all manufacturer's written recommendations. Protect all equipment, materials and work from the weather elements, paint, mortar, construction debris and damage throughout duration of project.

C. Damaged Products: Do not install damaged products. Arrange for prompt replacement.

3.3 EXAMINATION

A. Conditions Verification: Examine the areas and conditions under which the work is to be performed. Identify and report any conditions detrimental to the proper and timely completion of the work to the Owner's Representative.

3.4 DIMENSIONS

A. Building Dimensions: Exact locations of building elements shall be based on contractor's field measurements.

B. Limiting Dimensions: Where equipment dimension and clearances are indicated on the Drawings, do not provide equipment larger than equipment dimensions or clearances specified.

C. Verify all dimensions by field measurements.

3.5 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

3.6 CUTTING AND PATCHING

A. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting and patching of mechanical equipment and materials required to:
   1. Uncover Work to provide for installation of non-coordinated and/or improperly installed work.
   2. Remove and replace defective Work.
   3. Remove and replace Work not conforming to requirements of the Contract Documents.
   4. Remove samples of installed Work as specified for testing.
   5. Install equipment and materials in existing structures.
   6. Uncover and restore Work to provide for Engineer observation of concealed Work.

C. Cut, remove and legally dispose of equipment, components, and materials as indicated. Removal shall include all ancillary items associated with items removed. Remove all items made obsolete by the new work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated to be removed.

E. Provide and maintain temporary dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

F. Patch surfaces and building components using new materials matching existing adjacent materials.

3.7 ADMINISTRATION AND SUPERVISION

A. The Contractor shall supervise the work and shall have at all times some competent person, approved by the Owner, following the work to receive instructions and to act with authority.

3.8 TESTING AND ADJUSTING

A. General: Provide testing equipment, materials, instruments, and personnel to perform all test procedures and adjustments required by other Division 22 Sections and/or deemed necessary by the Engineer to establish proper performance and installation of systems and equipment. All test instruments to be accurately calibrated and in good working order.

B. Scheduling: Schedule tests at least three days in advance, and so as to allow Engineer and Owner representative(s) to witness the test, unless directed otherwise. Do not schedule tests until the system installation is complete and fully operational, unless indicated or directed otherwise.

C. Correction/Replacement: After testing, correct any deficiencies, and replace materials and equipment shown to be defective or unable to perform at design or rated capacity. Retest without additional cost to the Owner or Contract. Submit finalization report indicating corrective measures taken, and satisfactory results of retest.

3.9 SYSTEMS DEMONSTRATION

A. Instruct the Owner's representative(s) in the start-up, operation and maintenance of all systems and equipment in accordance with the Contract Documents.

3.10 CLEANING

A. General: Remove from the project site, all waste, rubbish, and construction debris weekly unless indicated otherwise. The premises shall be left clean and free of any debris and unused construction materials, prior to final acceptance.

B. Equipment: Remove all dust, dirt, debris, mortar, rust, and other foreign materials from the interior and exterior of all equipment and enclosures, and wipe down.

C. Utilities: Thoroughly clean all utilities, just prior to final inspection.

3.11 TOUCH-UP PAINTING

A. Touch-Up Painting: Restore and refinish to original condition, all surfaces of equipment scratched, marred and/or dented during shipping, handling, or installation. Remove all rust, and prime and paint as recommended by the manufacturer.

END OF SECTION

SECTION 220004 – COORDINATION WITH OTHER TRADES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. This section describes the coordination and procedural requirements for Contractors.

B. Definitions:
1. Owners Representative - Architect, Engineer, Construction Manager, General Contractor, Clerk of the works or any stipulated Agent or Representative of the Owner.
2. GC - General Contractor
3. MC - Mechanical Contractor/Subcontractor
4. PC - Plumbing Contractor/Subcontractor
5. EC - Electrical Contractor/Subcontractor
6. SM - Sheet Metal Subcontractor
7. SC - Sprinkler Contractor/Subcontractor

1.2 COMPLIANCE

A. Cost incurred including those of other contractors and/or Owner, due to non-compliance with this Section shall be the responsibility of the non-compliant contractor.

1.3 SUBMITTALS

A. Complete coordinated shop drawing shall be submitted in PDF format to the Engineer for their record by the MC. Submitted coordinated shop drawing shall include all signatures required by sign off procedure.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.1 COORDINATION

A. General: Sequence, coordinate and integrate the installation of all materials and equipment for efficient flow of work, in conjunction with the other trades. Review and become familiar with all of the Drawings and work of all the other trades. Report and resolve any discovered discrepancies and/or interferences prior to commencing work.

B. Cooperation: Cooperate with the other Contractors and individual disciplines for placement, anchorage and accomplishment of the work.

C. Chases, Slots, and Openings: Arrange for chases, slots, and openings during the progress of construction, as required to allow for installation of the work.

D. Supports and Sleeves: Coordinate the location installation of required supporting devices and sleeves to be set in concrete and other structural components, as they are constructed.

E. Right-Of-Way:

1. Adjust location of utilities, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered.
2. Determine the exact route and location prior to fabrication.
3. Pitched piping has the right-of-way over utilities which do not pitch.
4. Furnish and install ancillary materials & equipment including but not limited to traps, air vents, drains, etc., as required to accommodate offsets, transitions and changes in direction.

F. Headroom: Install systems, materials, and equipment to maximize headroom unless noted otherwise.

G. Utility Connections: Coordinate connection with underground and overhead utility services. Comply with requirements of governing regulations, utility providers, and controlling agencies. Provide required connection for each service.

3.2 COORDINATED SHOP DRAWINGS

A. The coordination shop drawing process shall occur in the following manner:

1. The MC shall create 3/8" scale AutoCAD (2002 or newer) base plans which shall incorporate and coordinate with structural steel and ceiling system framing supports and show framing members on the shop drawings. This shall include existing building components not shown on Contract Documents.
2. The MC shall require the Sheet Metal Subcontractor to submit AutoCAD shop drawings, as expeditiously as possible, to the Engineer (through normal channels) for review and approval. The shop drawings shall incorporate all ductwork (including top and bottom of duct elevations at a maximum interval of 25 linear feet and at each elevation change), structural steel (building and misc. support steel), equipment and accessories as shown and/or specified in the contract documents.
3. All roof penetrations, wall and floor openings shall be coordinated with the structural steel Subcontractor, Supplier and/or Erector, through the Owner's Representative. All conflicts with structural steel members shall be resolved through the Owner's Representative.
4. After review and final approval of the sheet metal shop drawing by the Engineer, the sheet metal Subcontractor shall incorporate all required corrections, additions and modifications on the AutoCAD ductwork shop drawings.
5. The approved AutoCAD ductwork shop drawings shall be utilized for coordination with all other Contractors or Subcontractors whose involvement is mandated. The SM shall submit the AutoCAD ductwork shop drawings (hard copy and electronic files) to the MC to initiate the "coordination" process. The MC shall review the drawings for accuracy and completeness prior to distribution.
6. The MC shall forward, with transmittal, the ductwork shop drawings (hard copy and electronic files) to the PC for coordination of the plumbing work. The MC shall forward a copy of the transmittal to the Owner's Representative.
7. The PC shall (upon receipt of drawings from the MC) superimpose his scope of work on the AutoCAD ductwork shop drawings illustrating all plumbing equipment, piping and hangers.
8. The PC shall include invert of pipes; elevations (top and bottom) and pipe sizes including insulation at a maximum of 25 foot intervals and at each elevation change.
9. Any conflicts between the plumbing and ductwork shall be clouded by the PC on the AutoCAD ductwork shop drawing file.
10. PC shall request coordination meeting to resolve the conflicts as clouded on the coordinated shop drawings. PC shall provide clouded shop drawing at the coordination meeting. All conflicts that arise between the plumbing and ductwork shall be resolved through and by the Owner's Representative.

11. The PC and/or the SM shall correct and shall complete the AutoCAD drawings depicting all resolutions.
12. When it is ascertained that no conflicts exist between the ductwork and plumbing work, the PC shall forward the final ductwork/plumbing coordinated drawings (hard copy and electronic files) to the MC with transmittal, and provide the Owner's Representative with a copy of the transmittal.
13. The MC shall (upon receipt of drawings from the PC) superimpose all heating and air conditioning piping, equipment, hangers, and insulation, including elevations (top and bottom) and pipe sizes (including insulation), on the AutoCAD drawings.
14. Any conflicts between the ductwork/plumbing/mechanical work shall be clouded by the MC on the AutoCAD shop drawing file.
15. MC shall request coordination meeting to resolve the conflicts as clouded on the coordinated shop drawings. MC shall provide clouded shop drawing at the coordination meeting. All conflicts that arise between the MC, SM and PC shall be resolved through and by the Owner's Representative.
16. The MC, PC and SM shall correct and complete the AutoCAD drawings depicting all resolutions.
17. When it is ascertained that no conflicts exist between the MC, SM and PC, the MC shall forward the final ductwork/plumbing/mechanical coordinated drawings (hard copy and electronic files) to the EC with transmittal, and provide the Owner's Representative with a copy of the transmittal.
18. The EC shall (upon receipt of drawings from the MC) superimpose all electrical equipment including but not limited to light fixtures, conduit and hangers on the AutoCAD drawings.
19. The EC shall include elevations of light fixtures, electrical conduit and conduit sizes.
20. Any conflicts with the ductwork/plumbing/mechanical/electrical work shall be clouded by the EC on the AutoCAD shop drawing file.
21. EC shall request coordination meeting to resolve any conflicts as clouded on the coordinated shop drawings. EC shall provide clouded coordinated shop drawing at the coordination meeting. All conflicts that arise between the EC, MC, PC and SM shall be resolved through and by the Owner's Representative.
22. The EC and/or the SM, PC, MC shall correct and complete the AutoCAD drawings depicting all resolutions.
23. When it is ascertained that no conflicts exist between the EC, MC, PC and SM, the EC shall forward the final ductwork/plumbing/mechanical/electrical coordinated drawings (hard copy and electronic file) to the SC with transmittal, and provide the Owner's Representative with a copy of the transmittal.
24. The SC shall (upon receipt of drawings from the EC) superimpose all sprinkler equipment, piping, hangers and sprinkler heads as required by the contract documents and the appropriate codes.
25. The SC shall include elevations of piping and piping sizes.
26. Any conflicts with the ductwork/plumbing/mechanical/electrical/sprinkler work shall be clouded by the SC on the AutoCAD shop drawings.
27. The SC shall request coordination meeting to resolve any conflicts as clouded on the coordinated shop drawings. SC shall provide clouded coordinated shop drawing at the coordination meeting. All conflicts that arise between the SC, EC, MC, PC, and/or SM shall be resolved through and by the Owner's Representative.
28. The SC and/or EC, MC, PC, SM shall complete the AutoCAD drawings depicting all resolutions.
29. When it is ascertained that no conflicts exist between the SC, EC, MC, PC, and SM, the SC shall forward the final ductwork/plumbing/mechanical/electrical/sprinkler coordination drawing to the MC with transmittal, and provide the Owner's Representative with a copy of the transmittal.

30. Sign Off:
    a. The MC shall provide the final coordinated shop drawing to the Engineer and the Owner's Representative. The final coordinated shop drawing shall contain signatures from SM, PC, MC, EC, and SC on each sheet.
    b. Upon completion of the coordination process by all Contractors and Subcontractors as described above, they shall sign off on all drawings in ink indicating company, name, date of sign-off and signature of company representative.
    c. Each contractor signature shall certify that each Contractor has shown their respective work on the drawings and have resolved all points of conflict and interference with other Contractors and Subcontractors.

3.3 COORDINATION MEETINGS

A. During the coordination process, separate meetings apart from project meetings concerning the progress and schedules may be called by the Owner's Representative when required or at the request of one or more of the coordinating Contractors.
    1. The Owner's Representative shall contact the Contractors and make all required arrangements, e.g. time, place, etc.
    2. All Contractors shall place emphasis and importance on equipment purchases, so as to not delay approvals, shop drawings and the coordinated drawings.

3.4 SCHEDULE OF COORDINATED SHOP DRAWINGS

A. The MC and SM shall complete the ductwork shop drawings within two (2) weeks after award of contract (or authorization to proceed).

B. Turn-around time for each Contractor shall be two (2) weeks maximum.

3.5 "AS BUILT" DRAWINGS

A. At the completion of the project, "As Built" corrections shall be made to each AutoCAD drawing by each of the aforementioned Contractors and returned to the Owner's Representative for the Owner's permanent files and records. These "As Builts" do <u>not</u> remove the obligation of "As Builts" and record drawings as outlined under other sections of the specifications <u>unless</u> the Owner's Representative elects to do so.

END OF SECTION

SECTION 220500 – BASIC PLUMBING MATERIALS AND METHODS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes the following basic materials and methods to complement other Division 22 Sections.
   1. Piping installation instructions common to most piping systems
   2. Dielectric fittings
   3. Flexible connectors
   4. Mechanical sleeve seals
   5. Sleeves
   6. Escutcheons
   7. Fire Stopping
   8. Identifying devices and labels
   9. Grout
   10. Interior concrete housekeeping pads
   11. Installation requirements common to equipment specification sections
   12. Touch-up painting
   13. Removals
   14. Repairs.

B. Pipe, pipe fittings and joining materials and methods are specified in Division 22 piping system sections.

1.2 DEFINITIONS

A. 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, crawl spaces, 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 duct shafts.

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. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. NP: Nylon plastic.
   4. HDPE: High Density Polyethylene plastic.
   5. PVC: Polyvinyl chloride plastic.

G. Existing: Condition present prior to award of this contract.

1.3 SUBMITTALS

A. Product Data: For all materials specified within this section

B. Fire Rated Penetration Listing Details: Submit Underwriters Laboratory penetration listing details specific to the penetrations required by the project along with fire stopping material data.

C. Quality Control Submittals: Fire stopping certificates specified in Quality Assurance below.

1.4 QUALITY ASSURANCE

A. Fire Stopping: Fire stopping installer shall be certified by the fire stopping manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Protect piping, flanges, fittings, and piping specialties to prevent pipe end damage. Maintain end caps through shipping, storage, and handling.

B. Store plastic pipes in locations not subject to direct sunlight.

C. Protect all stored materials from moisture and dirt. Elevate above grade and support to prevent sagging and bending. Do not exceed structural capacity of floor, if stored inside.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where identifying devices are to be applied.

B. Install identifying devices before concealment.

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. Dielectric Components:
      a. Watts Water Technologies, Inc.
      b. Grinnell Corp.; Grinnell Supply Sales Co.
      c. Victaulic Co. of America.
   2. Metal, Flexible Connectors:
      a. Engineered Flexible Products
      b. Flexicraft Industries.
      c. Grinnell Corp.; Grinnell Supply Sales Co.
      d. Mercer Rubber Co.
      e. Metraflex Co.
   3. Mechanical Sleeve Seals:
      a. Calpico, Inc.
      b. Metraflex Co.
      c. Proco Products, Inc.
      d. Thunderline/Link-Seal.

4. Fire-Stopping Sealant:
    a. Dow Corning Corp.
    b. 3M Corp.
    c. Hilti Corp.
5. Pipe Escutcheons:
    a. Chicago Specialty Mfg. Co.
    b. Sanitary-Dash Mfg. Co.
    c. Grinnell
6. Identifying Devices:
    a. Craftsmark Identification Systems
    b. Seton Identification Products
    c. W.H. Brady Company

2.2 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

C. Insulating Material: Suitable for system fluid, pressure, and temperature.

D. Dielectric-Flange Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers. Dielectric flange kit materials shall be compatible with system fluid, temperature and pressure.

E. Dielectric Couplings: ARE NOT ALLOWED

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; and 300-psig (2070-kPa) minimum working pressure at 225° F (107° C). Coordinate end selection with piping system specifications.

2.3 FLEXIBLE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig (860-kPa) minimum working-pressure rating at 220°F, unless higher working pressure or temperature is indicated. Coordinate end selection with piping system specifications.

B. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

2.4 MECHANICAL SLEEVE SEALS

A. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with stainless steel bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical isolation.

2.5 SLEEVES

A. General: The following materials are for wall, floor, slab and roof penetrations.

B. Pipe:
   1. Steel Sheet Metal: 0.0359-inch (0.9-mm) minimum thickness, galvanized, round tube closed with welded longitudinal joint.
   2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, and plain ends. Provide integral waterstop where indicated.
   3. Cast Iron: Cast or fabricated pipe equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
   4. 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.

C. Ductwork
   1. All sleeves shall be per SMACNA.

2.6 ESCUTCHEONS

A. General: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
   1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
   2. OD: Completely cover opening.
   3. Stamped Steel: One piece, with set screw and chrome-plated finish.
   4. Stamped Steel: Split plate, with concealed hinge, set screw, and chrome-plated finish.

2.7 FIRE STOPPING

A. UL listed material specific to the UL penetration listing detail.

2.8 IDENTIFYING DEVICES AND LABELS

A. Equipment Nameplates: Metal nameplate with operational data engraved or die-stamped; permanently fastened to equipment.
   1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.

B. Stick-on Pipe Markers: Manufacturer’s standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, complying with ASME A13.1.

C. Stick-on Duct Markers: Manufacturer’s standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, complying with ASME A13.1.

D. Stick-on Flow Marker: Manufacturer’s standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, two inch (2") wide band, color coded complying with ASME A13.1.

E. Rigid Pipe Markers: Manufacturer’s standard preprinted, color coded, rigid plastic with flow arrows and fluid medium designed to be applied to piping systems without the need of adhesives. For markers up to 6 inch, markers shall wrap completely around the pipe, and their own tension shall secure them in place. For markers over 6 inch, markers shall be provided with nylon ties to secure marker to piping system Markers comply with ANSI/ASME A13.1.

F. Valve Tags: Stamped or engraved 0.032-inch- (0.8-mm-) thick, polished brass, 1-1/2-inches (40-mm) diameter, with 1/4-inch (6-mm) piping system abbreviation letters and 1/2-inch (13-mm) sequenced numbers. Include 5/32-inch (4-mm) hole and brass, wire-link or beaded chain; or brass S-hook fastener.

G. Framed Valve Schedule: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include appropriate mounting hardware. Valve schedule shall be 8-1/2" x 11" with a minimum font height of 12 pt. Frame shall be extruded aluminum with ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass. Schedule shall include valve number, piping system, system abbreviation as shown on valve tag, location of valve (room or space), normal operating position (open, closed or modulating). Indicate valves utilized for emergency shut off or other special purposes.

H. Access Panel Markers: 1/16-inch- (2-mm-) thick, engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed valve. Provide 1/8-inch (3-mm) center hole for attachment

I. Plastic Equipment Markers: ASME A13.1, color-coded, laminated plastic. Include lettering identifying name, equipment service, design capacity, pressure drop, entering and leaving conditions and RPM indicated on the contract documents. Size shall be 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; and 4-1/2 by 6 inches (115 by 150 mm) for equipment. Identifying names and/or abbreviations shall match those indicated on the contract documents.

2.9 GROUT

A. Non-shrink, Non-metallic Grout: ASTM C 1107, Grade B, post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement grout recommended for interior and exterior applications. Design mix shall be 5000-psig (34.5-MPa), 28-day compressive strength.

2.10 INTERIOR CONCRETE HOUSEKEEPING PADS

A. Concrete: 3000-psig (20.7-MPa), 28-day compressive-strength concrete.

B. Form work: 14 gauge galvanized steel frame

C. Dowels: #4 rebar

D. Reinforcement: 6 X 6 –W2.9 X W 2.9 wire metal mesh at center

PART 3 – EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General: Install piping as described below, unless piping sections specify otherwise.

B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.

C. Install components with pressure and temperature ratings equal to or greater than system operating pressure and temperature.

D. Install piping free of sags and bends. Install fittings for changes in direction and branch connections. Install fittings, couplings, and accessories according to manufacturer's written instructions.

E. Install piping at parallel and perpendicular to building walls. Diagonal runs are prohibited, unless otherwise indicated. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

F. In areas of exposed piping, install piping to maximize headroom. In areas with ceilings, install piping to maximize clearance between ceiling and pipe. Allow sufficient space for ceiling panel removal.

G. Install piping to allow application of insulation plus 1-inch (25-mm) clearance around insulation.

H. Install pipe escutcheons for pipe penetrations of walls, partitions, floors and ceilings.

I. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, ¾" ball valve, threaded nipple and chained cap.

J. Install line size manual shutoff valve at each connection to each piece of equipment.

K. Install piping so that accessories are accessible for operation, maintenance, repair and replacement.

L. Install piping with sufficient clearance to allow for expansion and contraction.

M. Sleeves are not required for core drilled holes through interior solid concrete walls and floors, above grade exterior solid concrete walls and existing underground solid concrete walls. Floors in mechanical equipment areas or other wet areas shall be provided with a sleeve with waterstop.

N. Install sleeves for pipes passing through walls, partitions, and slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. In floors with water stop extend cast-iron sleeve fittings below floor slab as required to secure clamping ring.
   2. Build sleeves into new walls and slabs as walls and slabs are being constructed.
   3. Install sleeves in non-fired rated assemblies large enough to provide 1/2-inch (12.7-mm) annular clear space between sleeve and pipe or pipe insulation.
   4. Install sleeves in fire rated assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

O. Interior Wall and Floor Pipe Penetrations: Sleeves shall be steel pipe except steel sheet metal shall be used for gypsum wall penetrations.

P. Water Proof Floor and Roof Pipe Penetrations: For pipes penetrating floors and roofs with membrane waterproofing install stack sleeve fitting. Secure flashing between clamping flanges. Seal space outside of sleeve fittings with non-shrink, non-metallic grout. Provide Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant between sleeve and pipe.

Q. Aboveground, Exterior-Wall, Pipe Penetrations:
   1. Masonry Wall: Provide steel pipe wall sleeve. Seal space outside of sleeve with non-shrink, non-metallic grout. Provide Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant between sleeve and pipe.
   2. Non-Masonry or Non-Concrete Walls: Provide wall plate matching surrounding construction. Fill gap between wall opening and pipe with mineral wool. Provide Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant between wall plate and wall.

R. Underground, Exterior-Wall, Pipe Penetrations: Provide cast-iron or galvanized steel sleeves with integral waterstop, except for existing walls. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for annular clear space between pipe and sleeve for installing mechanical sleeve seals. Annular clear space shall be per mechanical sleeve seal manufacturer's written recommendation. Assemble and install mechanical sleeve seals according to manufacturer's written instructions.

S. Verify final equipment locations for roughing-in.

T. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:

1. Threaded Steel Pipe Joints: Thread pipe with tapered pipe threads in accordance with ANSI B2.1 and ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed. 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
2. Welded Steel Pipe Joints: Weld pipe joints in accordance with applicable ASME Codes and AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe".
3. Flanged Steel Pipe Joints: Clean flange faces and install gaskets. Align flange surfaces parallel. Use suitable lubricants on bolt threads. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.
4. Grooved Steel Pipe Joints: Install per grooved piping manufacturer's written installation instructions.
5. Copper Pipe Joints: Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
6. Gasket Materials: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.
7. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
8. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
9. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. ABS Piping: ASTM D 2235 and ASTM D 2661.
   c. CPVC Piping: ASTM D 2846 and ASTM F 493.
   d. PVC Pressure Piping: ASTM D 2672.
   e. PVC Nonpressure Piping: ASTM D 2855.
   f. PVC to ABS Nonpressure Transition Fittings: Procedure and solvent cement according to ASTM D 3138.
10. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 procedures and manufacturer's written instructions.
    a. Plain-End Pipe and Fittings: Use butt fusion.
    b. Plain-End Pipe and Socket Fittings: Use socket fusion.

U. Piping Connections: Make connections according to the following, unless otherwise indicated:

1. Remake leaking joints using new materials.

2. Install unions, in piping 2-inch NPS (DN50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
3. Install flanges, in piping 2-1/2-inch NPS (DN65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
4. Piping Systems: Install dielectric fittings to connect piping materials of dissimilar metals.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting and without interference(s) to other installations.

D. Extend grease fittings to accessible locations.

3.3 FIRE STOPPING

A. Fire Stopping: At penetrations through fire rated walls, partitions, barriers, ceilings, roofs or floors, the fire rated integrity shall be maintained. Provide manufacturer's standard fire-stopping sealant, with accessory materials, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

3.4 LABELING AND IDENTIFYING

A. Piping Systems: Install pipe markers on all piping of each system (insulated and un-insulated), including pipe sizes, fluid medium and direction of flow arrows. Interior, non-metal jacketed piping systems: Provide stick-on markers. Install flow marker 360 degrees at each end of each pipe marker.
   2. Interior metal jacketed and exterior piping systems: Provide rigid markers (for markers on piping over 6 inches provide nylon ties). Provide stick-on size marker attached to rigid marker.
   3. Markers shall be spaced at a maximum of 25-foot (7.5-m) intervals along each run. In addition to the 25 foot intervals, provide markers at the following locations:
      a. Near each valve and control device.
      b. Near each branch, excluding short takeoffs for fixtures and terminal units.
      c. Near locations where pipes pass through walls, floors, ceilings, or enter non-accessible enclosures.
      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. Valve Tags:
   1. Install on all valves and control devices (factory and field installed), except check valves, plumbing fixture supply stops, faucets, and hose connections. List tagged valves in valve schedule.
   2. Provide framed valve schedule(s) where directed by owners representative.

C. Install plastic equipment marker on all equipment provided under this contract.

D. Provide additional mechanical identification materials and devices to supplement field or factory supplied nameplates that have become visually blocked by work of this or other Divisions.

E. Clean faces of identification devices and glass frames of valve charts.

3.5 TOUCH-UP PAINTING

A. Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 GROUTING

A. Install nonmetallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix and cure grout according to manufacturer's written instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placing of grout.

E. Place grout to provide smooth bearing surface for equipment base.

F. Place grout, completely filling equipment bases.

G. Place grout around anchors.

3.7 INTERIOR CONCRETE HOUSEKEEPING PADS

A. Provide concrete housekeeping pads for all floor mounted equipment. Provide 6" tall 3000 psi concrete pad having 6 X 6 –W2.9 X W 2.9 wire metal mesh at center. Extend pad a minimum of 4" greater than equipment footprint in all directions. Provide a smooth trowel finish on top surface of pad.

B. Provide 14 gauge galvanized steel frame around entire perimeter of pad having a ¾" chamfer at all corners and at all edges. Frame to extend ½" over top of pad and 1" beneath bottom surface of pad. All corners to be welded.

C. Anchor pad to existing or new concrete floor with #4 rebar dowels set at a minimum 12" on center in each direction, having the last 2" of dowel bent at a 90 degree angle.
   1. Existing floors: Drill 1" diameter bores into the existing concrete floor at a minimum depth of 2" to accept dowels. Fasten dowels within bores with epoxy grout.
   2. Newly poured floors: Provide rebar dowels embedded to a depth of 2" below floor surface, having the last 2" of dowel bent at a 90 degree angle.

D. Prior to pouring concrete pad, place manufacture's recommended galvanized steel anchor bolts into pad using the equipment template provided.

E. Provide 5000 psi level grout bedding beneath equipment prior to setting and final tightening of fasteners.

3.8 REMOVALS

A. Disconnect and remove work where indicated on the contract documents in its entirety.

B. Removal: Remove indicated equipment, piping, ductwork, insulation and associated components from Project site and dispose of in a legal manner. Provide owner's right of first refusal for all equipment removed.

C. Where work is indicated to be abandoned in place, cut and remove pipe or ductwork a minimum of 2 inches (50 mm) beyond the wall, floor, ceiling or roof. Patch surface to match existing finish of adjacent construction.

D. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.9 REPAIRS

A. If existing or new work is damaged or disturbed, remove damaged sections and install new products of equal capacity and quality.

END OF SECTION

SECTION 220513 – ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 – GENERAL

1.1 SUMMARY

A. This section specifies the basic requirements for electrical components which are furnished with mechanical equipment (factory or field installed).

1.2 REFERENCES

A. The following references shall be applicable:
1. NEMA Standards MG 1: Motors and Generators
2. NEMA Standards ICS 2: Industrial Control Devices, Controllers, and Assemblies
3. NEMA Standard 250: Enclosures for Electrical Equipment
4. NEMA Standard KS 1: Enclosed Switches
5. Comply with National Electrical Code (NFPA 70).

1.3 SUBMITTALS

A. Factory furnished electrical component product data submittal requirements are specified within the individual equipment specification sections.

1.4 QUALITY ASSURANCE

A. Electrical components and materials shall be UL or ETL labeled.

PART 2 – PRODUCTS

2.1 MOTORS

A. Electrical Characteristics shall meet the following unless otherwise indicated:
1. Frequency Rating: 60 HZ
2. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):
a. 120V circuit: 115V motor rating.
b. 208V circuit: 200V motor rating.
c. 240V circuit: 230V motor rating.
d. 480V circuit: 460V motor rating.

B. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
1. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.

C. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors, unless otherwise indicated.

D. Temperature rating: Rated for 40°C (104°F) environment.

E. Temperature rise: Rated for maximum of 90°C (194°F) rise for continuous duty at full load, Class B insulation, except for inverter duty rated motors which shall use Class F insulation.

F. Starting capability: Frequency of starts as required to meet automatic control system sequence of operation, and not less than 5 evenly timed starts per hour.

G. Capacity: Sufficient to start and operate connected loads without exceeding name plate ratings.

H. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B," except "C" where required for high starting torque.

1. Bearings:
   a. Re-greasable, except permanently sealed motor;
   b. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor;
2. Mounting:
   a. Horizontal: foot mounted
   b. Vertical: base mounted
3. Enclosure Type: See individual equipment specifications for enclosure type.
4. Lifting Lug: lifting eye or lug for all motors exceeding 50 pounds.
5. Stamped Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, efficiency, special features and similar information.
6. All motors 1hp and larger shall be premium efficiency, constant speed, rpm as specified, squirrel cage, unless otherwise required to meet driven equipment's maximum starting duty. Minimum full-load nominal efficiencies per IEEE Standard 112, Test Method B shall be equal to or greater than those listed in the following tables.

I. Polyphase Motors:

1. General: Squirrel-cage induction-type conforming to the following requirements except as otherwise indicated.
2. Variable Speed Motors for Use with Solid-State Drives: Energy efficient, invertor ready, design B units with ratings, characteristics, and features coordinated with drive manufacturer.
3. Bearings: Suitable for radial and thrust loading of the application.
4. Severe Duty Motors: Minimum 1.25 service factor. Provide motors with regreasable bearings and equipped with capped relief vents. Insulate windings with nonhygroscopic material.
5. Motors for Reduced Inrush Starting: Coordinate with reduced inrush controller type and with characteristics of driven equipment load. Provide required wiring leads in motor terminal box to suit control method.

J. Single-Phase Motors:

1. Energy Efficient Motors: One of the following types as selected to suit the starting torque and other requirements of the specific motor application.
   a. Permanent Split Capacitor
   b. Split-Phase Start, Capacitor-Run
   c. Capacitor-Start, Capacitor-Run
   d. Shaded-Pole
   e. Capacitor Start, Induction Run.
2. Internal Thermal Overload Protection for Motors: Protection shall automatically open the power supply circuit to the motor, or a control circuit. Protection shall operate when winding temperature exceeds a safe value calibrated to the temperature rating of the motor insulation. Motor shall automatically reset when motor temperature returns to normal range.

3. Bearings: Belt connected motors or other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, prelubricated sleeve bearings may be used for other single phase motors.

2.2 STARTERS, DISCONNECTS AND ACCESSORIES

A. Motor Starter Characteristics:

1. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition. Minimum size starter shall be NEMA Size 1.

B. Manual Disconnect Switches:

1. Fusible switches: fused, each phase; general duty; horsepower rated; non-teasible quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as required by equipment manufacturer.
2. Non-fusible switches: horsepower rated toggle switch type; quantity of poles and voltage rating as required by equipment manufacturer.

C. Magnetic Starters:

1. Hand-off-auto, selector switches and pilot lights.
2. Trip-free thermal overload relays, each phase.
3. Interlocks, switches, contacts and similar devices as required for coordination with control requirements.
4. Built-in control circuit transformer, sized by manufacturer. Provide with minimum two normally-open and two normally closed spare auxiliary contacts.
5. Externally operated manual reset.
6. High voltage and low voltage protection in all three phases.
7. Internal Thermal Overload Protection For Motors: Protection shall automatically open control circuit. Protection shall operate when winding temperature exceeds safe value calibrated to the temperature rating of the motor insulation.

D. Starter Enclosures:

1. NEMA rated as required for environment in which equipment is to be installed.
2. Interlock covers of combination starters with operating handle providing access to inside of enclosure only when disconnect is in "OFF" position. Provide means to attach multiple padlocks for locking external operating handle in either the "ON" or "OFF" position.
3. Provide red colored RESET Button in cover of starter.
4. Provide and secure wiring diagram corresponding to motor and control wiring of associated equipment on inside of each magnetic and combination starter.
5. Manual starter shall have means for externally locking operating mechanism in "OFF" position.

E. Factory Installed Motor Connections:

1. Flexible conduit, except where plug-in electrical cords are specifically indicated.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Motors: Install field-installed motors in accordance with manufacturer's published instructions and the following:
   1. Direct Connected Motors: Mount securely in accurate laser alignment.
   2. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.
   3. Bearings: Provide extended lube lines for regreasable motors.

B. Motor Controllers (starters, Disconnects and Drives): Install field-installed starters, disconnects and drives in accordance with manufacturer's published instructions and the following:
   1. Locate controllers within sight of motors controller.
   2. Mounting: For control equipment at walls, bolt units to wall or mount on light-weight structural steel channels bolted to the wall. For controllers not at walls, provide freestanding racks fabricated of structural steel members and light-weight slotted structural steel channels. Use feet consisting of 3/8-inch thick steel plates, 6-inch square, bolted to the floor. Use feet for welded attachment of 1-1/2 inch thick steel plates, 6-inch square, bolted to the floor. Use feet for welded attachment of 1-1/2 inch by 1-1/2 inch by 1/4–inch vertical angle pots not over three feet on centers. Connect the posts with horizontal lightweight slotted steel channels and bolt the control equipment to the channels.
   3. Clearances: All motor controllers shall be installed per NEC requirements.

3.2 ACCEPTANCE

A. The right is reserved by the Owner's Representative to reject any motor which, in his opinion, either under test or in actual service is found to be overloaded, develops excessive mechanical noise, magnetic hum, or otherwise operates unsatisfactorily, within the speed range and load specified. The contractor shall adjust, or if necessary replace any such deflected motor with one satisfactory to the Owner or Owner's Representative without any extra cost to the Owner.

END OF SECTION

SECTION 220519 – METERS AND GAGES

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes the following types of meters and gages:
   1. Temperature gages and fittings.
   2. Pressure gages and fittings.
   3. Flow meters.

1.2 SUBMITTALS

A. Product data for each type of meter and gage. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gage schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gage.

B. Product certificates signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and products' compliance with specified requirements.

C. Maintenance data for each type of meter and gage.

1.3 QUALITY ASSURANCE

A. UL Compliance: Comply with applicable UL standards pertaining to meters and gages.

B. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Mercury-In-Glass Thermometers:
   1. Marshalltown Instruments, Inc.
   2. Trerice (H.O.) Co.
   3. Weiss Instruments, Inc.
   4. Weksler Instruments Corp.

B. Direct-Mount Filled-System Dial Thermometers:
   1. Ashcroft Dresser Industries Instrument Div.
   2. Marsh Instrument Co., Unit of General Signal.
   3. Trerice (H.O.) Co.
   4. Weiss Instruments, Inc.
   5. Weksler Instruments Corp.

C. Bimetal Dial Thermometers:
   1. Ashcroft Dresser Industries Instrument Div.
   2. Marshalltown Instruments, Inc.

3. Tel-Tru Manufacturing Co., Inc.
4. Trerice (H.O.) Co.
5. Weiss Instruments, Inc.
6. Weksler Instruments Corp.

D. Thermometer Wells: Same as for thermometers.

E. Insertion Dial Thermometers:
1. Ashcroft Dresser Industries Instrument Div.
2. Tel-Tru Manufacturing Co., Inc.
3. Trerice (H.O.) Co.
4. Weiss Instruments, Inc.
5. Weksler Instruments Corp.

F. Pressure Gages:
1. Ametek, U.S. Gauge Div.
2. Ashcroft Dresser Industries Instrument Div.
3. Marsh Instrument Co., Unit of General Signal.
4. Marshalltown Instruments, Inc.
5. Trerice (H.O.) Co.
6. Weiss Instruments, Inc.
7. Weksler Instruments Corp.
8. WIKA Instruments Corp.

G. Pressure Gage Accessories: Same as for pressure gages.

H. Test Plugs:
1. MG Piping Products Co.
2. Peterson Equipment Co., Inc.
3. Sisco, A Spedco, Inc. Co.
4. Trerice (H.O.) Co.
5. Watts Regulator Co.

2.2 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span

B. Scale range: Temperature ranges for services listed as follows:
1. General: Temperature range shall be selected such that normal operating temperature is at 75% of scale.
2. Domestic Hot Water: 30 to 240°F with 2-degree scale divisions (0 to 115°C with 1-degree scale divisions).
3. Domestic Cold Water: 0 to 100°F with 2-degree scale divisions (minus 18 to 38°C with 1-degree scale divisions).
4. Hot Water: 30 to 300°F with 2-degree scale divisions (0 to 150°C with 1-degree scale divisions).
5. Condensed Water: 0 to 160°F with 2-degree scale divisions (minus 18 to 70°C with 1-degree scale divisions).

6. Chilled Water: 0 to 100°F with 2-degree scale divisions (minus 18 to 38°C with 1-degree scale divisions).
7. Steam and Condensate: 50 to 400°F with 2-degree scale divisions (10 to 205°C with 1-degree scale divisions).

2.3 MERCURY-IN-GLASS THERMOMETERS

A. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9-inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Red reading, mercury filled, magnifying lens.

D. Scale: Satin-faced, non-reflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.4 DIRECT-MOUNT FILLED-SYSTEM DIAL THERMOMETERS

A. Type: Vapor actuated, universal angle.

B. Case: Drawn steel or cast aluminum, glass lens, 4-1/2-inch diameter.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Thermal Bulb: Copper with phosphor bronze bourdon pressure tube.

E. Movement: Brass, precision geared.

F. Scale: Progressive, satin faced, non-reflective aluminum, permanently etched markings.

G. Stem: Copper-plated steel, aluminum, or brass, for separable socket, length to suit installation.

2.5 REMOTE-READING FILLED-SYSTEM DIAL THERMOMETERS

A. Type: Vapor actuated.

B. Case: Drawn steel or cast aluminum, glass lens, 4-1/2-inch diameter.

C. Movement: Brass, precision geared.

D. Scale: Progressive, satin faced, non-reflective aluminum, permanently etched markings.

E. Tubing: Bronze double-braided armor over copper capillary, length to suit installation.

F. Bulb: Copper with separable socket for liquids, averaging element for air.

2.6 BIMETAL DIAL THERMOMETERS

A. Type: Direct mounted, bimetal, universal angle.

B. Case: Stainless steel, glass lens, 5-inch diameter.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Element: Bimetal coil.

E. Scale: Satin faced, non-reflective aluminum, permanently etched marking.

F. Stem: Stainless steel for separable socket, length to suit installation.

2.7 DIAL-TYPE INSERTION THERMOMETERS

A. Type: Bimetal, stainless steel case and stem, 1-inch-diameter dial, dust- and leakproof, 1/8-inch-diameter tapered-end stem with nominal length of 5 inches.

2.8 THERMOMETER WELLS

A. Thermometer Wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.9 PRESSURE GAGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon- tube type, bottom connection.

B. Case: Drawn steel or brass, glass lens, 4-1/2-inches diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.

F. Range: Conform to the following:
1. Vacuum: 30 inches Hg to 15 psi.
2. All fluids: 2 times operating pressure.

2.10 PRESSURE GAGE ACCESSORIES

A. Syphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.11 FLOW METERS, GENERAL

A. Flow rate of elements and meters shall be same as connected equipment or system.

2.12 WAFER ORIFICE-TYPE FLOOD ELEMENTS

A. Type: Differential-pressure wafer-type orifice insert flow elements designed for installation between pipe flanges.

B. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate. Elements shall be pressure rated for 300 psig and 250□F (120□C).

2.13 METERS

A. Permanently Mounted Meters: Suitable for mounting on wall or bracket, 6-inch dial or equivalent with fittings and copper tubing for connecting to flow element.

B. Scale shall be in gpm unless otherwise indicated.

C. Accuracy: Plus or minus 1 percent between 20 to 80 percent of range.

D. Portable Meters: Differential-pressure gage and two 12-foot hoses in carrying case with handle.

E. Scale: In inches of water unless otherwise indicated.

F. Accuracy: Plus or minus 2 percent between 20 to 80 percent of range.

G. Each meter shall be complete with operating instructions.

2.14 TEST PLUGS

A. Test Plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:
   1. Air, Water, Oil, and Gas, 20 to 200°F (minus 7 to 93°C): Neoprene.
   2. Air and Water, minus 30 to 275°F (minus 35 to 136°C): EPDM.

C. Test Kit: Provide test kit consisting of 1 pressure gage, gage adapter with probe, 2 bimetal dial thermometers, and carrying case.

D. Ranges of pressure gage and thermometers shall be approximately 2 times systems operating conditions.

PART 3 – EXECUTION

3.1 THERMOMETERS INSTALLATION

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Install in the following locations and elsewhere as indicated:
   1. At inlet and outlet of each hydronic zone.
   2. At inlet and outlet of each hydronic boiler and chiller.
   3. At inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
   4. At inlet and outlet of each hydronic heat exchanger.
   5. At inlet and outlet of each hydronic heat recovery unit.
   6. At inlet and outlet of each thermal storage tank.

C. Remote-Reading Dial Thermometers: Install in control panels, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

D. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.2 INSTALLATION OF PRESSURE GAGES

A. Install pressure gages in piping tee with pressure gage valve, located on pipe at most readable position.

B. Install in the following locations, and elsewhere as indicated:
   1. At suction and discharge of each pump.
   2. At discharge of each pressure-reducing valve.
   3. At building water service entrance.
   4. At chilled water and condenser water inlets and outlets of chillers.

C. Pressure Gage Needle Valves: Install in piping tee with snubber. Install syphon in lieu of snubber for steam pressure gages.

3.3 INSTALLATION OF TEST PLUGS

A. Test Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.4 INSTALLATION OF FLOW-MEASURING ELEMENTS AND METERS

A. General: Install flow meters for piping systems located in accessible locations at most readable position.

B. Locations: Install flow measuring elements and meters in the following locations and elsewhere as indicated.
   1. At discharge of each pump.
   2. At inlet of each hydronic coil in built-up central systems.

C. Differential-Pressure-Type Flow Elements: Install minimum straight lengths of pipe upstream and downstream from element as prescribed by the manufacturer's installation instructions.

D. Install wafer orifice-type element between 2 Class 125 pipe flanges, ANSI B16.1 (cast iron) or ANSI B16.24 (bronze).

E. Install connections for attachment to portable flow meters in a readily accessible location.

F. Meters for Use with Flow Elements: Install meters on wall or bracket in accessible location.

G. Install connections, tubing, and accessories between flow elements and meters as prescribed by the manufacturer's installation instructions.

H. Window Flow Meters: Install in vertical upward position with impact tube mounted in bushing centered on pipe with 10 pipe diameters upstream and 5 pipe diameters downstream of straight unrestricted piping for 1-1/4 inches and smaller, 20 pipe diameters upstream and 10 pipe diameters downstream for 1-1/2 inches and larger. Calibrate meter after installation in accordance with manufacturer's installation instructions.

I. BTU Meters: Install in piping where indicated in hydronic supply line. Install thermal well in return line for remote sensor. Mount meter on wall if accessible; if not, provide bracket to support meter.

3.5 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

3.6 CONNECTIONS

A. Piping installation requirements are specified in other sections. The drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install meters and gages piping adjacent to machine to allow servicing and maintaining of machine.

END OF SECTION

SECTION 220523 – VALVES

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes: This section includes general duty valves common to most plumbing piping systems. Special purpose valves are specified in individual piping system specifications.

1.2 SUBMITTALS

A. Product Data: Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances.

B. Valve Schedule: Valve schedule indicating manufacturer's figure number, size, location, and valve features for each required valve, and installation instructions.

1.3 QUALITY ASSURANCE

A. American Society of Mechanical Engineers (ASME) Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

B. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the various MSS Standard Practices referenced.

C. Low Lead Content: All valves submitted for use in potable water systems shall meet NSF/ANSI 372 Standard for Low Lead Content.

1.4 STORAGE AND HANDLING

A. Storage: Use the following precautions during storage:
   1. Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.
   2. Protect valves from weather. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.

B. Handling: Use a sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products from one of the manufacturers listed in valve schedule.

B. Provide valves of same manufacturer throughout where possible. Manufacturer's name, valve size, and pressure rating shall be clearly marked on outside of body.

2.2 VALVE FEATURES, GENERAL

A. Valve Design: Rising stem or rising outside screw and yoke stems.
   1. Non-rising stem valves may be used where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators: Provide the following special operator features:
   1. Handwheels, fastened to valve stem, for valves other than quarter turn.
   2. Lever handles, on quarter-turn valves 6-inch and smaller, except for plug valves. Provide plug valves with square heads; provide one wrench for every 10 plug valves.
   3. Chain-wheel operators, for valves 2-1/2-inch and larger, install 72-inches or higher above finished floor elevation. Extend chains to an elevation of 5'-0" above finished floor elevation.
   4. Gear drive operators, on quarter-turn valves 8-inch and larger.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.

G. End Connections: As indicated in the valve specifications.
   1. Threads: Comply with ANSI B1.20.1.
   2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
   3. Solder-Joint: Comply with ANSI B16.18.
      a. Caution: Where soldered end connections are used, use solder having a melting point below 840° DegF for gate, globe, and check valves; below 421° DegF for ball valves.

H. All valves submitted for use in potable water systems use shall meet NSF/ANSI 372 Standard for Low Lead Content.

2.3 GATE VALVES

A. Gate Valves, 3-Inch and Smaller: MSS SP-80; Class 125, body and bonnet of ASTM B 62 cast bronze; with threaded or solder ends, solid disc, copper-silicon alloy stem, brass packing gland, “Teflon” impregnated packing, and malleable iron handwheel.

2.4 BALL VALVES

A. Ball Valves, 1 Inch and Smaller: Rated for 150 psi saturated steam pressure, 600 psi WOG pressure; two-piece construction; with bronze body conforming to ASTM B 62, standard (or regular) port, chrome-plated brass ball, replaceable “Teflon” or “TFE” seats and seals, blowout-proof stem, and vinyl-covered steel handle. Provide solder ends for domestic hot and cold water service.

B. Ball Valves, 1-1/4 Inch to 2-1/2 Inch: Rated for 150 psi saturated steam pressure, 400 psi WOG pressure; 3-piece construction; with bronze body conforming to ASTM B 62, full port, stainless steel ball, replaceable “Teflon” or “TFE” seats and seals, blowout proof stem, and vinyl-covered steel handle. Provide solder ends for domestic hot and cold water service.

2.5 BUTTERFLY VALVES

2.6 CHECK VALVES

A. Swing Check Valves, 2-Inch and Smaller: MSS SP-80; Class 125, cast-bronze body and cap conforming to ASTM B 62; with horizontal swing, Y-pattern, and bronze disc; and having threaded or solder ends. Provide valves capable of being reground while the valve remains in the line.

PART 3 – EXECUTION

3.1 VALVE ENDS SELECTION

A. Select valves with the following ends or types of pipe/tube connections:
   1. Copper Tube Size, 2-Inch and Smaller: Solder ends.
   2. Steel Pipe Sizes, 2-Inch and Smaller: Threaded end.
   3. Steel Pipe Sizes 2-1/2 Inch and Larger: Flanged.

3.2 VALVE INSTALLATIONS

A. General Application: Use gate, ball, and butterfly valves for shut-off duty; globe, ball, and butterfly for throttling duty. Refer to piping system specification sections for specific valve applications and arrangements.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.

D. Install balance valves in the hot water recirculation piping where shown on the drawings.

E. Install three-valve bypass around each pressure reducing valve.

F. Install valves in horizontal piping with stem at or above the center of the pipe.

G. Install valves in a position to allow full stem movement.

H. Installation of Swing Check Valves: Install for proper direction of flow and with horizontal position with hinge pin level.

I. Install access doors in ceilings or walls as required in the types and sizes to accommodate easy valve access and construction (sheet rock, etc. and fire rating).

3.3 SOLDER CONNECTIONS

A. Apply heat evenly to outside of valve around joint until solder will melt upon contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.4 FLANGED CONNECTIONS

A. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.5 FIELD QUALITY CONTROL

A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.6 ADJUSTING AND CLEANING

A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

3.7 VALVE PRESSURE/TEMPERATURE CLASSIFICATION SCHEDULES

SERVICE	**GATE**	**BALL**	**CHECK**
Domestic Hot and Cold Water	125	150	125

SERVICE	**GATE**	**BUTTERFLY**	**CHECK**
Domestic Hot and Cold Water	125	200	125

3.8 VALVE SCHEDULE

A. Gate Valves - 3 Inch and Smaller - Class 125:

MANUFACTURER	**THREADED**		**SOLDER**	
	NRS	**RS**	**NRS**	**RS**
Milwaukee	UP105	UP148	UP115	UP149
Nibco	T-113-LF	T-111-LF	S-113-LF	S-111-LF
Stockham	LFB-103	X	LFB-104	X
X means not available.				

B. Ball Valves - 1 Inch and Smaller:

MANUFACTURER	**THREADED ENDS**	**SOLDER ENDS**
Conbraco (Apollo)	70LF-100	70LF-200
Milwaukee	UPBA-100	UPBA-150
Nibco	T-580-66-LF	S-580-66-LF

C. Ball Valves - 1-1/4 Inch to 2-1/2 Inch:

MANUFACTURER	**THREADED ENDS**	**SOLDER ENDS**
Conbraco (Apollo)	82LF-100	82LF-200
Milwaukee	UPBA-300S	UPBA-350S
Nibco	T-595-Y-66-LF	S-595-Y-66-LF

D. Butterfly Valves - 2 Inch and Larger:

1. The following are model numbers for lug-type, with aluminum-bronze disc:

MANUFACTURER	**LEVER**	**GEAR**
Milwaukee	ML-233-E	ML-333-E
Nibco	LD-20003	LD-20005
Watts	BF-03-121-1P	BF-03-121-1G

E. Swing Check Valves - 2 Inch and Smaller:

MANUFACTURER	**CLASS 125 THREADED ENDS**	**CLASS 125 SOLDER ENDS**
Milwaukee	UP509	UP1509
Nibco	T-413-Y-LF	S-413-Y-LF
Stockham	LFB-319Y	LFB-309Y

END OF SECTION

SECTION 220529 – HANGERS, SUPPORTS AND ANCHORS

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes the following:
   1. Horizontal-piping hangers and supports.
   2. Vertical-piping clamps.
   3. Hanger-rod attachments.
   4. Building attachments.
   5. Saddles and shields.
   6. Spring hangers and supports.
   7. Miscellaneous materials.
   8. Anchors.
   9. Equipment supports.

1.2 SUBMITTALS

A. Product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location, and features for each required pipe hanger and support.

B. Assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

C. Details of trapeze hangers and upper attachments for piping 4 inches in diameter and over. Include the number and size of pipe lines to be supported on each type of trapeze hanger.

D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

1.3 QUALITY ASSURANCE

A. NFPA Compliance: Hangers and supports shall comply with NFPA standard No. 13 when used as a component of a fire protection system.

B. MSS Compliance: Provide hangers, supports and components conforming to the latest requirements of MSS Standard Practices SP-58 and SP-69.

C. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code-Steel."
   1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

D. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

E. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.

1. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 – PRODUCTS

2.1 MANUFACTURED UNITS

A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.
   1. Components shall have zinc chromate or red oxide coatings where installed for piping and equipment.

B. Hangers, Supports, and Components: Factory-fabricated according to MSS SP-58.
   1. Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.
   2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

C. Thermal-Hanger Shield Inserts: 100-psi (690kPa) average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.

2.2 PIPE HANGERS AND SUPPORTS

A. Pipe Insulation Shields: Fabricated of steel, with a minimum of 180 degrees, unless otherwise indicated. Shields for use with hangers and supports, with the exception of combination clevis type hangers, shall be in accordance with the following schedule:

PIPE OR TUBING SIZE (INCHES)	**SHIELD LENGTH (INCHES)**	**SHIELD GAGE**
Up to 2	12	18

B. Pipe Covering Protection Saddles: 3/16 inch thick steel, of sufficient depth for the insulation thickness specified, notched so that saddle contact with the pipe is approximately 50 percent of the total axial cross section. Saddles for pipe 12-inches in size and larger shall have a center support.

C. Pipe Hangers: Height adjustable standard duty clevis type, with cross bolt and nut. Pipe spreaders or spacers shall be used on cross bolts of clevis hangers, when supporting piping 10-inches ips and larger.

D. Adjustable Floor Rests and Base Flanges: Steel.

E. Hanger Rods: Galvanized, mild low carbon steel, fully threaded with two nuts at each end for positioning rod and hanger, and locking each in place.

F. Riser Clamps: Malleable iron or steel.

G. Rollers: Cast Iron.

2.3 FASTENERS

A. Sleeve Anchors (Group II, Type 3, Class 3): Molly's Div./USM Corp. Parasleeve Series, Ramset's Dynabolt Series, or Red Head/Phillips AN1405, HN-1614, FS-1411 Series.

B. Wedge Anchors (Zinc Plated, Group II, Type 4, Class 1): Hilti's Kwik Bolt Series, Molly's Div./USM Corp. Parabolt PB Series, Ramset's Trubolt T Series, or Red Head/Phillips WS-3822.

C. Self-Drilling Anchors (Group III, Type 1): Ramset's RD Series, or Red Head/Phillips Series S-14.

D. Stud Anchors (Group VIII, Type 2): Red Head/Phillips JS-38 Series.

E. Threaded Type Concrete Insert: Galvanized ferrous castings, internally threaded to receive 3/4 inch dia. machine bolts.

F. Wedge Type Concrete Insert: Galvanized box-type ferrous castings, internally threaded to receive 3/4 inch bolts having special wedge shaped heads.

G. Bolts, Nuts, Washers, Lags, and Screws: Medium carbon steel; size and type to suit application; galvanized for high humidity locations, and treated wood; plain finish for other interior locations. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work.

2.4 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.

C. Washers: ASTM F 844, steel, plain, flat washers.

PART 3 – EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS

A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69 and SP-89. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

B. Do not hang or support one pipe from another or from ductwork.

C. Support all insulated horizontal piping conveying refrigerants or other fluids below ambient temperature, by means of hangers or supports with insulation shields installed outside of the insulation.

D. Space hangers or supports for horizontal piping on maximum center distances as listed in the following hanger schedules, except as otherwise specified, or noted on the Drawings.

E. For Steel, Alloy Steel and Threaded Brass Pipe:

PIPE SIZE (INCHES)	MAXIMUM SPACING (FEET)
1 and under	8
1-1/4 and 1-1/2	9
2	10

F. For Directional Changes: Install a hanger or support close to the point of change of direction of all pipe runs in either a horizontal or vertical plane.

G. For Concentrated Loads: Install additional hangers or supports, spaced as required and directed, at locations where concentrated loads such as in-line pumps, valves, fittings or accessories occur, to support the concentrated loads.

H. For Branch Piping Runs and Runouts over 5 feet in Length: Install a minimum of one hanger, and additional hangers if required by the hanger spacing schedules.

I. Parallel Piping Runs: Where several pipe lines run parallel in the same plane and in close proximity to each other, trapeze hangers may be submitted for approval. Base hanger spacing for trapeze type hangers on the smaller size of pipe being supported. Design the entire hanger assembly based on a safety factor of five, for the ultimate strength of the material being used.

J. Support floor drain traps from the overhead construction, with hangers of type and design as required and approved. Overhead supports are not required for floor drain traps installed directly below earth supported concrete floors.

K. Size hanger rods in accordance with the following:

PIPE OR TUBING SIZE (INCHES)	SINGLE ROD HANGER SIZE (INCHES)		DOUBLE ROD HANGER SIZE (INCHES)	
	PIPE	TUBING	PIPE	TUBING
Up to 2 inches	3/8	1/4	3/8	1/4
2-1/2 and 3	1/2	3/8	3/8	1/4

L. Secure hanger rods as follows: Install one nut under clevis, angle or steel member; one nut on top of clevis, angle or steel member; one nut inside insert or on top of upper hanger attachment and one nut and washer against insert or on lower side of upper hanger attachment. A total of four nuts are required for each road, two at upper hanger attachment and two at hanger.

M. Vertical Piping:

1. Support vertical risers of piping systems, by means of heavy duty hangers installed close to base of pipe risers, and by riser clamps with extension arms at intermediate floors, with the distance between clamps not to exceed 25 feet, unless otherwise specified. Support pipe risers in vertical shafts equivalent to the aforementioned. Install riser clamps above floor slabs, with the extension arms resting on floor slabs. Provide adequate clearances for risers that are subject to appreciable expansion and contraction, caused by operating temperature ranges.
2. Support extension arms of riser clamps, secured to risers to be insulated for cold service, 4-inches above floor slabs, to allow room for insulating and vapor sealing around riser clamps.

3. Install intermediate supports between riser clamps on a maximum 6 foot centers, for copper tubing risers 1-1/4" in size and smaller, installed in finished rooms or spaces other than mechanical equipment machine or steam service rooms, or penthouse mechanical equipment rooms.
4. Floor Supports: Install adjustable yoke rests with base flanges, for the support of piping, unless otherwise indicated on the Drawings. Install supports in a manner, which will not be detrimental to the building structure.

N. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.

O. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

P. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

Q. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 “Building Services Piping” is not exceeded.

3.2 UPPER HANGER ATTACHMENTS

A. General:
1. In all cases, secure upper hanger attachments to overhead structural steel, steel bar joists, or other suitable structural members.
2. Do not use flat bars or bent rods as upper hanger attachments.

B. Attachment to Wood Construction: Secure hangers to the sides (only) of wood members, by means of malleable iron side beam connectors, or malleable iron or steel side beam brackets. Do not secure hanger attachments to nailing strips resting on top of steel beams.
1. Secure side beam connectors to wood members with two No. 18 x 1-1/2 inch long wood screws, or two No. 16 x 1-1/2 inch long drive screws. Do not support piping over 1-1/2 inches in size from side beam connectors. Do not hammer in wood screws.
2. Secure side beam brackets to wood members with steel bolts or lag screws. Do not use lag screws in wooden members having a nominal thickness (beam face) under 2 inches in size. Install bolts or lag screws, in the sides of timber or a joist, at the mid-point or above, not less than 2-1/2 inches from the lower edge when supporting branch lines and not less than 3 inches from the lower edge when supporting mains. Install heavy gage steel washers under all nuts.
3. Secure side beam brackets to wooden beams or joists, with lag screws or bolts of size as follows:

PIPE SIZE (INCHES)	**LAG SCREW SIZE (INCHES)**	**BOLT DIAMETER (INCHES)**
2 and under	3/8 diameter x 1-3/4	3/8
2-1/2	1/2 diameter x 2	1/2

a. Do not support piping larger than 3 inches with lag screws. Predrill holes for lag screws 1/8 inch in diameter less than the root diameter of the lag screw thread.

b. The minimum width of the lower face of wood beams or joints in which lag screws of size as specified may be used is as follows:

LAG SCREW DIAMETER (INCHES)	NOMINAL WIDTH OF BEAM FACE (INCHES)
3/8	2
1/2	3

3.3 TRAPEZES

A. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

3.4 ANCHORS, RESTRAINTS, RIGID SUPPORTS, STAYS, AND SWAY BRACES

A. Install pipe anchors, restraints, and sway braces, at locations noted on the Drawings. Design anchors so as to permit piping to expand and contract freely in opposite directions, away from anchor points. Install anchors independent of all hangers and supports, and in a manner which will not affect the structural integrity of the building.

3.5 COMBINATION CLEVIS HANGER, PIPE INSULATION SHIELD, AND VAPOR BARRIER JACKETED HIGH DENSITY INSULATING SADDLES

A. Install a combination clevis hanger, pipe insulation shield and vapor barrier jacketed high density insulating saddles, at all points of support for piping or tubing to be insulated for cold service. Furnish companion high density vapor barrier jacketed saddle pieces, of the same material, thickness and length, for installation over the top 180 degree surface of pipe or tubing, at each point of support where an insulated clevis hanger is utilized.

3.6 PIPE INSULATION SHIELDS

A. Install a pipe insulation shield, at all points of support, for piping insulated with cold service insulation. Center shields on all hangers and supports, and install in such a manner so as not to cut, puncture or press into the insulation, or in any manner be detrimental to the vapor barrier.

3.7 PIPE COVERING PROTECTION SADDLES

A. Install pipe covering protection saddles at all points of support, for steel piping 6 inches in size and larger, insulated with hot service insulation. Weld saddles to piping to insure movement with pipe.

B. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

C. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

D. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.

E. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.8 EQUIPMENT SUPPORTS

A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

3.9 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

C. Ferrous Metals: Clean galvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structure Painting Council.

D. Galvanized Surfaces: Clean galvanized surfaces with non-petroleum based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

E. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

F. Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and 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 that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

3.10 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

END OF SECTION

SECTION 220700 – PLUMBING INSULATION

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes pipe, duct, and equipment insulation.

1.2 DEFINITIONS

A. Hot Surfaces: Normal operating temperatures of 100ºF or higher.

B. Cold Surfaces: Normal operating temperatures less than 75ºF.

C. Thermal Resistivity: "r-values" represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees Fahrenheit between two exposed faces required to cause one Btu to flow through one square foot of material, in one hour, at a given mean temperature.

D. Density: Is expressed in lb/sq.ft.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of mechanical insulation identifying k-value, thickness, and accessories.

C. Manufacturer's installation instructions.

D. Schedule of materials and thickness for each piece of equipment.

1.4 QUALITY ASSURANCE

A. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.
   1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.
   2. Exterior Insulation: Flame spread rating of 75 or less and a smoke developed rating of 150 or less.

1.5 SEQUENCING AND SCHEDULING

A. Schedule insulation application after testing of piping systems.

B. Schedule insulation application after installation and testing of heat trace tape.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Glass Fiber:
   a. CertainTeed Corporation.
   b. Knauf Fiberglass GmbH.
   c. Manville.
   d. Owens-Corning Fiberglas Corporation.
   e. USG Interiors, Inc. - Thermafiber Division.
2. Flexible Elastomeric Cellular:
   a. Armstrong World Industries, Inc.
   b. Halstead Industrial Products.
   c. IMCOA.
   d. Rubatex Corporation.
3. Open Weave Glass Cloth Membrane:
   a. Perma Glas-Mesh Corp.
4. Vinyl-Acrylic Mastic:
   a. Childers Products Co.

2.2 GLASS FIBER

A. Material: Inorganic glass fibers, bonded with a thermosetting resin.

B. Jacket: All-purpose, factory-applied, laminated glass-fiber-reinforced, flame-retardant Kraft paper and aluminum foil having self-sealing lap.

C. Preformed Pipe Insulation: ASTM C 547, Class 1, rigid pipe insulation, jacketed.
1. Thermal Conductivity: 0.27 average maximum at 75ºF mean temperature.
2. Density: 10 average maximum.

D. Adhesive: Produced under the UL Classification and Follow-up service.
1. Type: Non-flammable, solvent-based.
2. Service Temperature Range: Minus 20 to 180ºF.

E. Vapor Barrier Coating: Waterproof coating recommended by insulation manufacturer for outside service.

2.3 FLEXIBLE ELASTOMERIC CELLULAR

A. Material: Flexible expanded closed-cell structure with smooth skin on both sides.
1. Tubular Materials: ASTM C 534, Type I.
2. Sheet Materials: ASTM C 534, Type II.

B. Thermal Conductivity: 0.27 average maximum at 75ºF.

C. Coating: Water based latex enamel coating recommended by insulation manufacturer.

2.4 ADHESIVES

A. Flexible Elastomeric Cellular Insulation Adhesive: Solvent-based, contact adhesive recommended by insulation manufacturer.

B. Lagging Adhesive: MIL-A-3316C, non-flammable adhesive in the following Classes and Grades:
   1. Class 1, Grade A for bonding glass cloth and tape to unfaced glass fiber insulation, sealing edges of glass fiber insulation, and bonding lagging cloth to unfaced glass fiber insulation.
   2. Class 2, Grade A for bonding glass fiber insulation to metal surfaces.

2.5 JACKETS

A. General: ASTM C 921, Type 1, except as otherwise indicated.

B. Foil and Paper Jacket: Laminated glass-fiber-reinforced, flame-retardant Kraft paper and aluminum foil.
   1. Water Vapor Permeance: 0.02 perm maximum, when tested according to ASTM E 96.
   2. Puncture Resistance: 50 beach units minimum, when tested according to ASTM D 781.

C. PVC Jacketing: High-impact, ultra-violet-resistant PVC, 20-mils thick, roll stock ready for shop or field cutting and forming to indicated sizes.
   1. Adhesive: As recommended by insulation manufacturer.

D. PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultra-violet-resistant PVC.
   1. Adhesive: As recommended by insulation manufacturer.

2.6 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Woven glass fiber fabrics, plain weave, presized a minimum of 8 ounces per sq. yd.
   1. Tape Width: 4 inches.
   2. Cloth Standard: MIL-C-20079H, Type I.
   3. Tape Standard: MIL-C-20079H, Type II.

B. Bands: 3/4-inch wide, in one of the following materials compatible with jacket:
   1. Stainless Steel: Type 304, 0.020 inch thick.
   2. Galvanized Steel: 0.005 inch thick.
   3. Aluminum: 0.007 inch thick.
   4. Brass: 0.01 inch thick.
   5. Nickel-Copper Alloy: 0.005 inch thick.

C. Wire: 14-gage nickel copper alloy, 16-gage, soft-annealed stainless steel, or 16-gage, soft-annealed galvanized steel.

D. Corner Angles: 28-gage, 1-inch by 1-inch aluminum, adhered to 2-inch by 2-inch Kraft paper.

E. Anchor Pins: Capable of supporting 20 pounds each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for insulation type and thickness.

2.7 SEALING COMPOUNDS

A. Vapor Barrier Compound: Water-based, fire-resistive composition.
   1. Water Vapor Permeance: 0.08 perm maximum.
   2. Temperature Range: Minus 20 to 180ºF.

B. Weatherproof Sealant: Flexible-elastomer-based, vapor-barrier sealant designed to seal metal joints.
   1. Water Vapor Permeance: 0.02 perm maximum.
   2. Temperature Range: Minus 50 to 250ºF.
   3. Color: Aluminum.

PART 3 – EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.

B. Mix insulating cements with clean potable water. Mix insulating cements contacting stainless-steel surfaces with demineralized water.
   1. Follow cement manufacturer's printed instructions for mixing and portions.

3.2 INSTALLATION, GENERAL

A. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each mechanical system.

B. Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.

C. Install vapor barriers on insulated pipes and equipment having surface operating temperatures below 60ºF.

D. Install insulation only after systems to be insulated have been tested and approved.

E. Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.

F. Install insulation with smooth, straight, and even surfaces.

G. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.

H. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.

I. Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.

J. Apply adhesives and coatings at manufacturer's recommended coverage-per-gallon rate.

K. Keep insulation materials dry during application and finishing.

L. Install board and block materials with a minimum dimension of 12 inches and a maximum dimension of 48 inches.

M. Items Not Insulated: Unless otherwise indicated do not apply insulation to the following systems, materials, and equipment:
   1. Flexible connectors for pipes.
   2. Vibration control devices.
   3. Testing laboratory labels and stamps.
   4. Nameplates and data plates.
   5. Access panels and doors in air distribution systems.
   6. Sanitary drainage and vent piping, except for exposed sanitary on fixtures for the disabled.
   7. Drainage piping located in crawl spaces, unless indicated otherwise.
   8. Below grade piping.
   9. Chrome-plated pipes and fittings, except for plumbing fixtures for the disabled.
   10. Piping specialties including air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.3 PIPE INSULATION INSTALLATION, GENERAL

A. Tightly butt longitudinal seams and end joints. Bond with adhesive.

B. Stagger joints on double layers of insulation.

C. Apply insulation continuously over fittings, valves, and specialties, except as otherwise indicated.

D. Apply insulation with a minimum number of joints.

E. Apply insulation with integral jackets as follows:
   1. Pull jacket tight and smooth.
   2. Cover circumferential joints with butt strips, at least 3-inches wide, and of same material as insulation jacket. Secure with adhesive along both edges of butt strip and space 4 inches on center.
   3. Longitudinal Seams: Overlap seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap.
   4. Vapor Barrier Coatings: Where vapor barriers are indicated, apply on seams and joints and at ends butt to flanges, unions, valves, and fittings.
   5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor barrier coating.
   6. Repair damaged insulation jackets, except metal jackets, by applying jacket material around damaged jacket. Adhere and seal. Extend patch at least 2 inches in both directions beyond damaged insulation jacket and around the entire circumference of the pipe.

F. Roof Penetrations: Apply insulation for interior applications to a point even with the top of the roof flashing. Seal with vapor barrier coating. Apply insulation for exterior applications butted tightly to interior insulation ends. Extend metal jacket for exterior insulation outside roof flashing at least 2 inches below top of roof flashing. Seal metal jacket to roof flashing with vapor barrier coating.

G. Exterior Wall Penetrations: For penetrations of below grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor barrier coating.

H. Interior Walls and Partitions Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions. Apply an aluminum jacket with factory-applied moisture barrier over insulation. Extend 2-inches from both surfaces of wall or partition. Secure aluminum jacket with metal bands at both ends. Seal ends of jacket with vapor barrier coating. Seal around penetration with joint sealer. Refer to Division 7.

I. Floor Penetrations: Terminate insulation underside of floor assembly and at floor support at top of floor.

J. Flanges, Fittings, and Valves - Interior Exposed and Concealed: Coat pipe insulation ends with vapor barrier coating. Apply premolded, precut, or field-fabricated segments of insulation around flanges, unions, valves, and fittings. Make joints tight. Bond with adhesive.

1. Use same material and thickness as adjacent pipe insulation.
2. Overlap nesting insulation by 2-inches or 1-pipe diameter, whichever is greater.
3. Apply materials with adhesive, fill voids with mineral fiber insulating cement. Secure with wire or tape.
4. Insulate elbows and tees smaller than 3-inches pipe size with premolded insulation.
5. Insulate elbows and tees 3-inches and larger with premolded insulation or insulation material segments. Use at least three (3) segments for each elbow.
6. Cover insulation, except for metal jacketed insulation, with PVC fitting covers and seal circumferential joints with butt strips.
7. Cover insulation, except for metal jacketed insulation, with two (2) layers of lagging adhesive to a minimum thickness of 1/16 inch. Install glass cloth between layers. Overlap adjacent insulation by 2-inches in both directions from joint with glass cloth and lagging adhesive.

K. Hangers and Anchors: Apply insulation continuously through hangers and around anchor attachments. Install saddles, shields, and inserts as specified in "Hangers, Supports and Anchors." For cold surface piping, extend insulation anchor legs a minimum of 12-inches and taper and seal insulation ends.

1. Inserts and Shields: Cover hanger inserts and shields with jacket material matching adjacent pipe insulation.
2. Special Treatment at Hanger Locations: At hanger locations on insulated piping 2 inches and larger, install high density rigid fiber glass pipe support blocks. On piping up to and including 5 inches, install one block at each hanger, directly on the bottom of the pipe. For 6-, 8-, and 10-inch piping, install two (2) blocks at each hanger oriented 30 degrees from each side of the bottom. For piping 12-inches and larger, orientate blocks at both the 30 degrees positions and directly on the bottom. Install blocks inside cut out section of pipe insulation, being careful not to damage the vapor barrier jacketing. Any jacketing so damaged should be repaired with matching vapor barrier tape.

3.4 BELOW GROUND PIPE INSULATION INSTALLATION

A. General: The following are additional requirements for insulation applied to piping installed below ground.

B. Coat bore surfaces of insulation materials with insulating cement of type recommended by insulation manufacturer. Apply enough cement to fill surface cells. Do not use adhesives for this coating.

C. Secure insulation with a minimum of 2 stainless-steel bands for each section of insulation.

D. Terminate insulation at anchor blocks.

E. Apply insulation continuously through sleeves and manholes, except as specified above for exterior wall penetrations.

F. Finishing: Apply three (3) coats of asphaltic mastic to a finish thickness of 3/16 inch over insulation materials. Apply 10 x 10 mesh glass cloth between coats. Overlap edges of glass cloth by 2-inches.

3.5 GLASS FIBER PIPE INSULATION INSTALLATION

A. Bond insulation to pipe with lagging adhesive.

B. Seal exposed ends with lagging adhesive.

C. Seal seams and joints with vapor barrier compound.

3.6 FLEXIBLE ELASTOMERIC CELLULAR PIPE INSULATION INSTALLATION

A. Slip insulation on the pipe before making connections wherever possible. Seal joints with adhesive. Where the slip-on technique is not possible, cut one side longitudinally and apply to the pipe. Seal seams and joints with adhesive.

B. Valves, Fittings, and Flanges: Cut insulation segments from pipe or sheet insulation. Bond to valve, fitting, and flange and seal joints with adhesive.

1. Miter cut materials to cover soldered elbows and tees.
2. Fabricate sleeve fitting covers from flexible elastomeric cellular insulation for screwed valves, fittings, and specialties. Miter cut materials. Overlap adjoining pipe insulation.

3.7 EQUIPMENT INSULATION INSTALLATION, GENERAL

A. Groove and score insulation materials as required to fit as closely as possible to the equipment and to fit contours of equipment. Stagger end joints.

B. Insulation Thicknesses Greater than 2-Inches: Install insulation in multiple layers with staggered joints.

C. Bevel insulation edges for cylindrical surfaces for tight joint.

D. Secure sections of insulation in place with wire or bands spaced at 9-inch centers, except for flexible elastomeric cellular insulation.

E. Protect exposed corners with corner angles under wires and bands.

F. Manholes, Handholes, and Information Plates: Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

G. Removable Insulation: Install insulation on components that require periodic inspecting, cleaning, and repairing for easy removal and replacement without damage to adjacent insulation.

H. Finishing: Except for flexible elastomeric cellular insulation, apply two (2) coats of vapor barrier compound to a minimum thickness of 1/16 inch. Install a layer of glass cloth embedded between layers.

3.8 GLASS FIBER EQUIPMENT INSULATION INSTALLATION

A. Secure insulation with anchor pins and speed washers.

B. Space anchors at maximum intervals of 18-inches in both directions and not more than 3-inches from edges and joints.

C. Apply a smoothing coat of insulating and finishing cement to finished insulation.

3.9 FLEXIBLE ELASTOMERIC CELLULAR EQUIPMENT INSULATION INSTALLATION

A. Install sheets of the largest manageable size.

B. Apply full coverage of adhesive to the surfaces of the equipment and to the insulation.

C. Butt insulation joints firmly together and apply adhesive to insulation edges at joints.

3.10 JACKETS

A. Foil and Paper Jackets (FP): Install jackets drawn tight. Install lap or butt strips at joints with material same as jacket. Secure with adhesive. Install jackets with 1-1/2 inch laps at longitudinal joints and 3-inch-wide butt strips at end joints.
   1. Seal openings, punctures, and breaks in vapor barrier jackets and exposed insulation with vapor barrier compound.
   2. Provide PVC fitting covers.

B. Interior Exposed Insulation: Install continuous PVC jackets.

C. Interior Exposed Insulation: Install continuous glass cloth jackets.

D. Exterior Exposed Insulation: Install continuous aluminum jackets and seal all joints and seams with waterproof sealant.

E. Install metal jacket with 2-inch overlap at longitudinal and butt joints. Overlap longitudinal joints to shed water. Seal butt joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel draw bands 12-inches on center and at butt joints.

F. Install the PVC jacket with 1-inch overlap at longitudinal and butt joints and seal with adhesive.

G. Install glass cloth jacket directly over insulation. On insulation with a factory applied jacket, install the glass cloth jacket over the factory applied jacket. Install jacket drawn smooth and tight with a 2-inch overlap at joints. Embed glass cloth between two (2) 1/16 inch-thick coats of lagging adhesive. Completely encapsulate the insulation with the jacket, leaving no exposed raw insulation.

3.11 FINISHES

A. Paint finished insulation as specified in Division 9.

B. Flexible Elastomeric Cellular Insulation: After adhesive has fully cured, apply two (2) coats of protective coating to exposed insulation.

3.12 APPLICATIONS

A. General: Materials and thicknesses are specified in schedules at the end of this Section.

B. Interior Piping Systems: Unless otherwise indicated, insulate the following piping systems:
   1. Domestic cold water.

2. Domestic hot water.
3. Domestic recirculated hot water.
4. Sanitary drains for fixtures accessible to the disabled.

C. Equipment: Unless otherwise indicated, insulate the following indoor equipment:
1. Domestic hot water equipment, tanks, and water heaters.

3.13 PIPE INSULATION SCHEDULES

A. General: Abbreviations used in the following schedules include:
1. Field-Applied Jackets: P - PVC, K - Foil and Paper, A-Aluminum.
2. Pipe Sizes: NPS - Nominal Pipe Size.

B. Domestic Cold Water: 1/2 inch-thick glass fiber insulation. Field-applied jacket is not required.
1. Interior Domestic Hot Water and Recirculated Hot Water:

PIPE SIZES (NPS)	MATERIALS	THICKNESS IN INCHES	VAPOR BARRIER REQUIRED	FIELD-APPLIED JACKET
All	Glass Fiber	1	No	None

2. Sanitary Drains and Traps Exposed at Fixtures for Disabled:

PIPE SIZES (NPS)	MATERIALS	THICKNESS IN INCHES	VAPOR BARRIER REQUIRED	FIELD-APPLIED JACKET
1 to 1-1/2	Glass Fiber	1	No	None

3.14 EQUIPMENT INSULATION SCHEDULES

A. General: Abbreviations used in the following schedules include:
1. Field-Applied Jackets:
a. P - PVC.
b. K - Foil and Paper.
c. A - Aluminum.
2. Pipe Sizes: NPS - Nominal Pipe Size.
3. Interior Exposed Domestic Cold Water Equipment:

MATERIAL	FORM	THICKNESS IN INCHES	VAPOR BARRIER REQUIRED	FIELD-APPLIED JACKET
Glass Fiber	Block or Board	1	Yes	(P) (K) (A) (SS)
Flexible Elastomeric	Sheet	3/4	Yes	None

4. Interior Exposed Domestic Hot Water Equipment, Tanks, and Pumps:

MATERIAL	FORM	THICKNESS IN INCHES	VAPOR BARRIER REQUIRED	FIELD-APPLIED JACKET
Glass Fiber	Block	2	No	(A) (SS)

END OF SECTION

SECTION 221116 – WATER DISTRIBUTION PIPING

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes potable water distribution, including cold- and hot-water supply and hot-water recirculation to a point 5 feet outside the building.

1.2 SUBMITTALS

A. Product data for all products specified in this section.

B. Water samples, test results, and reports specified in "Field Quality Control" and "Cleaning" Articles.

C. Coordination drawings, drawn accurately to scale and coordinating penetrations.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide piping system with the following minimum working pressure ratings, except where indicated otherwise:
   1. Water Distribution Systems, Below Ground: 150 psig.
   2. Water Distribution Systems, Above Ground: 125 psig.

1.4 QUALITY ASSURANCE

A. Comply with the provisions of ASME B31.9 "Building Services Piping" for materials, products, and installation.

B. Provide listing/approval stamp, label, or other marking on piping made to specified standards.

PART 2 – PRODUCTS

2.1 GENERAL

A. All products specified in this section shall be manufactured in the USA and/or Canada.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.2 PIPES AND TUBES

A. General: The application of the following pipe, tube, and fitting materials and joining methods required for plumbing piping systems are indicated in Part 3 Article "Pipe and Fittings Applications."

B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.

C. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.

2.3 PIPE FITTINGS AND TUBE FITTINGS

A. Wrought-Copper, Solder-Joint Pressure Fittings: ASME B16.22.

B. Cast-Copper-Alloy, Solder-Joint Pressure Fittings: ASME B16.18.

C. Wrought-Copper and Bronze, Grooved-End Fittings: ASTM B 75 Tube and ASTM B 584 Bronze Castings.

D. Bronze Flanges: ASME B16.24, Classes 150 and 300.

E. Copper Unions: ASME B16.18, cast-copper-alloy body, hexagonal stock, with ball-and-socket joint, metal-to-metal seating surfaces, and solder-joint, threaded, or solder-joint and threaded ends.

1. Threaded Ends: Threads conforming to ASME B1.20.1.

F. Polyethylene Encasement: AWWA C105, 8-mil minimum thickness, tube or sheet.

2.4 JOINING MATERIALS

A. Solder, brazing, and welding filler metals are specified in other Sections.

B. Couplings for Grooved-End Copper Tube and Grooved-End Copper Fittings: ASTM A 536 ductile-iron or ASTM A 47 malleable-iron housing having copper-colored enamel finish, with synthetic-rubber gasket having central-cavity, pressure-responsive design and suitable for hot water, with ASTM A 183 carbon-steel bolts and nuts.

2.5 VALVES

A. Refer to other Sections.

PART 3 – EXECUTION

3.1 EXCAVATION

A. Excavation, trenching, and backfilling are specified elsewhere.

3.2 PIPE AND FITTINGS APPLICATIONS

A. General: Use pipe, tube, fittings, and joining methods for piping systems according to the following applications.

B. Water Distribution Piping Below Ground: Use the following:

1. 3-Inches and smaller: Soft copper tube, Type K, cast-copper-alloy solder-joint pressure fittings and soldered joints with Alloy Sn95 solder.

C. Water Distribution Piping Above Ground: Use the following:

1. 6-Inches and Smaller: Hard copper tube, Type L; wrought-copper or cast-copper-alloy pressure fittings; copper unions; bronze flanges; and solder joints with Alloy Sn95 solder.

3.3 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use gate, ball, or butterfly valves.
2. Throttling Duty: Use globe, ball, or butterfly valves.

3.4 PIPING INSTALLATION, GENERAL

A. Basic piping installation requirements are specified in other Sections.

3.5 SERVICE ENTRANCE PIPING

A. Extend water distribution piping and connect to water service piping of size and in location indicated for service entrance to building. Coordinate with other Sections.

B. Install shutoff valve, inside building at water service entrance.

C. Install sleeve and mechanical sleeve seal at service penetrations through below grade walls.

3.6 WATER DISTRIBUTION PIPING INSTALLATION

A. Install piping with 1/32-inch-per-foot (1/4 percent) slope downward toward drain.

3.7 JOINT CONSTRUCTION

A. Basic piping joint construction is specified in other Sections.

B. Grooved Copper Tube and Grooved-Tube Fitting Joints: Assemble joints with coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.8 ROUGHING-IN FOR WATER METER

A. Install roughing-in piping and plumbing specialties specified in other Sections for water meter installation according to utility company's instructions and requirements.

3.9 INSTALLATION OF VALVES

A. Sectional Valves: Install sectional valves close to main on each branch and riser serving two (2) or more plumbing fixtures or equipment connections and where indicated.

B. Shutoff Valves: Install shutoff valves on inlet to each plumbing equipment item, on each supply to each plumbing fixture not having stops on supplies, and elsewhere as indicated.

C. Drain Valves: Install drain valves, specified in other Sections, on each plumbing equipment item located to drain equipment for service and repair. Install drain valve at base of each riser, at low points of horizontal runs, and where required to drain water distribution piping system.
   1. Install hose-end drain valves at low points in water mains, risers, and branches.
   2. Install stop and waste drain valves where indicated.

D. Check Valves: Install check valve on discharge side of each pump and elsewhere as indicated.

E. Balance Valves: Install valve in each hot-water circulating loop, discharge side of each pump, and elsewhere as indicated.

3.10 HANGERS AND SUPPORTS INSTALLATION

A. Hanger, support and anchor devices are specified in other Sections.

3.11 CONNECTIONS

A. Supply Runouts to Fixtures: Install hot- and cold-water supply piping runouts of sizes indicated, but not smaller than required by plumbing code to fixtures.

B. Mechanical Equipment Connections: Connect hot- and cold-water supply piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection. Use flanges instead of unions for connections 2-1/2 inches and larger.

3.12 FIELD QUALITY CONTROL

A. Inspect water distribution piping as follows:
   1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.
   2. During progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to time inspection must be made. Perform tests specified below in presence of the plumbing official.
      a. Roughing-In Inspection: Arrange for inspection of piping system before concealed or closed-in after system roughing-in and prior to setting fixtures.
      b. Final Inspection: Arrange for final inspection by plumbing official to observe tests specified below and to ensure compliance with requirements of plumbing code.
   3. Reinspections: When a plumbing official finds that piping system will not pass test or inspection, make required corrections and arrange for reinspection by the plumbing official.
   4. Reports: Prepare inspection reports signed by plumbing official.

B. Test water distribution piping as follows:
   1. Test for leaks and defects in new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of system tested.
   2. Leave uncovered and unconcealed in new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved for testing.
   3. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
   4. Repair leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.
   5. Prepare reports for tests and required corrective action.

3.13 CLEANING

A. Clean and disinfect water distribution piping as follows:
   1. Purge new potable water distribution piping systems and parts of existing potable water systems that have been altered, extended, or repaired prior to use.
   2. Use purging and disinfecting procedure prescribed by authority having jurisdiction or, if a method is not prescribed by that authority, the procedure described in either AWWA C651 or AWWA C652 or as described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill system or part thereof with water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) and allow to stand for 24 hours.

c. Drain system or part thereof of previous solution and refill with water/chlorine solution containing at least 200 parts per million of chlorine. Isolate and allow to stand for 3 hours.

d. Flush system with clean, potable water until the chlorine level matches the level in clean potable water source.

e. Submit water samples in sterile bottles to authority having jurisdiction. Repeat procedure if biological examination made by the authority shows evidence of contamination.

B. Prepare and submit reports for purging and disinfecting activities.

C. Clean interior of piping system. Remove dirt and debris as work progresses.

3.14 COMMISSIONING

A. Fill water systems. Check compression tanks to determine that they are not air bound and that system is completely full of water.

B. Before operating systems, perform these steps:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to full open position.
3. Open throttling valves to proper setting.
4. Remove plugs used during testing of piping systems and plugs used for temporary sealing of piping during installation.
5. Remove, clean, and reinstall strainer screens. Replace damaged strainer screens. Close drain valves and replace drain plugs.
6. Remove filter cartridges from housings and verify that cartridges are clean, and ready for use.

C. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

D. Check plumbing specialties and verify proper settings, adjustments, and operation.

E. Energize pumps and verify proper operation.

END OF SECTION

SECTION 221119 – PLUMBING SPECIALTIES

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes plumbing specialties for water distribution systems; soil, waste, and vent systems; and storm drainage systems.

1.2 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working pressure ratings, except where otherwise indicated:
   1. Water Distribution Systems, Below Ground: 150 psig.
   2. Water Distribution Systems, Above Ground: 125 psig.
   3. Soil, Waste, and Vent Systems: 10-foot head of water.
   4. Storm Drainage Systems: 10-foot head of water.

1.3 SUBMITTALS

A. Submit product data for all materials specified within this Section, including rated capacities of selected models and weights (shipping, installation, and operation). Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following plumbing specialty products.

B. Maintenance data for all materials specified within this Section for inclusion in Operating and Maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

B. Electrical Component Standard: NFPA 70, "National Electrical Code."

C. Listing and Labeling: Provide equipment that is listed and labeled.
   1. The Terms "Listed" and "Labeled" as defined in the "National Electrical Code," Article 100.

D. Design Concept: The Drawings indicate capacities, sizes, and dimensional requirements of system components. Components having equal performance characteristics that deviate from the indicated size and dimensions may be considered, provided deviations do not change the design concept or intended performance. The burden of proof for equality of products is on the Contractor.

1.5 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials matching products installed as described below. Package them with protective covering for storage and identify with labels clearly describing contents.

B. Operating Keys (Handles): Furnish two (2) extra keys for each key-operated hose bibb and hydrant installed.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Water Meters:
      a. Badger Meter, Inc.
      b. Hersey Products, Inc., Grinnell Corp.
      c. Neptune Water Div., Schlumberger Industries, Inc.
   2. Backflow Preventers:
      a. Conbraco Industries, Inc.
      b. Febco.
      c. Watts Regulator Co.
      d. Wilkins Regulator Div., Zurn Industries, Inc.
   3. Thermostatic Water-Mixing Valves:
      a. Heat-Timer.
      b. Lawler Manufacturing Co., Inc.
      c. Leonard Valve Co.
      d. Powers Process Controls Unit, Mark Controls Corp.
      e. Symmons Industries, Inc.
      f. T & S Brass and Bronze Works, Inc.
   4. Water-Tempering Valves:
      a. Cash by A.W. Cash Valve Mfg. Corp.
      b. Leonard Valve Co.
      c. Watts Regulator Co.
   5. Wall Hydrants and Post Hydrants:
      a. Josam Co.
      b. Smith by Jay R. Smith Mfg. Co. Div., Smith Industries, Inc.
      c. Watts Regulator Co.
      d. Zurn by Hydromechanics Div., Zurn Industries, Inc.
   6. Sanitary Hydrants:
      a. Murdock, Inc.
   7. Water Hammer Arresters:
      a. Amtrol, Inc.
      b. Josam Co.
      c. Smith by Jay R. Smith Mfg. Co. Div., Smith Industries, Inc.
      d. Watts Regulator Co.
      e. Zurn by Hydromechanics Div., Zurn Industries, Inc.
   8. Trap Seal Protection Devices:
      a. Sure-Seal Manufacturing
      b. Drain-Net Technologies
   9. Sleeve Penetration Systems:
      a. Proset Systems, Inc.

2.2 WATER METERS

A. General: Register in gallons, except where registration in cubic feet is indicated.

B. Water Meters: AWWA C700, displacement (disc) type, with bronze main case.

C. Water Meters: AWWA C701, turbine type.

D. Water Meters: AWWA C702, compound type.

E. Water Meters: AWWA C704, propeller type.

F. Remote Registration Systems: Specified water meter type, modified to include factory- or field-installed, self-contained, pulsing- type, generating system transmitter. Include low-voltage connecting wiring, totalizing device, and remote wall register.

1. Direct-Reading, Remote-Registration System: AWWA C706; meter-mounted transmitter; 2-conductor connecting wire; weatherproof, outdoor, remote totalizing wall unit for visual reading; and conforming to utility standards.
2. Encoder-Type, Remote-Registration System: AWWA C707; meter-mounted transmitter; totalizing device; 2- or 3-conductor connecting wire; weatherproof, outdoor, remote receptacle for automatic reading and billing; and conforming to utility standards.
   a. Include hand-held, automatic reader.

2.3 BACKFLOW PREVENTERS

A. General: ASSE Standard, backflow preventers, of size indicated for maximum flow rate indicated and maximum pressure loss indicated.

1. Working Pressure: 150 psig minimum except where indicated otherwise.
2. 2 Inches and Smaller: Bronze body with threaded ends.
3. Interior Components: Corrosion-resistant materials.
4. Exterior Finish: Manufacturer's standard finish unless noted otherwise.
5. Strainer on inlet, where strainer is indicated.

B. Pipe-Applied, Atmospheric-type Vacuum Breakers: ASSE 1001, with floating disc and atmospheric vent.

C. Hose Connection Vacuum Breakers: ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7 garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.

D. Intermediate Atmospheric-Vent Backflow Preventers: ASSE 1012, consisting of inlet screen and 2 independent check valves with intermediate atmospheric vent for continuous pressure application.

E. Reduced-Pressure-Principle Backflow Preventer: ASSE 1013, consisting of ball valves valves on inlet and outlet and strainer on inlet. Include test cocks and pressure-differential relief valve having ASME A112.1.2 air-gap fitting located between 2 positive-seating check valves for continuous pressure application.

1. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.

2.4 THERMOSTATIC WATER-MIXING VALVES

A. General: ASSE 1017, manually adjustable, thermostatic water-mixing valve with bronze body. Include checkstop and union on hot-water and cold-water supply inlets, adjustable temperature setting, and capacity at pressure loss as indicated.

1. Operation and Pressure Rating: Bimetal thermostat, 125 psig minimum.
2. Operation and Pressure Rating: Liquid-filled motor, 100 psig minimum.

2.5 WATER-TEMPERING VALVES

A. General: Manually-adjustable, thermostatically-controlled water-tempering valve, bronze body, and adjustable temperature setting.

B. System Water-Tempering Valves: Piston or discs controlling both hot-water and cold-water flow, capable of limited antiscald protection. Include threaded inlets and outlet, and capacity at pressure loss, and temperature range or setting as indicated.
   1. Finish: Rough bronze, except where chrome-plated finish is indicated.

C. Limited-Volume Water-Tempering Valves: Solder-joint inlets and outlet, capacity indicated at pressure loss indicated.

2.6 MISCELLANEOUS PIPING SPECIALTIES

A. Piping specialties such as escutcheons, dielectric fittings, sleeves, and sleeve seals are specified in other Sections.

B. Strainers: Y pattern, except where otherwise indicated, full size of connecting piping. Include Type 304 stainless-steel screens with 3/64-inch perforations except where other screens are indicated.
   1. Pressure Rating: 125-psig minimum steam working pressure except where otherwise indicated.
   2. Sizes 2 Inches and Smaller: Bronze body, with female threaded ends.
   3. Sizes 2-1/2 Inches and Larger: Cast-iron body, with interior FDA-approved epoxy coating and flanged ends.
   4. Y-Type Strainers: Screwed screen retainer with centered blowdown.
      a. Drain: Pipe plug.
      b. Drain: Factory- or field-installed, hose-end drain valve.
   5. T-Type Strainers: Malleable-iron or ductile-iron body with grooved ends; access end cap with drain plug and access coupling with EDPM gasket.

C. Hose Bibbs: Bronze body, with renewable composition disc, 1/2- or 3/4-inch threaded or solder-joint inlet. Provide ASME B1.20.7 garden-hose threads on outlet and integral or field-installed, nonremovable, drainable, hose-connection vacuum breaker.
   1. Finish: Rough brass.
   2. Finish: Chrome or nickel plated.
   3. Operation: Wheel handle.
   4. Operation: Operating key (handle). Provide 1 operating key.

D. Wall Hydrants: ASME A112.21.3M, nonfreeze, key operation. Provide 1 operating key.
   1. Inlet: 3/4- or 1-inch threaded or solder joint.
   2. Outlet: ASME B1.20.7 garden-hose threads, and integral or field-installed, nonremovable and drainable hose-connection vacuum breaker having ASME B1.20.7 garden-hose threads on outlet.
   3. Type: Projecting.
   4. Type: Recessed.
   5. Finish: Rough bronze.
   6. Finish: Polished bronze.
   7. Finish: Nickel bronze.

E. Wall Hydrants: ASME A112.21.3M or ASSE 1019, nonfreeze, automatic draining, antibackflow type, key operation, with 3/4- or 1-inch threaded or solder-joint inlet, and ASME B1.20.7 garden-hose threads on outlet. Provide 1 operating key.
   1. Type: Projecting.
   2. Type: Recessed.
   3. Finish: Rough bronze.
   4. Finish: Polished bronze.
   5. Finish: Nickel bronze.

F. Wall Hydrants: ASME A112.21.3M, projecting, automatic-draining, antibackflow type, key operation. Provide 1 operating key.
   1. Inlet: 3/4- or 1-inch threaded or solder-joint.
   2. Outlet: ASME B1.20.7 garden-hose threads.
   3. Finish: Rough bronze.
   4. Finish: Polished bronze.
   5. Finish: Nickel bronze.

G. Hose-End, Drain Valves: 3/4-inch ball valve, rated for 400 psig WOG. Include 2-piece bronze body conforming to ASTM B 62, standard port, chrome-plated brass ball, replaceable "TFE" seats and seals, blowout-proof stem, and vinyl-covered steel handle.
   1. Inlet: Solder-joint or threaded.
   2. Outlet: Short-threaded nipple with ASME B1.20.7 garden-hose thread and cap.
   3. Hose-End, Drain Valve Option: MSS SP-80, gate valve, Class 125, ASTM B 62 body, with 3/4-inch solder-joint or threaded inlet and ASME B1.20.7 garden-hose thread outlet and cap. Hose bibbs are prohibited for this application.

H. Stop-and-Waste Drain Valves: Ball valve or MSS SP-80 gate valve, rated for 200 psig WOG minimum, ASTM B 62 bronze body, with 1/8-inch side drain outlet and cap.

I. Water Hammer Arresters: ASME A112.26.1M, ASSE 1010, or PDI WH-201, bellows or piston type with pressurized cushioning chamber. Sizes are based on water-supply fixture units, ASME A112.26.1M sizes "A" through "F" and PDI WH-201 sizes "A" through "F."

J. Trap Seal Protection Devices: ASSE 1072-2007
   1. Description: Device that utilizes a normally closed seal to prevent evaporation of the trap seal and protect against sewer gases from backing up into habitable areas. Device opens with fluid and allows liquid drainage to flow through into the building drain.
   2. Material: ASB plastic body with neoprene rubber diaphragm and sealing gasket or flexible elastomeric PVC material molded into shape of duck's bill, open on top with curl closure at bottom.

K. Stack Flashing Fittings: Counterflashing-type, cast-iron fitting, with bottom recess for termination of roofing membrane, and with threaded or hub top for extension of vent pipe.

L. Vent Caps: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and set-screws to secure to vent pipe.

M. Vent Terminals: Commercially manufactured, shop-fabricated or field-fabricated, frost-proof assembly constructed of galvanized steel, copper, or lead-coated copper. Size to provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing, as indicated.

N. Roof Flashing Assemblies: Manufactured assembly consisting of 4-psf lead flashing collar with boot and skirt extending at least 8 inches from pipe, with galvanized steel boot reinforcement and counterflashing fitting.
   1. Option 1: Open top.
   2. Option 2: Low-silhouette model with vandal-proof vent cap.
   3. Option 3: Extended model with field-installed, vandal-proof vent cap.

2.7 CLEANOUTS

A. General: Size cleanouts as indicated on drawings, or where not indicated, same size as connected drainage piping. Cleanouts larger than 4 inches are not required except where indicated.

B. Cleanouts: ASME A112.36.2M, cast-iron body with straight threads and gasket seal or taper threads for plug, flashing flange and clamping ring, and a brass closure plug. Cleanouts for installation in floors not having membrane waterproofing may be furnished without clamping ring. See Product Data Sheet at end of Part 3 of this Section for deck plate shape, top-loading classification, access cover, finish, and other specific features.

C. Products: Subject to compliance with requirements, provide one of the products specified in each schedule.

2.8 FLOOR DRAINS

A. General: Size outlets as indicated on schedule.

B. Floor Drains: ASME A112.21.1M, cast-iron body, with seepage flange and clamping device. Floor drains for installation in floors not having membrane waterproofing may have seepage flange without clamping device. Floor drains for use as area drains in exterior slab on grade may be furnished with anchor flange instead of seepage flange and clamping device. See schedule for shape, dimensions, strainer and body top finish, top-loading classification, sump size, and specific features.

C. Inlet Fittings: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.

D. Air Gap Fittings: ASME A112.1.2, cast iron or cast bronze, with fixed air gap, inlet for drain pipe or tube, and threaded or spigot outlet.

E. Products: Subject to compliance with requirements, provide one of the products specified in each Plumbing Specialties Product Data Sheet at end of this Section.

2.9 SLEEVE PENETRATION SYSTEMS

A. Description: UL 1479, through-penetration firestop assembly consisting of sleeve and stack fitting with firestopping plug.
   1. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on 1 end for installation in cast-in-place concrete slabs.
   2. Stack Fitting: ASTM A 48, cast-iron, hubless-pattern, wye branch stack fitting with neoprene O ring at base and cast-iron plug in thermal-release harness in branch. Include PVC protective cap for plug.
      a. Special Coating: Include corrosion-resistant interior coating on fittings for plastic chemical waste and vent stacks.

2.10 FLASHING MATERIALS

A. Lead: ASTM B 749, Type L51121, copper-bearing sheet, at least 4 psf (0.0625-inch thick) for general use, and at least 6 psf (0.0937-inch thick) for burning (welding), except as otherwise indicated.

B. Elastic Membrane: Nonreinforced flexible, black elastic, sheet, 50 to 65-mils thick and complying with the following:
   1. Shore A Hardness: ASTM D 2240, 50 to 70.
   2. Tensile Strength: ASTM D 412, 1200 psi.
   3. Tear Resistance: ASTM D 624, Die C, 20 lb per linear inch.
   4. Ultimate Elongation: ASTM D 412, 250 percent.
   5. Low-Temperature Brittleness: ASTM D 746, minus 30EF (minus 35EC).
   6. Resistance to Ozone Aging: ASTM D 1149, no cracks for 10 percent elongated sample for 100 hours in 50-mPa ozone at 104EF (70EC).
   7. Resistance to Heat Aging: ASTM D 573, maximum hardness increase of 15 points, elongation reduction of 40 percent, and tensile strength reduction of 30 percent, for 70 hours at 212EF (100EC).

C. Copper: ASTM B 370, sheet, 16 oz. per sq. ft. (0.0216-inch thick) except as otherwise indicated.
   1. General Use: Temper H00 (formerly cold-rolled).
   2. Forming Use: Temper 060 (formerly soft).

D. Zinc-Coated Steel: ASTM A 526, sheet, with 0.20 percent copper, G90 hot-dip galvanized, mill phosphatized where indicated for painting; 0.0359-inch thick (20 gage) except as otherwise indicated.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units as required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, Alloy Sn50.

H. Bituminous Coating: SSPC-12, solvent type, bituminous mastic.

PART 3 – EXECUTION

3.1 INSTALLATION OF WATER METER

A. Install water meter according to utility company's written installation instructions and requirements.

3.2 PIPING SPECIALTY INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated, at each water supply connection to mechanical equipment and systems, and to other equipment and systems as indicated. Comply with plumbing code and authority having jurisdiction. Locate in same room as equipment being connected. Install air-gap fitting on units having atmospheric vent connection and pipe relief outlet drain to nearest floor drain. Do not install bypass around backflow preventer.

B. Install expansion joints on vertical risers, stacks, and conductors as indicated.

C. Install cleanouts in above-ground piping and building drain piping as indicated, and where not indicated, according to the following:
   1. Size same as drainage piping up to 4-inch size. Use 4-inch size for larger drainage piping except where larger size 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 4 inches and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil or waste stack.

D. Install cleanout deck plates (covers), of types indicated, with top flush with finished floor, for floor cleanouts for piping below floors.

E. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.

F. Install flashing flange and clamping device with each stack and cleanout passing through floors having waterproof membrane.

G. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to the manufacturer's written instructions.

H. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

3.3 FLOOR DRAIN INSTALLATION

A. Install floor drains according to manufacturer's written instructions, in locations indicated.

B. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.

C. Set drain elevation depressed below finished slab elevation as listed below to provide proper floor slope to drain:
   1. 5-Foot Drain Area Radius: 1/2-inch depression.
   2. 10-Foot Drain Area Radius: 3/4-inch depression.
   3. 15-Foot Drain Area Radius: 1-inch depression.
   4. 20-Foot Drain Area Radius: 1-1/4-inch depression.
   5. 25-Foot Drain Area Radius: 1-1/2-inch depression.

D. Trap drains connected to sanitary building drain.

E. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

F. Position drains for easy accessibility and maintenance.

3.4 CONNECTIONS

A. Supply Runouts to Fixtures: Install hot- and cold-water supply piping runouts to fixtures of sizes indicated, but not smaller than required by plumbing code.

B. Drainage Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated, but not smaller than required by plumbing code.

C. Locate drainage piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

D. Electrical Connections: Power wiring and disconnect switches are specified in Division 26.
   1. Grounding: Connect unit components to ground according to the National Electrical Code and Division 26.

3.5 FLASHING INSTALLATION

A. Provide flashing manufactured in a single piece except where large pans, sumps, or other drainage shapes are required.

B. Install 4-psf lead flashing or 16-oz.-per sq. ft. copper, except when another weight or material is specified.

C. Install 6-psf lead flashing or heavier where burning (welding) of lead sheets is required.

D. Solder joints of copper sheets where required.

E. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with membrane waterproofing.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum sleeve 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.

F. Set flashing on floors and roofs in solid coating of bituminous cement.

G. Secure flashing into sleeve and specialty clamping ring or device.

H. Install flashing for piping passing through roofs with counter flashing or commercially made flashing fittings, according to Division 7 Section “Flashing and Sheet Metal.”

I. Extend flashing up vent pipe passing through roofs and turn down into pipe or secure flashing into cast-iron sleeve having calking recess.

3.6 COMMISSIONING

A. Preparation: Perform the following checks before start-up:
   1. Systems tests are complete.
   2. Damaged and defective specialties and accessories have been replaced or repaired.
   3. There is clear space for servicing of specialties.

B. Before operating systems, perform these steps:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open valves to full open position.
   3. Remove and clean strainers.
   4. Verify drainage and vent piping are clear of obstructions. Flush with water until clear.

C. Starting Procedures: Follow manufacturer's written procedures. If no procedures are prescribed by manufacturer, proceed as follows:

1. Energize circuits for grease recovery units. Start and run units through complete sequence of operations.

3.7 ADJUSTING

A. Adjust operation and correct deficiencies discovered during commissioning.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures related to startup and servicing of interceptors.

3.9 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or when work stops.

END OF SECTION

SECTION 221316 – DRAINAGE AND VENT SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes drainage and vent piping systems to a point 5 feet outside the building. Systems include the following:
   1. Sanitary and storm drainage and vent systems.

1.2 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working pressure ratings, except where indicated otherwise:
   1. Soil, Waste, and Vent Systems: 10-foot head of water.

1.3 SUBMITTALS

A. Coordination drawings, drawn accurately to scale and coordinating penetrations.

1.4 QUALITY ASSURANCE

A. Comply with the provisions of ASME B31.9 "Building Services Piping" for materials, products, and installation.

B. Provide listing/approval stamp, label, or other marking on piping made to specified standards.

PART 2 – PRODUCTS

2.1 PIPES AND TUBES

A. General: The application of the following pipe, tube, and fitting materials and joining methods required for plumbing piping systems are indicated in Part 3 Article "Pipe and Fittings Applications."

B. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.

C. Soft Copper Tube: ASTM B 88, Types K, water tube, annealed temper.

D. Copper Drainage Tube: ASTM B 306, Type DWV, drawn temper.

E. Steel Pipe: ASTM A 53, Type S, Grade A, Schedule 40, seamless, galvanized, plain ends.
   1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Schedule 40, seamless, galvanized, carbon-steel pipe.

F. Hub and Spigot, Cast-Iron Soil Pipe: ASTM A 74, Service Class.

G. Hubless, Cast-Iron Soil Pipe: CISPI 301.

2.2 PIPE FITTINGS AND TUBE FITTINGS

A. Wrought-Copper, Solder-Joint Pressure Fittings: ASME B16.22.

B. Cast-Copper-Alloy, Solder-Joint Pressure Fittings: ASME B16.18.

C. Wrought-Copper, Solder-Joint, Drainage Fittings: ASME B16.29.

D. Cast-Copper-Alloy, Solder-Joint, Drainage Fittings: ASME B16.23.

E. Bronze Flanges: ASME B16.24, Class 150.
   1. Threaded Ends: Threads conforming to ASME B1.20.1.

F. Hub and Spigot, Cast-Iron Soil Pipe Fittings: ASTM A 74, Service Class.

G. Hubless, Cast-Iron Soil Pipe Fittings: CISPI 301.

2.3 JOINING MATERIALS

A. Solder, brazing, and welding filler metals are specified in other Sections.

B. Cast-Iron Soil Pipe and Fittings: ASTM C 564 neoprene rubber gaskets and lubricant.

C. CISPI Couplings for Hubless Cast-Iron Soil Pipe and Fittings: CISPI 310, having ASTM C 564 neoprene sealing sleeve, with 300 Series stainless-steel corrugated shield-and-clamp assembly.

2.4 VALVES

A. Valves are specified in other Sections.

PART 3 – EXECUTION

3.1 EXCAVATION

A. Excavation, trenching, and backfilling are specified in other Sections.

3.2 PREPARATION OF FOUNDATION FOR BURIED PIPING

A. Grade trench bottom to provide smooth, firm, stable, and rock-free foundation throughout length of piping.

B. Remove unstable, soft, and unsuitable materials at surface on which piping is to be laid and backfill with clean sand or pea gravel to indicated level.

C. Shape bottom of trench to fit bottom of piping. Fill unevenness with tamped-sand backfill. Dig bell holes at each pipe joint to relieve bells of loads and to ensure continuous bearing of pipe barrel on foundation.

3.3 PIPE AND FITTINGS APPLICATIONS

A. General: Use pipe, tube, fittings, and joining methods for piping systems according to the following applications.

B. Soil, Waste, and Vent Piping Below Ground: Use the following:
   1. All: Hub-and-spigot cast-iron soil pipe, hub-and-spigot cast-iron soil pipe fittings, neoprene rubber gaskets, and compression joints.

C. Soil, Waste, and Vent Piping Above Ground: Use the following:

1. All: Hubless cast-iron soil pipe, hubless cast-iron soil pipe fittings, CISPI-type couplings for hubless cast-iron soil pipe and fittings, and hubless joints.
2. 1-1/4 to 4 Inches: Copper drainage tube, wrought-copper or cast-copper-alloy drainage fittings, and soldered joints with Alloy E solder.

3.4 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use gate, ball, or butterfly valves.
2. Throttling Duty: Use globe, ball, or butterfly valves.

3.5 PIPING INSTALLATION, GENERAL

A. Basic piping installation requirements are specified in other Sections.

3.6 SERVICE ENTRANCE PIPING

A. Extend building sanitary drain piping and connect to sanitary sewer piping of size and in location indicated for service entrance to building. Install cleanout and extension to grade at connection of building sanitary drain and building sanitary sewer. Sanitary sewerage piping is specified in other Sections.

B. Install sleeve and mechanical sleeve seal at service penetrations through foundation wall for watertight installation.

3.7 DRAINAGE AND VENT PIPING INSTALLATION

A. Install cast-iron soil pipe and cast-iron soil pipe fittings according to CISPI 1990 revised and edited edition of "Cast Iron Soil Pipe and Fittings Handbook, Volume I," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

B. Make changes in direction for drainage and vent piping using appropriate Y branches, Y branches with 1/8 bends, and long-sweep 1/4, 1/5, 1/6, 1/8, and 1/16 bends. Sanitary tees and short-sweep quarter bends may be used on vertical stacks of drainage lines where change in direction of flow is from horizontal to vertical. Use long-turn double-Y-branch and 1/8-bend fittings where two (2) fixtures are installed back to back or side by side and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. Make no change in direction of flow greater than 90 degrees. Where different sizes of drainage pipes and fittings are connected, use proper size standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

C. Lay buried building drains beginning at low point of each system, true to grades and alignment indicated, with unbroken continuity of invert. Place hub or bell ends of piping facing upstream. Install required gaskets according to manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in piping and pull past each joint as completed.

D. Install drainage and vent piping at the following minimum slopes, except where another slope is indicated:

1. Sanitary Building Drain: 1/4-inch per foot (2 percent) for piping 3 inches and smaller; 1/8-inch per foot (1 percent) for piping 4-inches and larger.
2. Horizontal Sanitary Drainage Piping: 1/4-inch per foot (2 percent).

3. Vent Piping: 1/8-inch per foot (1 percent).

E. Install force mains at elevations indicated.

F. Install underground plastic drainage piping according to ASTM D 2321.

G. Sleeves are not required for cast-iron soil pipes passing through concrete slab, without membrane waterproofing, on grade.

3.8 JOINT CONSTRUCTION

A. Basic piping joint construction is specified in other Sections

B. Cast-Iron Soil Pipe and Cast-Iron Soil Pipe Fitting Joints: Make joints according to recommendations in CISPI 1990 revised and edited edition of "Cast Iron Soil Pipe and Fittings Handbook, Volume I," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Compression Joint: Make with neoprene gasket matching class of pipe and fittings.
2. Hubless Joint: Make with neoprene gasket and sleeve or clamp.

3.9 INSTALLATION OF VALVES

A. Install valves for duty indicated, where indicated.

B. Shutoff Valves: For shutoff valves 2-inches and smaller, use gate or ball valves; for shutoff valves 2-1/2 inches and larger, use gate or butterfly valves.

C. Drain Valves: Install drain valves on each plumbing equipment item located to drain equipment for service and repair.

3.10 HANGERS AND SUPPORTS INSTALLATION

A. Hanger and support devices are specified in other Sections

3.11 CONNECTIONS

A. Drainage Runouts to Fixtures: Provide drainage and vent piping runouts, with approved trap, of sizes indicated, but not smaller than required by plumbing code, to plumbing fixtures and drains.

B. Locate drainage piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

C. Mechanical Equipment Connections: Install drain valve and union on each equipment drain connection.

3.12 FIELD QUALITY CONTROL

A. Inspect drainage piping as follows:

1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.
2. During progress of installation, notify the plumbing official having jurisdiction at least 24 hours prior to time such inspection must be made. Perform tests specified below in presence of the plumbing official.
   a. Roughing-In Inspection: Arrange for inspection of piping system after system roughing-in, before concealing, and prior to setting fixtures.

b. Final Inspection: Arrange for final inspection by plumbing official to observe tests specified below and to ensure compliance with requirements of plumbing code.

3. Reinspections: Make required corrections and arrange for reinspection by plumbing official when piping system fails to pass test or inspection.

4. Reports: Prepare inspection reports signed by the plumbing official.

B. Drainage and Vent Piping System Tests: Test drainage and vent systems according to procedures of authority having jurisdiction or, in absence of published procedure, as follows:

1. Test for leaks and defects in new drainage and vent piping systems and parts of existing systems that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

2. Leave uncovered and unconcealed in new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose for testing work that has been covered or concealed before it has been tested and approved.

3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open-jointed drain tile, test piping of plumbing drainage and venting systems on completion of roughing-in piping installation. Tightly close all openings in piping system and fill with water to point of overflow, but not less than 10-feet head of water. Water level shall not drop during the period from 15 minutes before inspection starts through completion of inspection. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and their traps filled with water, test connections and prove gastight and watertight. Plug stack openings on roof and building drain where it leaves the building and introduce air into the system equal to pressure of 1-inch water column. Use a U tube or manometer inserted in the trap of a water closet to measure this pressure. Air pressure shall remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.13 CLEANING

A. Clean interior of piping system. Remove dirt and debris as work progresses.

3.14 COMMISSIONING

A. Check plumbing equipment and verify proper settings, adjustments, and operation.

B. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.15 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or when work stops.

END OF SECTION

SECTION 223300 – ELECTRIC WATER HEATERS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes electric water heaters and accessories.

1.2 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate dimensions, finishes and coatings, required clearances, methods of assembly of components, and piping and wiring connections.

C. Shop Drawings showing layout of each unit, including tanks, pumps, controls, related accessories, and piping.

D. Setting Drawings with templates and directions for installing foundation bolts, anchor bolts, and other anchorages.

E. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between factory-installed and field-installed wiring.

F. Product certificates signed by manufacturers of water heaters certifying that their products comply with specified requirements.

G. Certificates of shop inspection and data report as required by provisions of ASME Boiler and Pressure Vessel Code, when ASME construction is indicated.

H. Field quality-control installation reports.

I. Maintenance data for water heaters to include in operation and maintenance. Include startup instructions.

1.3 QUALITY ASSURANCE

A. ASHRAE Standard: Comply with performance efficiencies prescribed in ASHRAE 90.1, "Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings."

B. ASHRAE Standard: Comply with performance efficiencies prescribed in ASHRAE 90.2, "Energy Efficient Design of New Low-Rise Residential Buildings."

C. NFPA Standard: Comply with NFPA 70, "National Electrical Code," for electrical components.

D. Listing and Labeling: Provide electrically operated water heaters, controls, and components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in National Electrical Code, Article 100.

E. Product Options: Drawings indicate size, profiles, connections, dimensional requirements, and characteristics of water heaters and accessories and are based on specific types and models indicated. Other manufacturers' water heaters and accessories with equal performance characteristics may be considered.

1.4 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 Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of Contract Documents.

B. Special Warranty: Submit a written warranty executed by manufacturer agreeing to repair or replace water heaters and accessories that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, tanks and elements. This warranty is in addition to, and not a limitation of, other rights Owner may have against Contractor under Contract Documents.

C. Warranty Period: Five (5) years after date of Substantial Completion.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Household, Storage, Electric Water Heaters:
   a. Bradford White Corp.
   b. Lochinvar Corp.
   c. Patterson-Kelley Co.
   d. Rheem Mfg. Co.; Rheem Water Heater Div.
   e. Rheem Mfg. Co.; Ruud Water Heater Div.
   f. Smith: A.O. Smith Water Products Co.
   g. State Industries, Inc.
2. Commercial, Point-of-Use, Storage, Electric Water Heaters:
   a. Lochinvar Corp.
   b. Rheem Mfg. Co.; Rheem Water Heater Div.
   c. Rheem Mfg. Co.; Ruud Water Heater Div.
   d. Smith: A.O. Smith Water Products Co.
   e. State Industries, Inc.
3. Light-Commercial, Storage, Electric Water Heaters:
   a. Bradford White Corp.
   b. Lochinvar Corp.
   c. Patterson-Kelley Co.
   d. Rheem Mfg. Co.; Rheem Water Heater Div.
   e. Rheem Mfg. Co.; Ruud Water Heater Div.
   f. Smith: A.O. Smith Water Products Co.
4. Commercial, Storage, Electric Water Heaters:
   a. Bradford White Corp.
   b. Lochinvar Corp.
   c. Patterson-Kelley Co.

d. PVI Industries, Inc.
e. Rheem Mfg. Co.; Rheem Water Heater Div.
f. Rheem Mfg. Co.; Ruud Water Heater Div.
g. Smith: A.O. Smith Water Products Co.
h. State Industries, Inc.

2.2 WATER HEATERS, GENERAL

A. Specified manufacturer's standard components and features are acceptable where specific product requirements are not indicated.

B. Temperature Control: Adjustable thermostat, except for units where other arrangement is indicated or temperature is regulated by flow-control fitting.

C. Safety Control: Automatic, high-temperature-limit cutoff device or system on commercial units and where indicated. Include automatic low-water cutoff device or system on commercial units where indicated.

D. Interior Finish: Materials that comply with requirements of applicable NSF, AWWA, or FDA and EPA regulatory standards for tasteless and odorless, potable-water-tank linings.

E. Tappings: Factory fabricated of materials compatible with tank. Include tappings for piping connections, relief valves, pressure gage, thermometer, blow down, and controls as required and others as indicated. Attach tappings to tank before testing and labeling. Include tappings and connections as follows:
1. 2-Inch NPS (DN50) and Smaller: Threaded ends.
2. 2-1/2 Inch NPS (DN65) and Larger: Flanged ends.

F. Insulation: Fiberglass, polyurethane foam, or manufacturer's standard that is suitable for operating temperature and required insulating value. Include insulation material that surrounds entire tank except connections and controls.

G. Jacket: Steel, with baked-on enamel finish, except where otherwise specified.

H. Anode Rods: Factory installed, magnesium.

I. Combination Temperature and Pressure Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input and pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.
1. Option: Separate temperature and pressure relief valves are acceptable instead of combination relief valve.
2. Exception: Omit relief valve for tankless water heater. Include pressure relief valve for installation in piping.

2.3 HOUSEHOLD, STORAGE, ELECTRIC WATER HEATERS

A. Description: UL 174, household, storage, electric water heater; with capacity more than 40 gal. (151 L), but not more than 120 gal. (454 L), and input not more than 12 kW.

B. Storage Tank Construction: Steel with 150-psig (1035-kPa) working-pressure rating.

C. Heating Elements: Two (2) electric, screw-in, immersion type.

D. Heat Traps: Manufactured, factory- or field-installed, cold-type inlet fitting in inlet and hot-type outlet fitting in outlet of household water heater.

E. Drain Valve: ASSE 1005, factory or field installed. Omit when water heater is without drain outlet and include general-duty drain valve in piping.

F. Vacuum Relief Valve: Comply with ASME PTC 25.3. Furnish for installation in piping.
   1. Exception: Omit where water heater has integral vacuum relieving device.

2.4 LIGHT-COMMERCIAL, STORAGE, ELECTRIC WATER HEATERS

A. Description: UL 174, but listed by manufacturer for commercial applications, or UL 1453, light-commercial, storage, electric water heater; with capacity more than 40 gal. (151 L), but not more than 120 gal. (454 L), and input not more than 12 kW.

B. Storage Tank Construction: Steel with 150-psig (1035-kPa) working-pressure rating.

C. Storage Tank Construction: ASME labeled, steel with 150-psig (1035-kPa) working-pressure rating.

D. Heating Elements: Two (2) electric, screw-in, immersion type wired for simultaneous operation.

E. Special Requirements: NSF 5 construction.

F. Inlet and Outlet Manifolds: Fabricated by water heater manufacturer and capable of providing balanced flow through water heaters, for multiple-unit installation.

G. Vacuum Relief Valve: Comply with ASME PTC 25.3. Furnish for installation in piping.
   1. Exception: Omit where water heater has integral vacuum relieving device.

2.5 COMMERCIAL, STORAGE, ELECTRIC WATER HEATERS

A. Description: UL 1453, commercial, storage, electric water heater; with capacity more than 40 gal. (151 L).

B. Storage Tank Construction: ASME labeled, steel with 150-psig (1035-kPa) working-pressure rating.

C. Storage Tank Construction: Steel with 150-psig (1035-kPa) working-pressure rating.

D. Heating Elements: Electric, screw-in or bolt-on, immersion type according to the following:
   1. Up to 9-kW Input: 2 or 3 elements.
   2. More than 9-kW Input: Elements arranged in multiples of 3.

E. Heating Elements: Electric, screw-in or bolt-on, immersion type arranged in multiples of 3.

F. Staging: Not exceeding 18 kW per step.

G. Temperature Control: Adjustable immersion thermostats.

H. Temperature Control: Adjustable surface-mounting thermostats.

I. Safety Control: Automatic, high-temperature-limit and low-water cutoffs.

J. Special Requirements: NSF 5 construction.

K. Inlet and Outlet Manifolds: Fabricated by water heater manufacturer and capable of providing balanced flow through water heaters, for multiple-unit installation.

L. Vacuum Relief Valve: Comply with ASME PTC 25.3. Furnish for installation in piping.
   1. Exception: Omit where water heater has integral vacuum relieving device.

PART 3 – EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases of dimensions indicated for water heaters and accessories.

3.2 WATER HEATER INSTALLATION

A. General: Install water heaters on concrete bases. Set and connect units according to manufacturer's written instructions. Install units plumb, level, and firmly anchored in locations indicated. Maintain manufacturer's recommended clearances. Install so controls and devices are accessible for service.

B. Anchor water heaters and storage tanks to substrate.

C. Install seismic restraints as indicated.

D. Install electric booster heaters with thermometer, pressure gage, and pressure regulator on hot-water inlet; and thermometer, pressure gage, and shock absorber on boosted-temperature, hot-water outlet.

E. Install temperature and pressure relief valves in top portion of storage water heater tanks and hot-water storage tanks. Use relief valves with sensing elements that extend into tanks. Extend relief valve outlet with water piping in continuous downward pitch and discharge to closest floor drain.

F. Install pressure relief valves in hot-water-outlet piping for water heaters without storage. Extend relief valve outlet with water piping in continuous downward pitch and discharge to closest floor drain.

G. Install vacuum relief valves in cold-water-inlet piping.

H. Install vacuum relief valves in water heaters and hot-water storage tanks that have copper lining.

I. Install water heater drain piping as indirect waste to spill 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.

J. Install thermometers on water heater inlet and outlet piping.

K. Install pressure gages on water heater piping when and as indicated.

L. Install inlet and outlet piping manifolds for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through water heaters. Include throttling valves in outlet manifolds and thermometers in inlet and outlet manifolds.

M. Install piping adjacent to water heaters to allow service and maintenance.

N. Arrange for field-applied insulation on equipment and piping not furnished with factory-applied insulation.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
   1. Connect hot- and cold-water piping to units with shutoff valves and unions. Connect hot-water circulating piping to unit with shutoff valve, check valve, and union.
   2. Make connections with dielectric fittings where piping is made of dissimilar metals. Dielectric fittings are specified in other Sections.

B. Electrical Connections: Power wiring and disconnect switches are specified in other Sections. Arrange wiring to allow unit servicing.

C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 COMMISSIONING

A. Startup Services: Engage a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.
   1. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.
   2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
   3. Review data in the operation and maintenance manuals.
   4. Schedule training with Owner with at least seven (7) days advance notice.

B. Perform the following final checks before startup:
   1. Fill water heaters with water.
   2. Check that piping system tests are complete.
   3. Check for piping connection leaks.
   4. Check for clear relief valve inlets, outlets, and drain piping.
   5. Check operation of pumps and circulators.
   6. Test operation of safety controls, relief valves, and devices.

C. Perform the following startup procedures:
   1. Energize electric circuits.
   2. Adjust operating controls.
   3. Adjust hot-water-outlet temperature settings.

END OF SECTION

SECTION 224000 – PLUMBING FIXTURES

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes plumbing fixtures and trim, fittings, and accessories, appliances, appurtenances, equipment, and supports associated with plumbing fixtures.

1.2 SUBMITTALS

A. Product data for each type of plumbing fixture specified, including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components, and finishes.

B. Wiring diagrams for field-installed wiring of electrically operated units.

C. Maintenance Data: For plumbing fixtures to include in maintenance manuals.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Useable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities.

B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.

1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.

C. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components – Health Effects," for fixture materials that will be in contact with potable water.

F. Design Concept: The drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models, and numbers indicated. Plumbing fixtures having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, color or finish, or other characteristics are minor and do not change the design concept or intended performance as judged by the Owner's Representative. Burden of proof for equality of plumbing fixtures is on the proposer.

1.4 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.5 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials described below matching products installed, packaged with protective covering for storage, and identified with labels clearly describing contents.

1. Faucet Washers and O-rings: Furnish quantity of identical units not less than 10 percent of amount of each installed.
2. Faucet Cartridges and O-rings: Furnish quantity of identical units not less than 5 percent of amount of each installed.
3. Faucet, Laminar-Flow Fittings: Furnish quantity of identical units not less than 10 percent of amount of each installed.
4. Faucet Stops: Furnish quantity of identical units not less than 10 percent of amount of each installed.
5. Flushometer Repair Kits: Furnish quantity of identical units not less than 10 percent of amount of each flushometer installed.
6. Provide a hinged-top wood or metal box, or individual metal boxes, having a separate compartment for each type and size of above extra materials.
7. Water Closet Tank Repair Kits: Furnish quantity of identical flush valve units not less than 5 percent of amount of each type installed.
8. Toilet Seats: Furnish quantity of identical units not less than 5 percent of amount of each type toilet seat installed.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products in each category, by one of the following listed for that category:

1. Water Closets:
   a. American Standard, Inc.
   b. Eljer; A Household International Co.
   c. Kohler Co.
2. Urinals:
   a. American Standard, Inc.
   b. Eljer; A Household International Co.
   c. Kohler Co.
3. Lavatories:
   a. American Standard, Inc.
   b. Eljer; A Household International Co.
   c. Kohler Co.
4. Mop Basins:
   a. Aqua Glass Corp.
   b. Crane Plumbing/Fiat Products.
   c. Florestone Products Co., Inc.
   d. Stern-Williams Co., Inc.
   e. Swan Corp.

5. Toilet Seats:
    a. Bemis Mfg. Co.
    b. Beneke Div.; Sanderson Plumbing Products, Inc.
    c. Church Seat Co.
    d. Olsonite Corp.
6. Flushometers:
    a. Coyne & Delany Co.
    b. Sloan Valve Co.
    c. Zurn Industries, Inc.; Flush Valve Operations.
7. Commercial/Industrial Cast-Brass Faucets:
    a. American Standard, Inc.
    b. Chicago Faucet Co.
    c. Crane Plumbing/Fiat Products.
    d. Eljer; A Household International Co.
    e. Kohler Co.
    f. Royal Brass Mfg. Co.
    g. Speakman Co.
    h. T & S Brass and Bronze Works, Inc.
8. Miscellaneous Fittings (Except Faucets):
    a. Aquaflo Corp.
    b. Beaton & Corbin Mfg. Co.
    c. Brass Craft Subsidiary; Masco Co.
    d. Bridgeport Plumbing Products, Inc.
    e. Central Brass Manufacturing Co.
    f. Chicago Faucet Co.
    g. Connecticut Stamping & Bending Co.
    h. Crane Plumbing/Fiat Products.
    i. Eljer; A Household International Co.
    j. Kohler Co.
    k. McGuire Manufacturing Co., Inc.
    l. Price Pfister, Inc.
    m. Royal Brass Mfg. Co.
    n. Sanitary-Dash Manufacturing Co., Inc.
    o. T & S Brass and Bronze Works, Inc.
    p. Teledyne Ansonia.
9. Supports:
    a. Ancon, Inc.
    b. Josam Co.
    c. Smith (Jay R.) Mfg. Co.
    d. Wade Div.; Tyler Pipe.
    e. Zurn Industries, Inc.; Hydromechanics Div.

2.2 FAUCETS

A. Faucets General: Unless otherwise specified, provide faucets that are cast brass with polished chrome-plated finish.

B. Lavatory Faucets: ASME A112.18.1M.

C. Sink Faucet: ASME A112.18.1M.

D. Mop Basin Faucet: ASME A112.18.1M, rough chrome finish, cast brass, with stops in shanks; wall brace, integral vacuum breaker, pail hook, and garden hose thread on spout; and hose and bracket.

2.3 FITTINGS, EXCEPT FAUCETS

A. Fittings General: Unless otherwise specified, provide fittings fabricated of brass, with a polished chrome plated finish.

B. Lavatory Supplies and Stops: Loose-key angle stop, having 3/8-inch NPS inlet with wall flange and 3/8-inch by 12-inch long flexible tubing riser outlet.

C. Lavatory Traps: Cast-brass, 1-1/4 inch NPS adjustable P-trap with cleanout, 17-gage tubular waste to wall, and wall flange.

D. Sink Supplies and Stops: Loose-key angle stop, having 1/2-inch NPS inlet with wall flange and 1/2-inch by 12-inch flexible tubing riser outlet.

E. Sink Traps: Cast-brass, 1-1/2 inch or 2-inch NPS adjustable P-trap with cleanout, 17-gage tubular waste to wall, and wall flange.

F. Sink Continuous Wastes: Polished chrome-plated, tubular brass, 1-1/2 inches or 2-inches, 17 gage, with brass nuts on slip inlets, and of configurations indicated.

G. Water Closet Supplies and Stops: Loose-key angle stop, having 1/2-inch NPS inlet with wall flange and 1/2-inch by 12-inch flexible tubing riser outlet with collar.

H. Trough-Type Urinal Supplies and Stops: Loose-key angle or straight stop, having 3/4-inch NPS inlet with wall flange.

I. Urinal Traps: 1-1/2 inch NPS adjustable P-trap with cleanout, 17-gage tubular waste to wall, and wall flange.

J. Fittings installed concealed inside a plumbing fixture or within wall construction may be without chrome plate finish.

K. Escutcheons: Wall flange with set screw.

L. Escutcheons: Polished chrome-plated, sheet steel wall flange with friction clips.

M. Deep Pattern Escutcheons: Wall flange with set screw or sheet steel wall flange with friction clips, of depth adequate to conceal protruding roughing-in fittings.

2.4 FLUSHOMETERS

A. Provide flushometers compatible with fixtures, with features and of consumption indicated.

B. Construction: Cast-brass body, brass or copper pipe or tubing inlet with wall flange and tailpiece with spud, screwdriver check stop, vacuum breaker, and brass lever handle actuation except where other variations are specified. Type shall be diaphragm operation except where other type is specified.

C. Finish: Exposed metal parts shall be polished chrome-plated, except components installed in a concealed location may be rough brass or unfinished.

2.5 TOILET SEATS

A. General: Provide toilet seats compatible with water closets, and of type, color, and features indicated.

B. Toilet Seats: Extra heavy-duty, commercial/industrial type, elongated, open front, solid plastic, with check hinge.

2.6 PLUMBING FIXTURE SUPPORTS

A. Supports: ASME A112.6.1M, categories and types as required for wall-hanging fixtures specified, and wall reinforcement.

B. Support categories are:
1. Carriers: Supports for wall-hanging water closets and fixtures supported from wall construction. Water closet carriers shall have an additional faceplate and coupling when used for wide pipe spaces. Provide tiling frame or setting gage with carriers for wall-hanging water closets.
2. Chair Carriers: Supports with steel pipe uprights for wall-hanging fixtures. Urinal chair carriers shall have bearing plates.
3. Chair Carriers, Heavy Duty: Supports with rectangular steel uprights for wall-hanging fixtures.
4. Reinforcement: 2-inch by 4-inch wood blocking between studs or 1/4-inch by 6-inch steel plates attached to studs, in wall construction, to secure floor-mounted and special fixtures to wall.

C. Support Types: Provide support of category specified, of type having features required to match fixture.

D. Provide supports specified as part of fixture description, in lieu of category and type requirements above.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Install plumbing fixtures and specified components, in accordance with designations and locations indicated on Drawings.

B. Install supports for plumbing fixtures in accordance with categories indicated, and of type required:
1. Carriers for following fixtures:
a. Wall-hanging water closets.
b. Wall-hanging fixtures supported from wall construction.

2. Chair carriers for the following fixtures:
   a. Wall-hanging urinals.
   b. Wall-hanging lavatories and sinks.
   c. Wall-hanging drinking fountains and electric water coolers.
3. Heavy-duty chair carriers for the following fixtures:
   a. Accessible lavatories.
   b. Fixtures where specified.
4. Reinforcement for the following fixtures:
   a. Floor-mounted lavatories required to be secured to wall.
   b. Floor-mounted sinks required to be secured to wall.
   c. Recessed, box-mounted electric water coolers.

3.3 INSTALLATION OF PLUMBING FIXTURES

A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturers' written installation instructions, roughing-in drawings, and referenced standards.

B. Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gage.

C. Install wall-hanging, back-outlet urinals with gasket seals.

D. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.

E. Fasten floor-mounted fixtures and special fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.

F. Fasten wall-mounted fittings to reinforcement built into walls.

G. Fasten counter-mounting-type plumbing fixtures to casework.

H. Secure supplies behind wall or within wall pipe space, providing rigid installation.

I. Set shower receptors and mop basins in leveling bed of cement grout.

J. Install stop valve in an accessible location in each water supply to each fixture.

K. Install trap on fixture outlet except for fixtures having integral trap.

L. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons where required to conceal protruding pipe fittings.

M. Seal fixtures to walls, floors, and counters using a sanitary-type, one-part, mildew-resistant, silicone sealant in accordance with sealing requirements specified in other Sections. Match sealant color to fixture color.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other Sections.
2. Install piping connections indicated between appliances and equipment specified in other sections, direct connected to plumbing piping systems.

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

3.6 ADJUSTING AND CLEANING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flushometers having controls, to provide proper flow and stream.

D. Replace washers of leaking and dripping faucets and stops.

E. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.

F. Review the data in Operating and Maintenance Manuals.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities, except when approved in writing by the Owner.

END OF SECTION

SECTION 230000 – GENERAL REQUIREMENTS FOR HVAC SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes general administrative and procedural requirements for all HVAC work. The administrative and procedural requirements included in this Section are to expand the requirements specified elsewhere.

1.2 SCOPE OF WORK

A. Provide all labor, material, equipment, and services necessary for and incidental to completion of all work as indicated on the Drawings and/or as specified herein. This includes all incidentals, equipment, appliances, services, hoisting, scaffolding, supports, sleeves, inserts, anchor bolts, tools, supervision, labor, consumable items, fees, licenses, etc., necessary to provide complete and workable systems.

1.3 DRAWING USE AND INTERPRETATION

A. Unless indicated by specific dimensions, drawings are meant to be diagrammatic. Exact equipment locations and routing of utilities shall be governed by field conditions and/or Owner's Representative's instructions.

B. All dimensions which relate to the building shall be taken as construction progresses. All errors incurred as result of the failure to check or verify dimensions, measurements, etc., shall be corrected.

C. The drawings show the general arrangement of utilities, equipment, and accessories. Drawings do not indicate all offsets, fittings, accessories, and changes in elevation, which may be necessary. Make all changes in equipment, locations, etc., to accommodate the work and to avoid obstacles at no increase in contract price. Provide offsets, fittings, and accessories as may be required to meet such conditions.

1.4 SPECIFICATION FORMAT AND CONTENT EXPLANATION

A. Specification Content: This Specification uses certain conventions regarding the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:

1. Abbreviated Language: Language used in Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpolated as the sense requires. Singular words will be interpreted as plural and plural words interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Streamlined Language: The Specifications generally use the imperative mood and streamlined language. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the Text, subjective language is used for clarity to describe responsibilities that must be fulfilled indirectly by the Contractor or by others when so noted.

a. The words "shall be" are implied where a colon (:) is used within a sentence or phrase.

1.5 DEFINITIONS

A. General: Basic Contract definitions are included in the conditions of the Contract.

B. Indicated: The term "indicated" refers to graphic representations, notes or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

D. Approved: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in the Conditions of the Contract.

E. Regulations: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

F. Furnish: The term "furnish" is used to mean "supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations."

G. Install: The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

H. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."

I. Installer: An "installer" is the Contractor or an entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

1. The term "experienced," when used with the term "installer," means having a minimum of five previous projects similar in size and scope to this Project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.
2. Trades: Use of titles such as "carpentry" is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades persons of the corresponding generic name.
3. Assignment of Specialists: Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in the operations to be performed. The specialists must be engaged for those activities, and assignments are requirements over which the Contractor has no choice or option. Nevertheless, the ultimate responsibility of fulfilling Contract requirement remains with the Contractor.
    a. This requirement shall not be interpreted to conflict with enforcement of building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.

J. The term "concealed": embedded in masonry or other construction, installed behind wall furring, within partitions or hung ceilings (permanent or removable), in trenches, or in crawl spaces.

K. The term "exposed": not installed underground or concealed. Equipment in rooms with exposed construction (i.e., mechanical rooms, electrical rooms, janitor's closets, etc.) are classified as exposed.

L. The term “piping”: piping fittings, flanges, valves, controls, hangers, traps, drains, insulation and items necessary or required in connection with or relating thereto.

M. The “Project Site” is the space available to the contractor for performance of construction activities, either exclusively or in conjunction with other performing other work as part of the Project.

N. Testing Laboratories: A “testing laboratory” is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.6 COMPLETE SYSTEMS

A. General: Provide all materials as required for complete systems, including all parts obviously or reasonably incidental to a complete installation, whether specifically indicated or not. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation prior to Owner’s acceptance.

B. Systems: The systems specified and/or shown on the Drawings are for complete and workable systems. Any deviation from these systems due to a particular manufacturer’s requirements shall be made at no additional cost to the Owner.

1.7 CODES AND REGULATIONS

A. General: Comply with all governing federal, state, and local laws, ordinances, codes, rules, and regulations. Where the Contract Documents exceed these requirements, the Contract Documents shall govern. In no case shall work be installed contrary to or below minimum legal standards.

B. Utilities: Comply with all applicable rules, restrictions, and requirements of the utility companies serving the project site/facilities. Contractor shall be required to contact state regulated “call before you dig” service prior to any excavation work.

C. Non-Compliance: Should any work be performed which is found not to comply with any of the above codes and regulations, provide all work and pay all costs necessary to correct the deficiencies.

1.8 REFERENCE STANDARDS

A. All published standards of the following associations/organizations, as mandated by specific state standards, shall be followed and applied as a minimum.
   1. AABC, Associated Air Balance Council
   2. AIA, The American Institute of Architects
   3. AISC, American Institute of Steel Construction
   4. AMCA, Air Movement and Control Assoc.
   5. ANSI, American National Standards Institute
   6. ARI, Air-Conditioning and Refrigeration Institute
   7. ASHRAE, American Society of Heating, Refrigerating and Air-Conditioning Engineers
   8. ASME, American Society of Mechanical Engineers
   9. ASTM, American Society for Testing and Materials
   10. AWS, American Welding Society
   11. ETL, ETL SEMKO a Division of Intertek Group
   12. FMG, Factory Mutual Global
   13. ISA, Instrument Society of America

14. MCAA, Mechanical Contractors Association of America
15. MSS, Manufacturers Standardization Society
16. NACE, National Association of Corrosion Engineers International
17. NADCA, National Air Duct Cleaners Association
18. NEC, National Electrical Code (from NFPA)
19. NECA, National Electrical Contractors Assoc.
20. NEMA, National Electrical Manufacturers Assoc.
21. NFPA, National Fire Protection Assoc.
22. SMACNA, Sheet Metal and Air Conditioning Contractors
23. UL, Underwriters Laboratories Inc.

B. Federal Government Agencies: Names and titles of federal government standard- or Specification-producing agencies are often abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard- or Specification-producing agencies of the federal government. Names are subject to change and are believed, but are not assured, to be accurate and up-to-date as of the date of the Contract Documents.
1. EPA, Environmental Protection Agency.
2. NIST, National Institute of Standards and Technology (U.S. Department of Commerce).
3. OSHA, Occupational Safety and Health Administration (U.S. Department of Labor).

C. Applicability of Standards: Except where 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. Such standards are made a part of the Contract Documents by reference.

D. Copies of Standards: Each entity engaged in construction on the project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents. Where copies of standards are needed for performance of a required construction activity, the contractor shall obtain copies directly from the publication source.

1.9 QUALITY ASSURANCE

A. Manufacturers' Qualifications: Not less than five years of experience in the actual production of the specified products.

B. Installers' Qualifications:
1. Firm with not less than five years of experience in the installation of mechanical systems and equipment similar in scope and complexity to those required for this Project, and having successfully completed at least ten comparable scale projects.
2. Painting, patching, carpentry, and the like related to or required for Division 23 work shall be performed by craftsman skilled in the appropriate trade.
3. All welding shall be performed by ASME-certified welders.

1.10 INSPECTIONS

A. General: During and upon completion of the work, arrange and pay all associated costs for inspections of all work installed under this Contract, in accordance with the Conditions of the Contract.

B. Inspections Required: As per the laws and regulations of the local and/or state agencies having jurisdiction at the project site.

C. Inspection Agency: Approved by the local and/or state agencies having jurisdiction at the project site.

PART 2 – PRODUCTS

2.1 GENERAL

A. Where Specified: Materials and equipment shall be as specified in subsequent sections of the Project Manual and/or as indicated on the Drawings.

B. General: All materials and equipment to be new, clean, undamaged, and free of defects and corrosion.

C. Acceptable Products: The product will be acceptable only when that product complies with all requirements of the Contract Documents as determined by the Engineer.

D. Common Items: Where more than one of any specific item is required, all shall be of the same type and manufacturer.

E. Listing: All materials and equipment shall be Underwriters' Laboratories (UL) or ETL SEMKO (ETL) listed and labeled where UL or ETL standards and listings exist for the specified materials or equipment.

F. Special Tools: Provide all special tools needed for proper operation, adjustment, and maintenance of equipment.

PART 3 – EXECUTION

3.1 GENERAL

A. The installation of all mechanical work shall be in accordance with the letter and intent of the Contract Documents as determined by the Engineer.

B. Installation Requirements: All materials and equipment shall be installed as recommended by the respective manufacturers, by mechanics experienced and skilled in their particular trade, in a neat and workmanlike manner, in accordance with the standards of the trade, and so as not to void any warranty, UL, or ETL listing.

3.2 DELIVERY STORAGE AND HANDLING

A. Packing and Shipping: Deliver products in original, unopened packaging and properly identified with manufacturer's identification and compliance labels.

B. Storage and Protection: Comply with all manufacturer's written recommendations. Protect all equipment, materials, and work from the weather elements, paint, mortar, construction debris, and damage throughout duration of project.

C. Damaged Products: Do not install damaged products. Arrange for prompt replacement.

3.3 EXAMINATION

A. Conditions Verification: Examine the areas and conditions under which the work is to be performed. Identify and Report any conditions detrimental to the proper and timely completion of the work to the Owner's Representative.

3.4 DIMENSIONS

A. Building Dimensions: Exact locations of building elements shall be based on contractor's field measurements.

B. Limiting Dimensions: Where equipment dimension and clearances are indicated on the Drawings, do not provide equipment larger than equipment dimensions or clearances specified.

C. Verify all dimensions by field measurements.

3.5 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

3.6 CUTTING AND PATCHING

A. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting and patching of mechanical equipment and materials required to:
   1. Uncover Work to provide for installation of non-coordinated and/or improperly installed work.
   2. Remove and replace defective Work.
   3. Remove and replace Work not conforming to requirements of the Contract Documents.
   4. Remove samples of installed Work as specified for testing.
   5. Install equipment and materials in existing structures.
   6. Uncover and restore Work to provide for Engineer observation of concealed Work.

C. Protect the structure, furnishings, finishes, and adjacent materials not indicated to be removed.

D. Provide and maintain temporary dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

E. Patch surfaces and building components using new materials matching existing adjacent materials.

3.7 ADMINISTRATION AND SUPERVISION

A. The Contractor shall supervise the work and shall have at all times some competent person, approved by the Owner, following the work to receive instructions and to act with authority.

3.8 TESTING AND ADJUSTING

A. General: Provide testing equipment, materials, instruments, and personnel to perform all test procedures and adjustments required by the Contract Documents and/or deemed necessary by the Engineer to establish proper performance and installation of systems and equipment. All test instruments to be accurately calibrated and in good working order.

B. Scheduling: Schedule tests at least three days in advance and so as to allow Engineer and Owner representative(s) to witness the test, unless directed otherwise. Do not schedule tests until the system installation is complete and fully operational unless indicated or directed otherwise.

C. Correction/Replacement: After testing, correct any deficiencies and replace materials and equipment shown to be defective or unable to perform at design or rated capacity. Retest without additional cost to the Owner or Contract. Submit finalization report indicating corrective measures taken and satisfactory results of retest.

3.9 SYSTEMS DEMONSTRATION

A. Instruct the Owner's representative(s) in the startup, operation, and maintenance of all systems and equipment in accordance with the Contract Documents.

3.10 CLEANING

A. General: Remove from the project site all waste, rubbish, and construction debris weekly unless indicated otherwise. The premises shall be left clean and free of any debris and unused construction materials, prior to final acceptance.

B. Equipment: Remove all dust, dirt, debris, mortar, rust, and other foreign materials from the interior and exterior of all equipment and enclosures, and wipe down.

C. Utilities: Thoroughly clean all utilities just prior to final inspection.

3.11 TOUCH-UP PAINTING

A. Touch-Up Painting: Restore and refinish to original condition all surfaces of equipment scratched, marred, and/or dented during shipping, handling, or installation. Remove all rust prior to prime and paint as recommended by the manufacturer.

END OF SECTION

SECTION 230004 – COORDINATION WITH OTHER TRADES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. This section describes the coordination and procedural requirements for Contractors.

B. Definitions:
1. Owners Representative - Architect, Engineer, Construction Manager, General Contractor, Clerk of the works, or any stipulated Agent or Representative of the Owner.
2. GC - General Contractor.
3. MC - Mechanical Contractor/Subcontractor.
4. PC - Plumbing Contractor/Subcontractor.
5. EC - Electrical Contractor/Subcontractor.
6. SM - Sheet Metal Subcontractor.

1.2 COMPLIANCE

A. Cost incurred including those of other contractors and/or Owner due to non-compliance with this Section shall be the responsibility of the non-compliant contractor.

1.3 SUBMITTALS

A. Complete coordinated shop drawing shall be submitted in PDF and ACAD format to the Engineer for their record by the MC. Submitted coordinated shop drawing shall include all signatures required by sign off procedure.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.1 COORDINATION

A. General: Sequence, coordinate, and integrate the installation of all materials and equipment for efficient flow of work in conjunction with the other trades. Review and become familiar with all of the Drawings and work of all the other trades. Report and resolve any discovered discrepancies and/or interferences prior to commencing work.

B. Cooperation: Cooperate with the other Contractors and individual disciplines for placement, anchorage and accomplishment of the work.

C. Chases, Slots, and Openings: Arrange for chases, slots, and openings during the progress of construction, as required to allow for installation of the work.

D. Supports and Sleeves: Coordinate the location installation of required supporting devices and sleeves to be set in concrete and other structural components, as they are constructed.

E. Right-Of-Way:

1. Adjust location of utilities, equipment, etc., to accommodate the work to prevent interferences – both anticipated and encountered.
2. Determine the exact route and location prior to fabrication.
3. Pitched piping has the right-of-way over utilities which do not pitch.
4. Furnish and install ancillary materials and equipment including but not limited to traps, air vents, drains, etc., as required to accommodate offsets, transitions, and changes in direction.

F. Headroom: Install systems, materials, and equipment to maximize headroom unless noted otherwise.

G. Utility Connections: Coordinate connection with underground and overhead utility services. Comply with requirements of governing regulations, utility providers, and controlling agencies. Provide required connection for each service.

3.2 COORDINATED SHOP DRAWINGS

A. The coordination shop drawing process shall occur in the following manner:

1. The MC shall create 3/8-inch scale AutoCAD (2002 or newer) base plans, which shall incorporate and coordinate with structural steel and ceiling system framing supports and show framing members on the shop drawings. This shall include existing building components not shown on Contract Documents.
2. The MC shall require the Sheet Metal Subcontractor to submit AutoCAD shop drawings, as expeditiously as possible, to the Engineer (through normal channels) for review and approval. The shop drawings shall incorporate all ductwork (including top and bottom of duct elevations at a maximum interval of 25 linear feet and at each elevation change), structural steel (building and miscellaneous support steel), equipment, and accessories as shown and/or specified in the contract documents.
3. All roof penetrations, wall, and floor openings shall be coordinated with the structural steel Subcontractor, Supplier, and/or Erector through the Owner's Representative. All conflicts with structural steel members shall be resolved through the Owner's Representative.
4. After review and final approval of the sheet metal shop drawing by the Engineer, the sheet metal Subcontractor shall incorporate all required corrections, additions, and modifications on the AutoCAD ductwork shop drawings.
5. The approved AutoCAD ductwork shop drawings shall be utilized for coordination with all other Contractors or Subcontractors whose involvement is mandated. The SM shall submit the AutoCAD ductwork shop drawings (hard copy and electronic files) to the MC to initiate the "coordination" process. The MC shall review the drawings for accuracy and completeness prior to distribution.
6. The MC shall forward with transmittal the ductwork shop drawings (hard copy and electronic files) to the PC for coordination of the plumbing work. The MC shall forward a copy of the transmittal to the Owner's Representative.
7. The PC shall (upon receipt of drawings from the MC) superimpose his scope of work on the AutoCAD ductwork shop drawings illustrating all plumbing equipment, piping, and hangers.
8. The PC shall include invert of pipes, elevations (top and bottom) and pipe sizes including insulation at a maximum of 25-foot intervals and at each elevation change.
9. Any conflicts between the plumbing and ductwork shall be clouded by the PC on the AutoCAD ductwork shop drawing file.
10. PC shall request coordination meeting to resolve the conflicts as clouded on the coordinated shop drawings. PC shall provide clouded shop drawing at the coordination meeting. All conflicts that arise between the plumbing and ductwork shall be resolved through and by the Owner's Representative.

11. The PC and/or the SM shall correct and shall complete the AutoCAD drawings depicting all resolutions.
12. When it is ascertained that no conflicts exist between the ductwork and plumbing work, the PC shall forward the final ductwork/plumbing coordinated drawings (hard copy and electronic files) to the MC with transmittal and provide the Owner's Representative with a copy of the transmittal.
13. The MC shall (upon receipt of drawings from the PC) superimpose all heating and air conditioning piping, equipment, hangers, and insulation including elevations (top and bottom) and pipe sizes (including insulation) on the AutoCAD drawings.
14. Any conflicts between the ductwork/plumbing/mechanical work shall be clouded by the MC on the AutoCAD shop drawing file.
15. MC shall request coordination meeting to resolve the conflicts as clouded on the coordinated shop drawings. MC shall provide clouded shop drawing at the coordination meeting. All conflicts that arise between the MC, SM, and PC shall be resolved through and by the Owner's Representative.
16. The MC, PC, and SM shall correct and complete the AutoCAD drawings depicting all resolutions.
17. When it is ascertained that no conflicts exist between the MC, SM, and PC, the MC shall forward the final ductwork/plumbing/mechanical coordinated drawings (hard copy and electronic files) to the EC with transmittal and provide the Owner's Representative with a copy of the transmittal.
18. The EC shall (upon receipt of drawings from the MC) superimpose all electrical equipment including but not limited to light fixtures, conduit, and hangers on the AutoCAD drawings.
19. The EC shall include elevations of light fixtures, electrical conduit, and conduit sizes.
20. Any conflicts with the ductwork/plumbing/mechanical/electrical work shall be clouded by the EC on the AutoCAD shop drawing file.
21. EC shall request coordination meeting to resolve any conflicts as clouded on the coordinated shop drawings. EC shall provide clouded coordinated shop drawing at the coordination meeting. All conflicts that arise between the EC, MC, PC, and SM shall be resolved through and by the Owner's Representative.
22. The EC and/or the SM, PC, and MC shall correct and complete the AutoCAD drawings depicting all resolutions.
23. When it is ascertained that no conflicts exist between the EC, MC, PC, and SM, the EC shall forward the final ductwork/plumbing/mechanical/electrical coordinated drawings (hard copy and electronic file) to the SC with transmittal and provide the Owner's Representative with a copy of the transmittal.
24. Sign Off:
    a. The MC shall provide the final coordinated shop drawing to the Engineer and the Owner's Representative. The final coordinated shop drawing shall contain signatures from SM, PC, MC and EC on each sheet.
    b. Upon completion of the coordination process by all Contractors and Subcontractors as described above, they shall sign off on all drawings in ink indicating company, name, and date of sign-off and signature of company representative.
    c. Each contractor signature shall certify that each Contractor has shown their respective work on the drawings and have resolved all points of conflict and interference with other Contractors and Subcontractors.

3.3 COORDINATION MEETINGS

A. During the coordination process, separate meetings apart from project meetings concerning the progress and schedules may be called by the Owner's Representative when required or at the request of one or more of the coordinating Contractors.

1. The Owner's Representative shall contact the Contractors and make all required arrangements (e.g., time, place, etc.).
2. All Contractors shall place emphasis and importance on equipment purchases so as to not delay approvals, shop drawings, and the coordinated drawings.

3.4 SCHEDULE OF COORDINATED SHOP DRAWINGS

A. The MC and SM shall complete the ductwork shop drawings within 2 weeks after award of contract (or authorization to proceed).

B. Turn-around time for each Contractor shall be 2 weeks maximum.

3.5 "AS BUILT" DRAWINGS

A. At the completion of the project, "As Built" corrections shall be made to each AutoCAD drawing by each of the aforementioned Contractors and returned to the Owner's Representative for the Owner's permanent files and records. These "As Builts" do <u>not</u> remove the obligation of "As Builts" and record drawings as outlined under other sections of the specifications <u>unless</u> the Owner's Representative elects to do so.

END OF SECTION

SECTION 230500 – BASIC MECHANICAL MATERIALS AND METHODS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes the following basic materials and methods to complement other Division 23 Sections.
   1. Flexible connectors.
   2. Sleeves.
   3. Identifying devices and labels.
   4. Installation requirements common to equipment specification sections.
   5. Touch-up painting.
   6. Repairs.

1.2 DEFINITIONS

A. 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, crawl spaces, 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 duct shafts.

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. Existing: Condition present prior to award of this contract.

1.3 SUBMITTALS

A. Product Data: For all materials specified within this section.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect all stored materials from moisture and dirt. Elevate above grade and support to prevent sagging and bending. Do not exceed structural capacity of floor if stored inside.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where identifying devices are to be applied.

B. Install identifying devices before concealment.

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. Metal, Flexible Connectors:
      a. Engineered Flexible Products.
      b. Flexicraft Industries.
      c. Grinnell Corp.; Grinnell Supply Sales Co.
      d. Mercer Rubber Co.
      e. Metraflex Co.
   2. Identifying Devices:
      a. Craftsmark Identification Systems.
      b. Seton Identification Products.
      c. W.H. Brady Company.

2.2 FLEXIBLE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125 psig (860 kPa) minimum working-pressure rating at 220° DegF unless higher working pressure or temperature is indicated. Coordinate end selection with piping system specifications.

B. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors (non-potable applications only): Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

2.3 SLEEVES

A. General: The following materials are for wall, floor, slab, and roof penetrations.

B. Pipe:
   1. Steel Sheet Metal: 0.0359-inch (0.9-mm) minimum thickness, galvanized, round tube closed with welded longitudinal joint.
   2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, and plain ends. Provide integral waterstop where indicated.
   3. Cast Iron: Cast or fabricated pipe equivalent to ductile-iron pressure pipe with plain ends and integral waterstop.

C. Ductwork
   1. All sleeves shall be per SMACNA.

2.4 IDENTIFYING DEVICES AND LABELS

A. Equipment Nameplates: Metal nameplate with operational data engraved or die-stamped; permanently fastened to equipment.
   1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.

B. Stick-on Duct Markers: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl complying with ASME A13.1.

C. Stick-on Flow Marker: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, 2-inch wide band, color coded complying with ASME A13.1.

D. Rigid Pipe Markers: Manufacturer's standard preprinted, color coded, rigid plastic with flow arrows and fluid medium designed to be applied to piping systems without the need of adhesives. For markers up to 6 inches, markers shall wrap completely around the pipe, and their own tension shall secure them in place. For markers over 6 inches, markers shall be provided with nylon ties to secure marker to piping system Markers comply with ANSI/ASME A13.1.

E. Access Panel Markers: 1/16-inch (2-mm-) thick, engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed valve. Provide 1/8-inch (3-mm) center hole for attachment.

F. Plastic Equipment Markers: ASME A13.1, color-coded, laminated plastic. Include lettering identifying name, equipment service, design capacity, pressure drop, entering and leaving conditions, and RPM indicated on the Contract Documents. Size shall be 2-1/2 by 4-inches (65 by 100 mm) for control devices, dampers, and valves; and 4-1/2 by 6-inches (115 by 150 mm) for equipment. Identifying names and/or abbreviations shall match those indicated on the Contract Documents.

PART 3 – EXECUTION

3.1 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom if mounting heights are not indicated.

B. Install equipment level and plumb, parallel, and perpendicular to other building systems and components unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting and without interference(s) to other installations.

D. Extend grease fittings to accessible locations.

3.2 LABELING AND IDENTIFYING

A. Install plastic equipment marker on all equipment provided under this contract.

B. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers. Duct markers shall identify service and direction of flow. Locate markers at maximum intervals of 50 feet (15 m) near points where ducts enter and exit the space, and on ducts located behind all access doors.

C. Provide additional mechanical identification materials and devices to supplement field or factory supplied nameplates that have become visually blocked by work of this or other Divisions.

D. Clean faces of identification devices.

3.3 TOUCH-UP PAINTING

A. Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 REPAIRS

A. If existing or new work is damaged or disturbed, remove damaged sections and install new products of equal capacity and quality.

END OF SECTION

SECTION 230513 – ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 – GENERAL

1.1 SUMMARY

A. This section specifies the basic requirements for electrical components, which are furnished with mechanical equipment (factory or field installed).

1.2 REFERENCES

A. The following references shall be applicable:
1. NEMA Standards MG 1: Motors and Generators.
2. NEMA Standards ICS 2: Industrial Control Devices, Controllers, and Assemblies.
3. NEMA Standard 250: Enclosures for Electrical Equipment.
4. NEMA Standard KS 1: Enclosed Switches.
5. Comply with National Electrical Code (NFPA 70).

1.3 SUBMITTALS

A. Factory furnished electrical component product data submittal requirements are specified within the individual equipment specification sections.

1.4 QUALITY ASSURANCE

A. Electrical components and materials shall be UL or ETL labeled.

PART 2 – PRODUCTS

2.1 MOTORS

A. Electrical Characteristics shall meet the following unless otherwise indicated:
1. Frequency Rating: 60 Hz.
2. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):
a. 120V circuit: 115V motor rating.

B. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
1. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.

C. Service Factor: 1.15 for poly-phase motors and 1.35 for single-phase motors unless otherwise indicated.

D. Temperature rating: Rated for 104 DegF environment.

E. Temperature rise: Rated for maximum of 194 DegF rise for continuous duty at full load, Class B insulation except for inverter-duty rated motors, which shall use Class F insulation.

F. Starting capability: Frequency of starts as required to meet automatic control system sequence of operation and not less than 5 evenly timed starts per hour.

G. Capacity: Sufficient to start and operate connected loads without exceeding name plate ratings.

H. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B" except "C" where required for high starting torque.

1. Bearings:
   a. Regreasable except permanently sealed motor.
   b. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
2. Mounting:
   a. Horizontal: foot mounted.
   b. Vertical: base mounted.
3. Enclosure Type: See individual equipment specifications for enclosure type.
4. Stamped Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, efficiency, special features, and similar information.

I. Single-Phase Motors:

1. Energy Efficient Motors: One of the following types as selected to suit the starting torque and other requirements of the specific motor application.
   a. Permanent Split Capacitor.
   b. Split-Phase Start, Capacitor-Run.
   c. Capacitor-Start, Capacitor-Run.
   d. Shaded-Pole.
   e. Capacitor Start, Induction Run.
2. Internal Thermal Overload Protection for Motors: Protection shall automatically open the power supply circuit to the motor or a control circuit. Protection shall operate when winding temperature exceeds a safe value calibrated to the temperature rating of the motor insulation. Motor shall automatically reset when motor temperature returns to normal range.
3. Bearings: Belt connected motors or other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, prelubricated sleeve bearings may be used for other single-phase motors.

2.2 STARTERS, DISCONNECTS AND ACCESSORIES

A. Motor Starter Characteristics:

1. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and startup condition. Minimum size starter shall be NEMA Size 1.

B. Manual Disconnect Switches:

1. Non-fusible switches: Horsepower rated toggle switch type; quantity of poles and voltage rating as required by equipment manufacturer.

C. Magnetic Starters:

1. Hand-off-auto, selector switches and pilot lights.
2. Trip-free thermal overload relays, each phase.
3. Interlocks, switches, contacts, and similar devices as required for coordination with control requirements.
4. Built-in control circuit transformer, sized by manufacturer. Provide with minimum two normally-open and two normally-closed spare auxiliary contacts.
5. Externally operated manual reset.

6. High voltage and low voltage protection in all three phases.
7. Internal Thermal Overload Protection for Motors: Protection shall automatically open control circuit. Protection shall operate when winding temperature exceeds safe value calibrated to the temperature rating of the motor insulation.

D. Starter Enclosures:
1. NEMA rated as required for environment in which equipment is to be installed.
2. Interlock covers of combination starters with operating handle providing access to inside of enclosure only when disconnect is in "OFF" position. Provide means to attach multiple padlocks for locking external operating handle in either the "ON" or "OFF" position.
3. Provide red colored RESET Button in cover of starter.
4. Provide and secure wiring diagram corresponding to motor and control wiring of associated equipment on inside of each magnetic and combination starter.
5. Manual starter shall have means for externally locking operating mechanism in "OFF" position.

E. Factory Installed Motor Connections:
1. Flexible conduit, except where plug-in electrical cords are specifically indicated.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Motors: Install field-installed motors in accordance with manufacturer's published instructions and the following:
1. Direct Connected Motors: Mount securely in accurate laser alignment.
2. Bearings: Provide extended lube lines for regreasable motors.

B. Motor Controllers (starters, Disconnects and Drives): Install field-installed starters, disconnects and drives in accordance with manufacturer's published instructions and the following:
1. Locate controllers within sight of motors controller.
2. Mounting: For control equipment at walls, bolt units to wall or mount on light-weight structural steel channels bolted to the wall. For controllers not at walls, provide freestanding racks fabricated of structural steel members and light-weight slotted structural steel channels. Use feet consisting of 3/8-inch thick steel plates, 6-inch square, bolted to the floor. Use feet for welded attachment of 1-1/2-inch thick steel plates, 6-inch square, bolted to the floor. Use feet for welded attachment of 1-1/2-inch by 1-1/2-inch by 1/4-inch vertical angle pots not over 3 feet on centers. Connect the posts with horizontal lightweight slotted steel channels and bolt the control equipment to the channels.
3. Clearances: All motor controllers shall be installed per NEC requirements.

3.2 ACCEPTANCE

A. The right is reserved by the Owner's Representative to reject any motor, which, in his opinion, either under test or in actual service is found to be overloaded, develops excessive mechanical noise, magnetic hum, or otherwise operates unsatisfactorily within the speed range and load specified. The contractor shall adjust or if necessary replace any such deflected motor with one satisfactory to the Owner or Owner's Representative without any extra cost to the Owner.

END OF SECTION

SECTION 230529 – SUPPORTS AND ANCHORS

PART 1 – GENERAL

1.1 SUMMARY

A. This section specifies mechanical hangers, support, and anchors and includes the following:
   1. Hanger-rod attachments.
   2. Building attachments.
   3. Spring hangers and supports.
   4. Miscellaneous materials.
   5. Anchors.
   6. Equipment supports.

1.2 SUBMITTALS

A. Product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location, and features for each required pipe hanger and support.

B. Assembly-type shop drawings for each type of support and anchor indicating dimensions, weights, required clearances, and methods of assembly of components.

C. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

1.3 QUALITY ASSURANCE

A. NFPA Compliance: Hangers and supports shall comply with NFPA Standard No. 13 when used as a component of a fire protection system.

B. MSS Compliance: Provide hangers, supports, and components conforming to the latest requirements of MSS Standard Practices SP-58 and SP-69.

C. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code-Steel."
   1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

D. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

E. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.
   1. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems.
   2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 – PRODUCTS

2.1 MANUFACTURED UNITS

A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.
   1. Components include galvanized coatings where installed for equipment that will not have a field-applied finish.

B. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

C. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

2.2 FASTENERS

A. Sleeve Anchors (Group II, Type 3, Class 3): Molly's Div./USM Corp. Parasleeve Series, Ramset's Dynabolt Series, or Red Head/Phillips AN1405, HN-1614, FS-1411 Series.

B. Wedge Anchors (Zinc Plated, Group II, Type 4, Class 1): Hilti's Kwik Bolt Series, Molly's Div./USM Corp. Parabolt PB Series, Ramset's Trubolt T Series, or Red Head/Phillips WS-3822.

C. Self-Drilling Anchors (Group III, Type 1): Ramset's RD Series, or Red Head/Phillips Series S-14.

D. Non-Drilling Anchors (Group VIII, Type 1): Ramset's Dynaset DS Series, Hilti's HDI Series, or Red Head/Phillips J Series.

E. Stud Anchors (Group VIII, Type 2): Red Head/Phillips JS-38 Series.

F. Bolts, Nuts, Washers, Lags, and Screws: Medium carbon steel, size and type to suit application, galvanized for high humidity locations, and treated wood, plain finish for other interior locations. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work.

2.3 MISCELLANEOUS MATERIALS

A. Sleeve Anchors (Group II, Type 3, Class 3): Molly's Div./USM Corp. Parasleeve Series, Ramset's Dynabolt Series, or Red Head/Phillips AN1405, HN-1614, FS-1411 Series.

B. Bolts and Nuts: ASME B18.10 or ASTM A183, steel, hex-head, track bolts, and nuts.

C. Washers: ASTM F844, steel, plain, flat washers.

D. Grout: ASTM C 1107, Grade B, nonshrink, nonmetallic.
   1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is nonstaining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
   2. Design Mix: 5000-psi (34.5MPa), 28-day compressive strength.
   3. Water: Potable.
   4. Packaging: Premixed and factory-packaged.

PART 3 – EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS

A. Secure hanger rods as follows: Install one nut under clevis, angle, or steel member; one nut on top of clevis, angle or steel member; one nut inside insert or on top of upper hanger attachment and one nut and washer against insert or on lower side of upper hanger attachment. A total of four nuts are required for each road, two at upper hanger attachment and two at hanger.

3.2 UPPER HANGER ATTACHMENTS

A. General:
1. In all cases, secure upper hanger attachments to overhead suitable structural members.
2. Do not use flat bars or bent rods as upper hanger attachments.

B. Attachment to Wood Construction: Secure hangers to the sides (only) of wood members by means of malleable iron side beam connectors or malleable iron or steel side beam brackets. Do not secure hanger attachments to nailing strips resting on top of steel beams.
1. Secure side beam connectors to wood members with two No. 18 by 1-1/2 inch long wood screws, or two No. 16 by 1-1/2 inch long drive screws. Do not hammer in wood screws.
2. Secure side beam brackets to wood members with steel bolts or lag screws. Do not use lag screws in wooden members having a nominal thickness (beam face) under 2-inches in size. Install bolts or lag screws in the sides of timber or a joist at the mid-point or above, not less than 2-1/2 inches from the lower edge when supporting branch lines and not less than 3-inches from the lower edge when supporting mains. Install heavy gage steel washers under all nuts.
a. The minimum width of the lower face of wood beams or joints in which lag screws of size as specified may be used is as follows:

LAG SCREW DIAMETER (INCHES)	**NOMINAL WIDTH OF BEAM FACE (INCHES)**
3/8	2
1/2	3

3.3 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

3.4 EQUIPMENT SUPPORTS

A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

3.5 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

C. Ferrous Metals: Clean galvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structure Painting Council.

1. Blast steel surfaces clean as recommended by the paint system manufacturer and in accordance with requirements of SSPC specification SSPC-SP 10.
2. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
3. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer and touch up with the same primer as the shop coat.

D. Galvanized Surfaces: Clean galvanized surfaces with non-petroleum based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

E. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

F. Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and 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 that no roughness shows after finishing and so that contours of welded surfaces match adjacent contours.

3.6 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

END OF SECTION

SECTION 230593 – TESTING, ADJUSTING, AND BALANCING

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:
   1. Balancing airflow within distribution systems to indicated quantities according to specified tolerances.
   2. Adjusting total HVAC systems to provide indicated quantities.
   3. Measuring electrical performance of HVAC equipment.
   4. Setting quantitative performance of HVAC equipment.
   5. Verifying that automatic control devices are functioning properly.
   6. Measuring sound and vibration.
   7. Reporting results of the activities and procedures specified in this Section.

1.2 DEFINITIONS

A. Adjust: To regulate air patterns at the terminal equipment, such as to reduce fan speed.

B. Balance: To proportion flows within the distribution system according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

G. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

H. Terminal: A point where the controlled medium enters or leaves the distribution system.

I. Test: A procedure to determine quantitative performance of a system or equipment.

J. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

K. AABC: Associated Air Balance Council.

L. AMCA: Air Movement and Control Association.

M. NEBB: National Environmental Balancing Bureau.

N. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.3 SUBMITTALS

A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.

B. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.

C. Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.

D. Certified Testing, Adjusting, and Balancing Reports: Submit two (2) copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

E. Warranty: Submit two (2) copies of special warranty specified in the "Warranty" Article below.

1.4 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.

B. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Engineer's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
   a. Submittal distribution requirements.
   b. Contract Documents examination report.
   c. Testing, adjusting, and balancing plan.
   d. Work schedule and Project site access requirements.
   e. Coordination and cooperation of trades and subcontractors.
   f. Coordination of documentation and communication flow.

C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

D. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Testing, Adjusting, and Balancing Reports: Use standard forms from SMACNA's "HVAC Systems--Testing, Adjusting, and Balancing."

F. Testing, Adjusting, and Balancing Reports: Use testing, adjusting, and balancing Agent's standard forms approved by the Architect.

G. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.

H. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.5 PROJECT CONDITIONS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after the required leakage and pressure tests on air distribution systems have been satisfactorily completed.

1.7 WARRANTY

A. General Warranty: The national project performance guarantee 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. Guarantee: Provide a guarantee on AABC'S "National Standards" forms stating that AABC will assist in completing the requirements of the Contract Documents or NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified Agent has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 – EXECUTION

2.1 EXAMINATION

A. Examine approved submittal data of HVAC systems and equipment.

B. Examine equipment performance data, including fan curves. 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.

C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

D. Examine system and equipment test reports.

E. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

F. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, and equipment with functioning controls is ready for operation.

G. Examine equipment for installation and for properly operating safety interlocks and controls.

H. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

2.2 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:
   1. Permanent electrical power wiring is complete.
   2. Equipment and duct access doors are securely closed.

2.3 GENERAL TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut ducts for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including fan-speed-control levers, and similar controls and devices, to show final settings.

2.4 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

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. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

C. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

D. Verify that motor starters are equipped with properly sized thermal protection.

E. Check for airflow blockages.

F. Check for proper sealing of air-handling unit components.

2.5 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

A. The procedures in this Article apply to constant-volume exhaust-air systems. Additional procedures are required for other systems. These additional procedures are specified in other articles in this Section.

B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:
   a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet, do not measure through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
2. Measure static pressure across each air-handling unit component.
   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
3. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures.
4. Adjust fan speed to obtain design cfm.
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 no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

2.6 MOTORS

A. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

2.7 TOLERANCES

A. Set HVAC system airflow rates within plus or minus 10 percent.

2.8 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' 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: As Work progresses, prepare 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.

2.9 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include the following:
   1. Fan curves.
   2. Manufacturers' test data.
   3. Field test reports prepared by system and equipment installers.
   4. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of testing, adjusting, and balancing Agent.
   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 testing, adjusting, and balancing Agent who certifies the report.
   10. Summary of contents, including the following:
      a. Design versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   11. Nomenclature sheets for each item of equipment.
   12. Notes to explain why certain final data in the body of reports vary from design values.
   13. Test conditions for fans performance forms, including the following:
      a. Settings for exhaust-air dampers.
      b. Conditions of filters.
      c. Fan drive settings, including settings and percentage of maximum pitch diameter.
      d. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air distribution systems. Present with single-line diagrams and include the following:
   1. Quantities of exhaust airflows.
   2. Duct sizes.
   3. Balancing stations.

F. Fan Test Reports: For exhaust fans, include the following:
   1. Fan Data: Include the following:
      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 (mm), and bore.
h. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).

2. Motor Data: Include the following:
a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).

3. Test Data: Include design and actual values for the following:
a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Suction static pressure in inches wg (Pa).

G. Round Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data: Include the following:
a. System and air-handling unit number.
b. Location and zone.
c. Traverse air temperature in DegF (DegC).
d. Duct static pressure in inches wg (Pa).
e. Duct size in inches (mm).
f. Duct area in sq. ft. ((sq. m)).
g. Design airflow rate in cfm (L/s).
h. Design velocity in fpm (m/s).
i. Actual airflow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

2. Test Data: Include design and actual values for the following:
a. Airflow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary airflow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final airflow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in DegF (DegC).

H. Instrument Calibration Reports: For instrument calibration, include the following:

1. Report Data: Include the following:
a. Instrument type and make.

b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

2.10 ADDITIONAL TESTS

A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION

SECTION 230951 – MOTORS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes basic requirements for factory-installed motors.

1.2 SUBMITTALS

A. Product Data: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, grounding lug; and coatings.

B. Factory Test Reports: For specified tests.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Listing and Labeling: Provide motors specified in this Section that are listed and labeled.
1. Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
3. Motors shall be UL labeled:
a. Motors shall conform to NEMA Standards MGI, Motors and Generators.

PART 2 – PRODUCTS

2.1 BASIC MOTOR REQUIREMENTS

A. Basic requirements apply to mechanical equipment motors, unless otherwise indicated.

B. Motors smaller than 1/2 HP: Single phase.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: Determined by voltage of circuit to which motor is connected.

E. Service Factor: According to NEMA MG 1, unless otherwise indicated.

F. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

G. Enclosure: Open dripproof, unless otherwise indicated.

2.2 SINGLE-PHASE MOTORS

A. Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.
   1. Permanent-split capacitor.
   2. Split-phase start, capacitor run.
   3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: Do not use, unless motors are smaller than 1/20 HP.

C. Thermal Protection: Where indicated or required, internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range, unless otherwise indicated.

D. Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, prelubricated sleeve bearings for other single-phase motors.

END OF SECTION

SECTION 233113 – METAL DUCTS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes round metal ducts and plenums for heating, ventilating, and air-conditioning systems in pressure classes from minus 2- to plus 10-inch wg (minus 500 to plus 2490 Pa).

1.2 DEFINITIONS

A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C168. In this Section, these values are the result of the formula Btu x in./h x sq. ft. x DegF or W/m x K at the temperature differences specified. Values are expressed as Btu or W.

1.3 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select and size air-moving and -distribution equipment and other components of air system. Changes to layout or configuration of duct system must be specifically approved in writing by Engineer. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.4 SUBMITTALS

A. Product Data: For duct liner and sealing materials.

B. Shop Drawings: Show details of the following:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Duct layout indicating pressure classifications and sizes on plans.
   3. Fittings.
   4. Reinforcement and spacing.
   5. Seam and joint construction.
   6. Hangers and supports, including methods for building attachment, vibration isolation, seismic restraints, and duct attachment.

C. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
   1. Ceiling suspension assembly members.
   2. Other systems installed in same space as ducts.
   3. Ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
   4. Coordination with ceiling-mounted items, including lighting fixtures, diffusers, grilles, speakers, sprinkler heads, access panels, and special moldings.

D. Welding Certificates: Copies of certificates indicating welding procedures and personnel comply with requirements in “Quality Assurance” Article.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

F. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.5 QUALITY ASSURANCE

A. Welding Standards: Qualify welding procedures and welding personnel to perform welding processes for this Project according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports; AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members; and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," unless otherwise indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver sealant materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle sealant materials according to manufacturer's written recommendations.

C. Deliver and store stainless-steel sheets with mill-applied adhesive protective paper maintained through fabrication and installation.

PART 2 – PRODUCTS

2.1 SHEET METAL MATERIALS

A. Aluminum Sheets: ASTM B209 (ASTM 209M), Alloy 3003, Temper H14, sheet form with standard, one-side bright finish for ducts exposed to view and with mill finish for concealed ducts.

B. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for 36-inch (900-mm) length or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36-inches (900 mm).

2.2 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is limited to materials of adhesive or mastic nature.
   1. Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant, formulated with a minimum of 66 percent solids.
   2. Flanged Joint Mastics: One-part, acid-curing, silicone, elastomeric joint sealants, complying with ASTM C920, Type S, Grade NS, Class 25, Use O.

2.3 HANGERS AND SUPPORTS

A. Hanger Materials: Galvanized, sheet steel or round, threaded steel rod.
   1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rod or galvanized rods with threads painted after installation.
   2. Straps and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for sheet steel width and thickness and for steel rod diameters.

B. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

C. Trapeze and Riser Supports: Steel shapes complying with ASTM A36/A36M.

1. Supports for Aluminum Ducts: Aluminum support materials, unless materials are electrolytically separated from ductwork.

2.4 ROUND DUCT FABRICATION

A. Round Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

PART 3 – EXECUTION

3.1 DUCT INSTALLATION, GENERAL

A. Drawings indicate general arrangement of ducts, fittings, and accessories. Provide all required fittings, accessories, and ancillaries as required for a complete system as determined by the Engineer.

B. Construct and install each duct system for the specific duct pressure classification indicated.

C. Install round ducts in lengths not less than 12-feet (3.7 m) unless interrupted by fittings.

D. Install ducts with fewest possible joints.

E. Install fabricated fittings for changes in directions, changes in size and shape, and connections.

F. Install couplings tight to duct wall surface with a minimum of projections into duct.

G. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Install ducts with a clearance of 1-inch (25 mm) plus allowance for insulation thickness.

J. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.

K. Coordinate layout with suspended ceiling, fire and smoke-control dampers, lighting layouts, and similar finished work.

L. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches (38 mm).

3.2 SEAM AND JOINT SEALING

A. General: Seal duct seams and joints according to the duct pressure class indicated and as described in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Pressure Classification Less than 2-Inch wg (500 Pa): Transverse joints.

C. Seal externally insulated ducts before insulation installation.

3.3 HANGING AND SUPPORTING

A. Install rigid round metal duct with support systems indicated in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

3.4 CONNECTIONS

A. Connect equipment with flexible connectors according to other Sections.

3.5 FIELD QUALITY CONTROL

A. Disassemble, reassemble, and seal segments of systems as required to accommodate leakage testing and as required for compliance with test requirements.

B. Conduct tests, in presence of Architect, at static pressures equal to maximum design pressure of system or section being tested. If pressure classifications are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. Determine leakage from entire system or section of system by relating leakage to surface area of test section.

D. Maximum Allowable Leakage: Comply with requirements for Leakage Classification 3 for round and flat-oval ducts, Leakage Classification 12 for rectangular ducts in pressure classifications less than and equal to 2-inch wg (500 Pa) (both positive and negative pressures), and Leakage Classification 6 for pressure classifications from 2- to 10-inch wg (500 to 2490 Pa).

E. Remake leaking joints and retest until leakage is less than maximum allowable.

F. Leakage Test: Perform tests according to SMACNA's "HVAC Air Duct Leakage Test Manual."

3.6 ADJUSTING

A. Detailed procedures for Testing, Adjusting, and Balancing are specified in other Sections.

3.7 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect the system. Vacuum ducts before final acceptance to remove dust and debris.

END OF SECTION

SECTION 233300 – DUCT ACCESSORIES

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Flexible connectors.
   2. Duct accessory hardware.

1.2 SUBMITTALS

A. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, location, and size of each field connection. Detail the following:
   1. Special fittings and manual- and automatic-volume-damper installations.

B. Product Certificates: Submit certified test data on dynamic insertion loss; self-noise power levels; and airflow performance data, static-pressure loss, dimensions, and weights.

1.3 QUALITY ASSURANCE

A. NFPA Compliance: Comply with the following NFPA standards:
   1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

1.4 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 – PRODUCTS

2.1 SHEET METAL MATERIALS

A. Aluminum Sheets: ASTM B209 (ASTM B209M), Alloy 3003, Temper H14, sheet form; with standard, one-side bright finish for ducts exposed to view and mill finish for concealed ducts.

B. Extruded Aluminum: ASTM B221 (ASTM B221M), Alloy 6063, Temper T6.

C. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for 36-inch (900-mm) length or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.2 FLEXIBLE CONNECTORS

A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

1. Standard Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4 inch (70-mm) wide, 0.028-inch (0.7-mm) thick, galvanized, sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected ducts.

2.3 ACCESSORY HARDWARE

A. 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 length to suit duct insulation thickness.

B. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches (75 to 450 mm) to suit duct size.

C. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.

B. Provide test holes at fan inlet and outlet and elsewhere as indicated.

C. Label access doors according to other Sections.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

END OF SECTION

SECTION 233400 – FANS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes the following types fans:
   1. Ceiling-mounted ventilators.

1.2 SUBMITTALS

A. Product data for selected models, including specialties, accessories, and the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound power ratings.
   3. Motor ratings and electrical characteristics plus motor and fan accessories.
   4. Materials gages and finishes including color charts.
   5. Dampers, including housings, linkages, and operators.

B. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.

C. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.

D. Maintenance data:

1.3 QUALITY ASSURANCE

A. UL Compliance: Fans and components shall be UL listed and labeled.

B. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

C. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ceiling-Mounted Ventilators:
      a. Carnes Company, Inc.
      b. Cook (Loren) Co.
      c. Greenheck Fan Corp.

2.2 SOURCE QUALITY CONTROL

A. Testing Requirements: The following factory tests are required:

1. Sound Power Level Ratings: Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating." Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51, "Laboratory Methods of Testing Fans for Rating."

2.3 FANS, GENERAL

A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished, with indicated capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

C. Shaft Bearings: Provide type indicated, having a median life "Rating Life" (AFBMA (L50)) of 200,000, calculated in accordance with AFBMA Standard 9 for ball bearings and AFBMA Standard 11 for roller bearings.

D. Factory Finish: The following finishes are required:

1. Sheet Metal Parts: Prime coating prior to final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.

E. Motors:

1. Refer to other Sections for motor equipment.

2.4 CEILING-MOUNTED VENTILATORS

A. General Description: Centrifugal fan designed for installation in ceiling applications.

B. Housing: Galvanized steel lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in. Junction box shall be mounted above ceiling.

F. Remote Fan Speed Control: Solid state, capable of controlling fan speed from full speed to approximately half speed. Controller shall be mounted above ceiling.

G. Accessories: Manufacturer's standard roof jack, wall cap, and transition fittings as indicated.

2.5 MOTORS

A. Torque Characteristics: Sufficient to accelerate the driven loads satisfactorily.

B. Motor Sizes: Minimum sizes and electrical characteristics as indicated. If not indicated, large enough so that the driven load will not require the motor to operate in the service factor range.

C. Temperature Rating: 50° DegC maximum temperature rise at 40° DegC ambient for continuous duty at full load (Class A Insulation).

D. Service Factor: 1.35 for single-phase motors.

E. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design B. Provide permanent-split capacitor classification motors for shaft-mounted fans.

1. Bases: Adjustable.
2. Bearings: The following features are required:
   a. Ball or roller bearings with inner and outer shaft seals.
   b. Grease lubricated.
   c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
3. Enclosure Type: The following features are required:
   a. Open dripproof motors where satisfactorily housed or remotely located during operation.
   b. Guarded dripproof motors where exposed to contact by employees or building occupants.
4. Overload protection: Built-in, automatic reset, thermal overload protection.
5. Noise rating: Quiet.
6. Efficiency: Energy-efficient motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, Test Method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors" in accordance with IEEE Standard 112, Test Method B.
7. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, and special features.

F. Starters, Electrical Devices, and Wiring: Electrical devices and connections are specified in other Sections.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, housekeeping pads, and other conditions affecting performance of fans.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install fans level and plumb, in accordance with manufacturer's written instructions. Support units as described below, using the vibration control devices provided by manufacturer.

1. Suspended Units: Suspend units from structural steel support frame using threaded steel rods and fan manufacturers housed vibration isolation springs.

B. Arrange installation of units to provide access space around air- handling units for service and maintenance.

3.3 CONNECTIONS

A. Duct installations and connections are specified in other Sections. Make final duct connections with flexible connections.

B. Electrical Connections: The following requirements apply:
   1. Electrical power wiring is specified in other Divisions.
   2. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Inspection: Arrange and pay for a factory- authorized service representative to perform the following:
   1. Inspect the field assembly of components and installation of fans including ductwork and electrical connections.
   2. Prepare a written report on findings and recommended corrective actions.

3.5 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust damper linkages for proper damper operation.

B. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.6 COMMISSIONING

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
   1. Remove shipping blocking and bracing.
   2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
   3. Perform cleaning and adjusting specified in this Section.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
   5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
   6. Verify manual and automatic volume control and that fire and smoke dampers in connected ductwork systems are in the full-open position.
   7. Disable automatic temperature control operators.

B. Starting procedures for fans:
   1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
      a. Replace fan and motor pulleys as required to achieve design conditions.
   2. Measure and record motor electrical values for voltage and amperage.

C. Shut unit down and reconnect automatic temperature control operators.

D. Refer to Division 23 Section “Testing, Adjusting, and Balancing” for procedures for air-handling-system testing, adjusting, and balancing.

3.7 DEMONSTRATION

A. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner’s maintenance personnel on the following:

1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of Operating and Maintenance Manuals.

B. Schedule training with at least seven (7) days advance notice.

END OF SECTION

SECTION 260001 – ELECTRICAL

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, material, tools, equipment, transportation and services necessary for and incidental to completion of all electrical work as indicated on the Drawings and/or as specified herein.

1.2 DRAWING USE AND INTERPRETATION

A. The Drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions or details. Exact equipment locations and raceway routing, etc. shall be governed by actual field conditions and/or instructions of the Engineer and/or Owner's Representative.

1.3 COMPLETE SYSTEMS

A. General: Furnish and install all materials as required for complete systems, including all parts obviously or reasonably incidental to a complete installation, whether specifically indicated or not. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation prior to Owner's acceptance.

B. Wiring: The wiring specified and/or shown on the Drawings is for complete and workable systems. Any deviations from the wiring shown due to a particular manufacturer's or subcontractor's requirements shall be made at no cost to either the Contract or the Owner.

1.4 CODES AND REGULATIONS

A. General: Comply with the latest recognized edition of the National Electrical Code (NEC) and all governing federal, state, and local laws, ordinances, codes, rules, and regulations. Where the Contract Documents exceed these requirements, the Contract Documents shall govern. In no case shall work be installed contrary to or below minimum legal standards.

B. Utilities: Comply with all applicable rules, restrictions, and requirements of the utility companies serving the project site/facilities.

C. Non-Compliance: Should any work be performed which is found not to comply with any of the above codes and regulations, provide all work and pay all costs necessary to correct the deficiencies.

1.5 REFERENCE STANDARDS

A. All latest published standards of the following associations/organizations shall be followed and applied where applicable as minimum requirements:
   1. (ADA), Americans with Disabilities Act.
   2. (ANSI), American National Standards Institute.
   3. (ASTM), American Society for Testing and Materials.
   4. (CBM), Certified Ballast Manufacturer.
   5. (EPACT), National Energy Policy Act.
   6. (ETL), Electrical Testing Laboratory.
   7. (ICEA), Insulated Cable Engineers Association.
   8. (IEEE), Institute of Electrical and Electronic Engineers.

9. (IESNA), Illuminating Engineering Society of North America.
10. (NBFU), National Board of Fire Underwriters.
11. (NEMA), National Electrical Manufacturers Association.
12. (NESC), National Electrical Safety Code.
13. (NFPA), National Fire Protection Association.
14. (UL), Underwriter's Laboratories.

1.6 PERMITS

A. General: Obtain and pay for any and all permits required by all applicable agencies, prior to commencing work.

1.7 SUBMITTALS

A. General: Prepare and submit for approval, per the procedures set forth in Division 1, all submittals required by Division 1, this section, and by all other Contract Documents.

B. Types: Required submittals may include: Schedule of Values; List of Subcontractors; Product Data; Shop Drawings; Samples; Test Reports; Certifications; Warranties; Maintenance Manuals; Record Drawings; and various administrative submittals.

C. Number of Copies: As indicated in Division 1, Division 26 or elsewhere in the Contract Documents. For quantities indicated in the Contract Documents or specification sections other than Division 26 sections, increase number of copies by one to allow for the Engineer's record copy. Minimum number of copies per submittal: three.

D. Product Data: Submit for all basic electrical equipment, devices, and materials to be used on the project. Product data to consist of manufacturer's standard catalog cuts, descriptive literature and/or diagrams, in 8-1/2" x 11" format, and in sufficient detail so as to clearly indicate compliance with all specified requirements and standards. Mark each copy to clearly indicate proposed product, options, finishes, etc.

E. Shop Drawings: Submit for all custom equipment and systems (e.g., panelboards) to be used on the project. Shop Drawings to be newly prepared, specifically for this project, and shall include all information listed in the Shop Drawings submittal requirements in the respective specification section. Include all pertinent information such as equipment/system identification, manufacturer, dimensions, nameplate data, sizes, capacities, types, materials, performance data, features, accessories, wiring diagrams, etc., in sufficient detail so as to clearly indicate compliance with all specified requirements and standards. For control systems, provide computer generated control ladder diagrams specifically developed for this project (standard diagrams not acceptable).

F. Maintenance Manuals: Include operating and maintenance data in accordance with Division 1. Include all Product Data/Shop Drawing submittals as well as descriptions of function, normal operating characteristics and limitations, and manufacturer's printed operating maintenance, trouble shooting, repair, adjustment, and emergency instructions, and complete replacement parts listing.

G. Record Documents: Prepare and submit in accordance with Division 1. In addition to Division 1 requirements, indicate actual installed locations for all equipment and devices, routing of major interior raceways, locations of all concealed and underground equipment and raceways, and all approved modifications to the Contract Documents, and deviations necessitated by field conditions and change orders.

1.8 QUALITY ASSURANCE

A. Manufacturers' Qualifications: Not less than three years experience in the actual production of the specified products.

B. Installers' Qualifications: Firm with not less than five years experience in the installation of electrical systems and equipment similar in scope and complexity to those required for this Project, and having successfully completed at least ten comparable scale projects.

C. Incidental Work: Excavation, backfill, painting, patching, welding, carpentry, mechanical work, concrete pads and the like related to or required for Division 26 work shall be performed by craftsman skilled in the appropriate trade, but shall be provided for under Division 26.

1.9 INSPECTIONS

A. General: During and upon completion of the work, arrange and pay all associated costs for inspections of all electrical work installed under this contract, in accordance with the Conditions of the Contract.

B. Inspections Required: As per the laws and regulations of the local and/or state agencies having jurisdiction at the project site.

C. Inspection Agency: Approved by the local and/or state agencies having jurisdiction at the project site.

D. Certificates: Submit all required inspection certificates.

E. Coordination: Coordinate inspections with the local utility.

1.10 DELIVERY STORAGE AND HANDLING

A. Comply with Division 1 requirements.

B. Packing and Shipping: Deliver products in original, unopened packaging, properly identified with manufacturer's identification, and compliance labels.

C. Storage and Protection: Comply with all manufacturer's written recommendations. Store all products in a manner which shall protect them from damage, weather, and entry of debris.

D. Damaged Products: Do not install damaged products. Arrange for prompt replacement.

PART 2 – PRODUCTS

2.1 GENERAL

A. Where Specified: Materials and equipment shall be as specified herein and/or as indicated on the Drawings.

B. General Requirements: All materials and equipment shall be in accordance with the Contract Documents, and to the extent possible, standard products of the various manufacturers, except where special construction or performance features are called for. All materials and equipment to be new, clean, undamaged, and free of defects and corrosion.

C. Acceptable Products: The product of a specified or approved manufacturer will be acceptable only when that product complies with or is modified as necessary to comply with all requirements of the Contract Documents.

D. Common Items: Where more than one of any specific item is required, all shall be of the same type and manufacturer.

E. UL Listing: All electrical materials and equipment shall be Underwriters' Laboratories (UL) listed and labeled, where UL standards and listings exist for such materials or equipment.

2.2 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Refer to the Conditions of the Contract, and Division 1.

2.3 FIRESTOPPING MATERIALS

A. General: Firestop systems composed of firestop compounds and appropriate damming materials installed together with the penetrant (e.g., conduit) to form a complete firestop system, providing a fire resistant rating at least equal to the hourly fire resistance rating of the floor, wall or partition into which the firestop system is to be installed.

B. Test Standards: Fires topping materials shall be tested together as a system to the time/temperature requirements of ASTM E119 and shall be tested to UL 1479 (ASTM E814) and be UL classified for up to 3 hours.

C. Firestop Sealants: Non-hardening, conformable, intumescent putties, sealants or other compounds, containing no toxic solvents or asbestos, and exhibiting aggressive adhesion to all common building materials and penetrants, while allowing reasonable movement of the penetrants, without being displaced. Compounds shall be waterproof, non-toxic and smoke and gas tight.

D. Firestop Mortars: Light-weight, water-based, cementitious, fast drying, low density mortar, non-shrinking and non-cracking during its cure, and which forms a surface capable of being sanded, bored and painted.

E. Damming Materials: Mineral wool or ceramic fiber.

F. Multi-Cable Transits: Assemblies consisting of a frame, a compression mechanism, and grooved insert sealing modules sized for multiple penetrating elements of various sizes.

G. Acceptable Manufacturers: Hilti; Heavy Duty/Nelson; International Protective Coatings; Specified Technologies, Inc.

2.4 SOIL MATERIALS

A. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.

B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2 inch sieve, and not more than 5 percent passing a No. 4 sieve.

C. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP, free of clay, rock, or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetable, and other deleterious matter.

2.5 CONCRETE WORK

A. Concrete:
   1. Minimum Strength: 3000 psi @ 28 days.
   2. Aggregate: 3/4" aggregate.
   3. Cement: 588 #/cu. yd. minimum, type I or II.
   4. Slump: 4 inches maximum.
   5. Air: 5 to 7 percent.

B. Reinforcing: Grade 60 bars, sized as indicated, and 6" x 6" - W1.4 x W1.4 mesh, and other reinforcing as indicated.

C. Forms: Wood, metal or other approved materials, constructed so as to withstand the forces of the newly placed concrete.

D. Equipment Pads: Minimum 4" thick indoor, 12” thick outdoor (with 9” below grade), with 1" x 45º chamfer on all top edges. For on grade installations provide 12" layer of crushed stone beneath pad. For pads to be placed on concrete floors, provide anchors into concrete floor.
   1. Comply with equipment manufacturer’s specifications and/or utility company requirements.

2.6 RACEWAY SYSTEMS

A. Raceway Sizing: As required by the NEC (minimum) with oversized raceways as indicated and where required for ease of pulling cable. Minimum conduit size: 3/4-inch, unless indicated otherwise.

B. Raceway Types: Rigid galvanized steel conduit, liquid-tight flexible steel conduit and Schedule 40 heavywall and Schedule 80 extra-heavywall rigid non-metallic (PVC) conduit, conforming to applicable ANSI, NEMA and UL standards.

C. Fittings: All raceway fittings (except for rigid non-metallic conduit) to be steel or malleable iron, and UL-listed for the intended application. Outlet Boxes (Concealed in Walls): Non-gangable, galvanized steel, with square cornered tile (or masonry) type extension rings or cover. Minimum size: two-gang masonry box or 4" square box with single-gang adapter (plaster) ring. Depth of adapter ring to suit application. Minimum depth: 1-1/2". Minimum capacity: 21 cubic inches.

D. Outlet Boxes (Surface Mounted): Cadmium plated cast or malleable iron.

E. Pull and Junction Boxes, and Wireways: Use as indicated and required. Junction and pull boxes for general indoor use (dry locations) to be of galvanized code gauge steel construction, minimum 4" square by 1-1/2" deep, with screw-on covers. Wireways to be UL listed, sheet steel construction with screw-on covers. For exterior and damp or wet indoor locations, use boxes and wireways approved for such use.

F. Handholes: Light-weight and high-strength, constructed of fiberglass reinforced polymer concrete, gray color, suitable for use at temperatures down to -50ºF, and resistant to sunlight, weathering, chemicals and freeze-thaw cycles, with bolt-on cover (with standard logo indicating type of service), and designed for in-grade use in areas with light vehicular traffic (5,000 lb. load over 10"x10" area). Acceptable Manufacturers: Quazite “Composolite,” Styles “PC” or “PG”, Carson Oldcastle.

G. Pipe Sleeves: Rigid steel conduit or iron pipe.

H. Conduit Seals: For Cast-in-Place Concrete Applications: Acceptable Manufacturers: O-Z/Gedney Type "FSK"; Thunderline Corp. "Link Seal" with "Link Seal Wall Sleeve." For Core Drilled and Pre-Cast Opening Applications: Acceptable Manufacturers: O-Z/Gedney Type "CSML"; Thunderline corp. "Link Seal."

I. Pull Wires: No. 14 AWG zinc-coated steel monofilament plastic line with 200 lb. tensile strength.

2.7 600 VOLT CLASS WIRE

A. General: All wire and cable shall be constructed in accordance with all applicable ICEA, NEMA and IEEE published standards, and shall be UL-listed and labeled. Single-conductor, 98% conductivity, annealed, uncoated copper conductors with 600-volt rated type "THHN/THWN" insulation.

B. Wire shall be annealed bare copper per ANSI/ASTM B3, UL 83, and Federal Specification JC-30A with 600 volt insulation, be stranded (except for #10 AWG and smaller may be solid), and be minimum size #12 AWG (Except for control wiring and signal circuits).

C. Insulation: Provide THHN/THWN insulation for all conductors, except XHHW insulation may be used for conductors #4 and larger.

D. Ampacity of conductors shall be rated for 75 degrees C regardless of temperature of conductor insulation when combining circuits in one conduit. Derate conductors and increase size per NEC when installing multiple circuits in a raceway, utilizing 75˚C ampacity table.

E. Connectors: Nylon shell insulated metallic screw-on connectors for #14-10 AWG, and bolted pressure or compression type lugs and connectors with insulating covers for #8 AWG and larger.

2.8 WIRING DEVICES

A. Switches: 20 amp, 120-277 volt, A.C. only, toggle type, single-pole, double-pole, three-way or four-way as indicated or required. Acceptable Manufacturers: Leviton; Arrow-Hart; Hubbell; Pass and Seymour.

B. Receptacles (General Use): 125 volt, 20 amp, NEMA 5-20R, duplex type. Acceptable Manufacturers: Leviton; Arrow-Hart; Hubbell; Pass and Seymour.

C. GFI Receptacles: Ground fault circuit interrupter, feed-through, duplex type, 125 volt, 20 amp, NEMA 5-20R, with solid-state ground-fault sensing and 5 mA trip level. Acceptable Manufacturers: Leviton; Arrow-Hart; Hubbell; Pass and Seymour.

D. Special Receptacles: As indicated by ratings and/or NEMA configuration. Acceptable Manufacturers: Leviton; Arrow-Hart; Hubbell; Pass and Seymour.

E. Minimum .032" thick, Type 430 stainless steel with U.S. #32D satin finish.

F. Coverplates (Exterior Locations): Weatherproof cast aluminum or polycarbonate. Receptacles installed in damp or wet locations shall have an enclosure and cover that are weatherproof with the attachment plug inserted or removed per NEC 406.9.

2.9 EQUIPMENT CONNECTIONS

A. Materials as specified in this section, and as required.

2.10 HANGERS AND SUPPORTS

A. General: All hangers, supports, fasteners and hardware shall be zinc-coated or of equivalent corrosion resistance by treatment or inherent property, and shall be manufactured products designed for the application. Products for outdoor use shall be hot dip galvanized.

B. Types: Hangers, straps, riser supports, clamps, U-channel, threaded rods, etc. as indicated and/or required.

C. Seismic restraints and supports as indicated and/or required.

2.11 ELECTRICAL IDENTIFICATION

A. Nameplates: Three-layer laminated plastic with minimum 3/16" high white engraved characters on black background, and punched for mechanical fastening. Fasteners: self-tapping stainless-steel screws or number 10-32 stainless steel machine screws with nuts and flat and lock washers. Each nameplate on all panelboards and switchgear shall indicate the following:
   1. Panel Name
   2. Voltage, Phase, Number of Wires
   3. Source.

B. Underground Warning Tape: Six-inch wide polyethylene tape, permanently bright colored with continuous-printed legend indicating general type of underground line below and “CAUTION.” Colors as follows:
   1. Red - Electric
   2. Orange – Communications.

C. Marking Pens: Permanent, waterproof, quick drying black ink. Acceptable Manufacturers: Sanford Fine Point “Sharpie,” or equal.

D. Wire Tags: Vinyl or vinyl-cloth self-adhesive wraparound type indicating appropriate circuit number, etc.

E. Arc Flash Panelboard Stickers: Provide per NEC 110.16.

2.12 ELECTRIC SERVICE

A. Materials as specified elsewhere in this section, and as required by the serving electric utility company.

2.13 GROUNDING

A. General: Ground rods, conductors, clamps and connectors, etc. as required.

B. Ground Rods: Minimum 5/8” diameter by 10’ long copper clad steel.

C. Welded Connectors: Exothermic process.

2.14 DRY TYPE TRANSFORMERS

A. General: Transformers shall be UL listed and labeled, and meet all applicable NEMA, ANSI, and IEEE standards. Transformers shall be factory assembled, general purpose, ventilated type of size and electrical characteristics indicated.

B. Enclosure: Ventilated, drip-proof code gauge steel housing with bolted removable access panels, phosphatized and finished with corrosion inhibiting undercoat and ANSI-61 gray baked enamel. Transformers shall be suitable for mounting on floor or other substantial structure, except for 15 KVA size and smaller which shall be suitable for wall mounting.

C. Core and Coil: Constructed of continuous copper windings and high grade non-aging, grain oriented silicon steel core laminations having high magnetic permeability and low hysteresis and eddy current losses. Core and coil of units rated 15 KVA or more shall be completely isolated from the enclosure using vibration absorbing mounts and shall have flexible grounding strap connected to the enclosure. Connections to primary and secondary bushing shall be made using fully rated flexible straps.

D. Insulation System: 220ºC temperature class for all transformers.

E. Temperature Rise: Winding temperature rise by resistance limited to 115ºC for all transformer sizes, referenced to 40ºC ambient temperature. Hot spot temperature shall not exceed 30ºC above winding temperature rise rating. Case temperature shall not exceed 35ºC above 40ºC ambient temperature.

F. Taps: Two 5% FCBN taps for transformer sizes below 30 KVA; and two 2-1/2% FCAN and four 2-1/2% FCBN taps for transformer sizes 30 KVA and larger; referenced to nameplate voltage.

G. Noise Levels: Less than ANSI standards and shall meet the following requirements:
1. 15 to 50 kVa 45 dB
2. 51 to 150 kVa 50 dB
3. 151 to 300 kVa 55 dB
4. 301 to 500 kVa 60 dB
5. 501 to 700 kVa 62 dB
6. 701 to 1000 kVa 64 dB

H. Efficiencies shall be as indicated in the following table:

NEMA CLASS 1 EFFICIENCY LEVELS FOR DRY-TYPE TRANSFORMERS LOW VOLTAGE, 75˚C AT 35% OF NAMEPLATE LOAD			
SINGLE-PHASE EFFICIENCY		**THREE-PHASE EFFICIENCY**	
15 kVA	97.7	15 kVA	97.0
25 kVA	98.0	30 kVA	97.5
37.5 kVA	98.2	45 kVA	97.7
50 kVA	98.3	75 kVA	98.0
75 kVA	98.5	112.5 kVA	98.2
100 kVA	98.6	150 kVA	98.3
167kVA	98.7	225 kVA	98.5
250 kVA	98.8	300 kVA	98.6
333 kVA	98.9	500 kVA	98.7
		750 kVA	98.8
		1000 kVA	98.9

I. Ratings: KVA rating, voltages, phases and configuration as indicated. Minimum impedance: 4.5%.

J. Nameplates: The nameplate shall be permanently mounted to the exterior front, with permanently etched numbers and letters, and shall include the following:
   1. KVA size
   2. Primary and Secondary Voltage Ratings
   3. Serial Number
   4. Weight
   5. Composition of Windings (Primary, Secondary)
   6. Wiring Diagram
   7. Percent impedance
   8. Taps
   9. Basic Impulse Level.

K. Acceptable Manufacturers: General Electric; Square D; Cutler-Hammer, Siemens; ACME.

2.15 PANELBOARDS

A. Types: Two-row, bolt-on circuit breaker branch circuit panelboards, and circuit breaker or fusible switch type distribution panelboards, as indicated or required.

B. General: Ratings, mains, mounting and complement of branch overcurrent protective devices as indicated below or on the Drawings.

C. Short Circuit Ratings: Minimum 10,000 amps for 208/120 volt panelboards and 14,000 amps for 480/277 volt panelboards. Provide panelboards with higher ratings as indicated or as required.

D. Enclosures: NEMA-1 for dry locations and NEMA 3R for wet locations (unless indicated otherwise). Provide galvanized steel rough-in box and cover with gray enamel finish Panel fronts are to have a door (circuit breakers) in door (circuit breakers & wiring gutters) in trim with concealed hinges and flush type tumbler lock. All panels shall be keyed alike. Doors in excess of 48" high shall be equipped with a three-point catch and vault handle with integral tumbler lock. Panel shall be dead front, safety type and be multi-section as noted or as necessary to comply with NEC.

E. Bussing: Full capacity Copper, include solid copper ground bus, bonded to enclosure and solid copper neutral bus with lug for each branch circuit

F. Acceptable Manufacturers: General Electric “A Series” and “Spectra Series”; Square D “NQOD,” “NEHB,” “I-Line” and “QMB”; Cutler-Hammer “Pow-R-Line C.”

G. Panelboard Schedules: Refer to the schedules on the Contract Drawings.

2.16 CIRCUIT BREAKERS

A. General: Molded case with thermal and magnetic trips unless indicated otherwise. Minimum 10,000 amps interrupting capacity for 208V and 240V, 14,000 amps interrupting capacity for 480V and higher ratings as indicated or required.

B. For Panelboard Mounting: Bolt-on type.

C. INDIVIDUAL MOTOR CONTROLLERS Manual Motor Starters: Fractional horsepower, single-phase, snap action toggle type which clearly indicates “On,” “Off” and “Trip” positions, with properly sized thermal overload protection, NEMA-1 enclosure (unless indicated otherwise) with handle locking guard, and pilot light.

D. Manual Motor Starter with Relay: Similar to "Manual Motor Starter" above, except two gang with relay sized for load indicated and hand-off-auto switch. Connect relay for 120V operation on load side of starter in "automatic" mode. Coordinate connection of Form C maintained contact for control with mechanical contractor.

E. Magnetic Starters: As scheduled or indicated on the Drawings, and unless indicated otherwise, NEMA rated (IEC rated not acceptable), full voltage, non-reversing type with properly sized overload protection in all phases, low voltage protection or release and external manual reset. Equip each starter with holding coil rated for 120 volts unless otherwise indicated or required; control circuit transformer sized for the number of devices controlled, with dual fused primary and single fused secondary (omit for 120 volt starters); and interlock contacts rated for the coil, unit, or motor controlled. If standard interlock contacts are of insufficient quantity and/or ratings, provide auxiliary contacts or relays.

F. Combination Magnetic Starters: Magnetic starters as specified above, with fusible or non-fused switch as indicated, sized as indicated, with defeatable cover interlock, quick-make, quick-break switching mechanism and padlockable indicating handle.

G. Enclosures: NEMA-1 for indoor application, and NEMA-3R for outdoor application unless indicated otherwise, sized as required to house all components, including any optional accessories.

H. Acceptable Manufacturers: Allen Bradley; General Electric; Square D; Cutler-Hammer; Siemens.

2.17 LIGHTING FIXTURES

A. General:

1. Fixture types as described below or indicated on the Drawings. Lighting fixture manufacturers’ series or catalog numbers listed indicate general quality, type, and style, but may not cover all required design features and details. Provide lighting fixtures having all features, details and accessories as noted in the fixture descriptions. Provide all fittings, hangers, clamps, brackets, yokes, flanges and miscellaneous devices required for a complete installation.
2. Whenever possible, (based upon design requirements) provide lighting fixtures with ballasts provided integral to fixture and prewired.

B. LED Lamps: Minimum 40,000 hours lamp life before 20% loss of output, 3500k interior, 4500K site and parking lot lighting, unless indicate otherwise. Acceptable Manufacturers: Philips, Cree, Luxeon, OSRAM.

C. Site Lighting Fixtures: Include foundations, poles (match campus wide poles), luminaries (match campus wide luminaires – Kim Lighting Curvilinear LED), lamps, drivers and all miscellaneous accessories as indicated or required for a complete assembly. Unless indicated otherwise, foundations to be cast-in-place concrete with constructed forms for square foundations and spirally wrapped treated paper forms for round foundations. Provide concrete as specified in this section or in Division 3, anchor bolts, and reinforcing steel as indicated or required. Provide a 1"x45º chamfer at top of each foundation. Poles to be able to withstand winds of not less than 100 mph without damage to the poles or attached luminaries. Provide pole bases with handholes, handhole covers finished to match the pole finish, and ground lug.

2.18 LIGHTING CONTROL EQUIPMENT

A. Occupancy Sensor Wall Switches: Two-wire (retrofit applications only) or three-wire (new installations), dual technology, employing a temperature compensated dual element sensor and multi-faceted fresnel lens, designed for taking the place of a standard toggle switch, and compatible with solid-state lighting ballasts, rated 120/277VAC 0-800 watts ballast or tungsten, 277VAC 0-1200 watts. Occupancy Sensor Wall Switches (cont.): Adjustments to include auto-off time delay adjustable 5, 15, or 30 minutes with walk through test mode, and adjustable sensitivity. Sensitivity adjustments shall be as follows: PIR-High/Low, Ultrasonic fully adjustable. Controls to include manual-on, manual-off, and automatic-off. Indicators to include red LED to indicate when unit is triggered; Acceptable Manufacturers: Watt Stopper DW-100, or approved equal.

B. Lighting Control Contactors: 277 volt AC (all loads), 30 amp, number of poles lighting contactors as indicated on Drawings. Normally open, mechanically held, 277 volt coil, with "Hand-Off Auto" selector switch, NEMA-3 enclosure with engraved nameplate "LIGHTING CONTROL", interior mounting panel and hinged, lockable cover. Acceptable Manufacturers: Square D, or equal by GE or Westinghouse.

C. Lighting Control Relays: 277 volt AC (all loads), 20 amp, 6-pole (N.O.), magnetically held, 120 volt coil, with "Hand-Off Auto" selector switch, green push-to-test/transformer type interlocked pilot light and NEMA-3R enclosure with engraved nameplate "LIGHTING CONTROL RELAY." Acceptable Manufacturers: Square D Class 8903, Type "L"; or equal by GE, Cutler-Hammer, Siemens.

D. Photoswitches: Raintight, 120 volt or 277 volt as indicated or required, with SPST contacts rated for 2000 watts, with field adjustable light level sensitivity (1-15FC), and time delay. Acceptable Manufacturers: Tork #2100 Series, or approved equal.

E. Time Switches: Two-channel, programmable, astronomic, seven-day digital time switch with 365-day, holiday capability (16 single dates and 5 holiday blocks), and capable of 48 events per channel, per week. Unit to include automatic adjustment for daylight savings switchovers and leap years corrections, manual on-off override control for each channel, 72-hour battery backup, and NEMA-1 metal enclosure. Astronomic feature to be field adjustable for 10º - 60º Northern or Southern latitudes, and selectable to one or both channels, with adjustable 1-99 minute offset from sunrise or sunset. Time switches to be suitable for operation from a 120 or 277 volt power source, as indicated or required. Contacts to be rated 10 amp resistive, 7.5 amp inductive and 1/3 horsepower, at 120 volts AC, and 10 amp resistive at 277 volts AC. Acceptable Manufacturers: Tork #DZS200A Series; or equal by Paragon or Intermatic.

PART 3 – EXECUTION

3.1 GENERAL

A. The installation of all electrical work shall be in accordance with the intent of the Contract Documents, as determined by the Engineer.

B. Installation Requirements: All materials and equipment shall be installed as recommended by the respective manufacturers, by mechanics experienced and skilled in their particular trade, in a neat and workmanlike manner, in accordance with the standards of the trade, and so as not to void any warranty or UL listing.

C. Administration and Supervision: All electrical work shall be performed under the Contractor's direct supervision, using sufficient and qualified personnel as necessary to complete the work in accordance with the progress schedule. The Contractor shall assign one or more competent supervisors who shall have authority to accept and execute orders and instructions, and who shall cooperate with the other Contractors and subcontractors, the Engineer and Owner in all matters to resolve conflicts and avoid delays.

3.2 EXAMINATION

A. Conditions Verification: Examine the areas and conditions under which the work is to be performed, and identify any conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.3 COORDINATION

A. General: Sequence, coordinate and integrate the installation of all electrical materials and equipment for efficient flow of work, in conjunction with the other trades. Review the Drawings for work of the other trades, and report and resolve any discovered discrepancies, prior to commencing work.

B. Cooperation: Cooperate with the other Contractors and individual disciplines for placement, anchorage and accomplishment of the work. Resolve interferences between work of other disciplines or Contractors, prior to commencing installation.

C. Supports and Sleeves: Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

D. Obstacles and Interferences: When installing equipment and raceways, provide offsets, fittings, accessories and changes in elevation or location as necessary to avoid obstacles and interferences, per actual field conditions.

E. Space Requirements: Electrical equipment sizes indicated on drawings are generally based on specified manufacturer. Verify that the proposed equipment will fit in the space indicated on the drawings. Maintain clearances required by NEC.

3.4 DIMENSIONS

A. Building Dimensions: For exact locations of building elements, refer to dimensioned drawings. However, field measurements take precedence over dimensioned drawings.

B. Site Dimensions: Field measurements take precedence over scaled electrical site plans.

C. Limiting Dimensions: Equipment outlines shown on detail drawings of 1/4" = 1'-0" scale or larger and dimensions indicated on the Drawings are limiting dimensions. Do not install equipment exceeding dimensions indicated by outlines on Drawings, or equipment or arrangements that reduce indicated clearances.

D. Establish the exact location of electrical equipment based on the actual field verified dimensions of equipment furnished.

3.5 EQUIPMENT PROTECTION

A. Protect all electrical equipment, and materials and work from the weather elements, paint, mortar, construction debris and damage, until project is substantially complete. Repair, replace, clean all electrical work so affected.

3.6 ELECTRICAL INSTALLATION - GENERAL

A. Dimensions and Clearances: Field measure all dimensions and clearances affecting the installation of electrical work, in relation to established datum, building openings and clearances, and work of other trades, as construction progresses.

B. Rough-In Locations: Verify final locations for rough-ins with field measurements and requirements of actual equipment being installed.

C. Door Swings: Verify the swings of all doors before switch outlets or other electrical devices are installed. If necessary, relocate devices so they are not obstructed by doors when doors are open.

D. Ceiling Mounted Devices: The locations indicated on the architectural reflected ceiling plans take precedence over the electrical documents, in the event of conflict.

E. Install equipment according to manufacturer's written instructions.

F. Install equipment, conduit, cable tray, hangers, and supports to withstand seismic forces for the seismic zone of the installation.

3.7 LAYOUT

A. General: Install electrical systems, materials and equipment level and plumb, and parallel and perpendicular to other building systems and components, where installed exposed.

B. Serviceability: Install electrical equipment and raceways, etc. to readily facilitate servicing, maintenance and repair or replacement of components, and so as to minimize interference with other equipment and installations.

C. Clearances: Prior to commencing work, verify that all electrical equipment will adequately fit and conform to the indicated and code required clearances, in the spaces indicated on the Drawings. If rearrangement is required, submit plan and elevation drawings or sketches indicating proposed rearrangement, for the Engineer's approval. Do not rearrange without express written permission of the Engineer.

3.8 RIGHT-OF-WAY:

A. When laying out electrical work, give priority in available space to steam and condensate lines, sanitary lines, drain lines, fire protection piping and sheet metal duct work. Provide offsets as required to avoid conflicts. Resolve all conflicts before commencing installation.

3.9 MOUNTING HEIGHTS

A. General: Indicated heights are measured from the center of the device outlet box to finished floor or grade, unless indicated otherwise. Request instructions for mounting heights not indicated.

3.10 HOLES, SLEEVES, AND OPENINGS

A. General: Provide all holes, sleeves, and openings required for the completion of Division 26 work and restore all surfaces damaged, to match surrounding surfaces. Maintain integrity of all fire and smoke rated barriers using approved fire stopping systems. When cutting holes or openings, or installing sleeves, do not cut, damage or disturb structural elements or reinforcing steel, unless approved, in writing, by the Project Structural Engineer.

B. Conduit Penetrations: Size core drilled holes so that an annular space of not less than 1/4" and not more than 1" is left around the conduit. When openings are cut in lieu of core drilled, provide sleeve in rough opening. Size sleeves to provide and annular space of not less than 1/4" and not more than 1" around the conduit. Patch around sleeve to match surrounding surfaces.

3.11 FIRESTOPPING SYSTEMS

A. General: Install fire stopping at all electrical raceway and cable penetrations through floor structures and interior walls or partitions which are time-rated fire and/or smoke barriers.

B. Preparation: Prior to installation, verify that all penetrating elements and supporting devices are permanently installed and that surfaces which will be in contact with penetration seal materials are clean and free of dust, dirt, grease, oil, loose materials, rust or other substances.

C. Installation: Install firestop systems in accordance with UL approved design details and the manufacturer's instructions. Install sleeves, conduits and cables with required clearance spaces, allowing installation of sealing materials. Do not exceed the outside diameter of the sleeve, conduit or cable by more than one inch or by less than 1/4" when making openings for penetrations. Install firestop systems so as to completely seal openings to prevent passage of smoke and water.

3.12 CUTTING AND PATCHING

A. General: Provide all cutting, drilling, chasing, fitting and patching necessary for accomplishing the work of Division 26. This includes any and all work necessary to: uncover work to provide for the installation of ill-timed work; remove and replace defective work and work not conforming to the requirements of the Contract Documents; install equipment and materials in existing structures; in addition to that required during the normal course of construction.

B. Comply with the cutting and patching requirements of Division 1.

C. Building Structure: Do not endanger the integrity of the building structure by cutting, drilling or otherwise modifying any structural member, without specific approval. Do not proceed with any structural modifications without written permission of the Project Structural Engineer.

D. Repairs: Repair any and all damage to work of other trades caused by cutting and patching operations, using skilled mechanics of the trades involved.

3.13 WELDING

A. General: Where welding is required, such welding shall be performed in a skilled manner by certified welders. Verify that welds are free from cracks, craters, undercuts, and strikes, weld spatter, and any other surface defects. Clean and re-weld any welds deemed unacceptable in size or configuration. Do not weld to structural steel without prior written permission from the Project Structural Engineer.

3.14 UNDERGROUND ELECTRICAL WORK

A. General: Perform all excavating, trenching and backfilling, etc. as indicated or required for the installation of all underground electrical work. Coordinate work with other trades and verify existing underground services and conditions.

B. Conduit Burial Depth: 30" below finished grade or 6" below bottom of frost line, whichever is deeper, unless indicated otherwise. All excavation and burial depths indicated are below finished grade.

C. Excavating: Do not excavate below required depth, except as necessary for removal of unstable soil or when rock is encountered. When rock is encountered, excavate six inches below the required depth and backfill with a minimum 6" layer of crushed stone or gravel between rock bearing surface and the electrical installation. Stockpile satisfactory excavated materials where directed, until required for backfilling.

Remove and legally dispose of excess excavated materials and materials not suitable for backfill use. Shore and brace as required for stability of excavation. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting off at an elevation of 30" below finished grade.

D. Protection: Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by excavations.

E. Existing Utilities: Remove existing electrical and other utility lines so indicated. Where existing utilities which are to remain exist within areas of excavation, locate such utilities and support and protect during excavation operations.

F. Trenching: Cut all trenches neatly and uniformly and so as to provide ample working room and at least six inches clearance on both sides of raceways, etc., unless otherwise noted. Take necessary precautions when working near existing underground utilities, and coordinate with the installation of concurrent utilities by other trades. Unless indicated otherwise, pitch all electrical conduit runs downward away from buildings, manholes, and pad mounted equipment. Excavate trenches to depth indicated or required. Limit length of open trench to that in which installations can be made and trenches backfilled within the same day.

G. Sand Envelope: Install a minimum envelope of three inches (top, bottom, and sides: three inches each) of fine grain sand around all electrical cables and conduits installed below grade unless indicated otherwise.

H. Preparation for Backfilling: Backfill excavations as promptly as work permits, but not until completion of inspection, testing, approvals, and recording of underground utility locations. Prior to backfilling, remove all concrete form work, shoring, bracing, trash and debris.

I. Backfilling: Use only approved materials free from boulders, sharp objects and other unsuitable materials. Match the final elevations and materials of areas affected by electrical excavating, trenching and backfilling. Replace conduit and cables damaged by improper backfilling. Replace surface materials to match existing surface materials if no other utility or site work is being done in area. Place specified soil materials in 4" - 8" layers to required subgrade elevations, for area classifications as follows:

1. Under Sidewalks: Use combination of subbase materials and excavated or borrowed materials.
2. Under Building Slabs: Use drainage fill materials.
3. Under Piping and Equipment: Use subbase materials where required over rock bearing surfaces and for correction of unauthorized excavation.
4. For Raceways Less Than 30" Below Surface of Paved Areas or Roadways: Provide 4" thick concrete base slab support. After raceway installation, provide 4" thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase. Refer to Contract Documents for Conduit Encased in Concrete Details.

J. Backfill Placement: Place backfill and fill materials in layers of not more than 8" in loose depth for material compacted by heavy equipment, and not more than 4" in loose depth for material compacted by hand-operated tampers. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.

K. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

L. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D1557 and not less than the following percentages of relative density, determined in accordance with ASTM D2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

1. Areas under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive materials and 95 percent relative density for cohesionless materials.
2. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive materials, and 95 percent relative density for cohesionless materials.
3. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive materials, and 90 percent relative density for cohesionless materials.

M. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

N. Subsidence: Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.15 CONCRETE WORK

A. General: All concrete shall be prepared from approved materials and poured on clean, stable surfaces.

B. Exterior Base Surfaces: Twelve-inch layer of crushed stone over well consolidated, stable, undisturbed soil. Where the underlying soil contains excess organic material, trash or voids, or fails to provide solid bearing for any other reason, excavate to the depth required for solid bearing and re-establish the required elevation with approved granular materials.

C. Finishing: Trowel all exposed surfaces smooth. Round-off or chamfer all exposed edges.

D. Curing: Beginning immediately after placement, protect concrete from premature drying, excessive hot or cold temperatures and mechanical injury. Maintain minimal moisture loss at relatively constant temperature throughout period necessary for hydration of cement and hardening of concrete.

3.16 RACEWAY SYSTEMS

A. Raceway Types: Unless indicated otherwise, use raceway types as follows:

1. Indoors, Concealed in Walls or Above Ceilings: Rigid galvanized steel conduit.
2. Indoors, Exposed: Use rigid galvanized steel conduit below ten feet above finished floor.
2. Outdoors, Below Grade: (Minimum 1-inch size). Schedule 40 rigid non-metallic conduit. Stub up using rigid galvanized steel elbows.
3. Outdoors, Exposed: Rigid galvanized steel conduit.
4. Liquid-Tight Flexible Steel Conduit: Use where flexible steel conduit connections are required in damp, wet or oily locations, and for final connections to all motors and similar equipment.

B. Raceway Routing: As required by job conditions unless specific routes or dimensioned positions are indicated on the drawings. Install tight to slabs, beams and joists wherever possible. Route exposed conduit, and conduit installed above ceilings, parallel or perpendicular to walls ceilings and structural members. Install to maintain minimum headroom and to present a neat appearance. Run parallel raceways together with bends made from same center line. Verify exact locations of all raceways, pull boxes, and junction boxes. Resolve any conflicts before installation.

C. Raceway Installation: Cut conduit ends square using saw or pipecutter and ream each cut end smooth. Carefully make all conduit bends and offsets so that the inside diameter of pipe is not reduced. Make bends so that legs are in the same plane. Make offsets so that legs are in the same plane and parallel. Protect stub-ups from damage, and carefully re-bend when necessary.

D. Fittings: Make up all raceway fittings tight so that final installation of raceway, fittings and enclosures constitutes a firm mechanical assembly and a continuous electrical conductor. Where required, provide bonding jumpers to assure electrical continuity.

E. Protection: Protect all raceways, enclosures and equipment during construction to prevent entry of concrete, debris and other foreign matter. Free clogged conduits of all obstructions, or replace, prior to pulling wire. Do not pull wire within buildings until buildings are completely enclosed.

F. Boxes: Install all outlet, pull and junction boxes rigidly, plumb and level. Support and secure boxes independently from conduits terminating at box. Install all boxes so as to be accessible and so that covers may be easily removed.

G. Handholes: Provide as indicated, installed plumb and level. Where not indicated, install every 200’ at a minimum.

H. Conduit Seals: Install conduit seal for each conduit penetrating an exterior building wall below grade (unless penetration is below lowest building floor slab), and elsewhere as indicated, and so as to achieve a sealed watertight installation.

I. Pull Strings: Provide pull strings in all spare conduits.

3.17 CONDUCTORS - 600 VOLT AND BELOW

A. Minimum Conductor Size: All branch circuit wiring shall be minimum #12 AWG. All control circuit wiring shall be minimum #14 AWG, unless indicated otherwise. Provide larger sizes as indicated or required.

B. Branch Circuit Conductor Sizes: Provide branch circuit conductor sizes as indicated on the panelboard schedules, plans, or elsewhere. Neutral conductor size to match phase conductors unless indicated otherwise. Provide branch circuit switch legs and travelers as required for the switching indicated.

C. Equipment Grounding Conductor Required: For each branch circuit and feeder run, provide an equipment grounding conductor for continuous length of run, sized per NEC 250-122 (minimum), larger if so indicated.

D. Feeders: Provide feeder conductor sizes and quantities as indicated.

E. In Raceway: Install all wiring in conduit or other specified raceway, unless indicated otherwise.

F. Terminations: Furnish and install terminations, including lugs if necessary, to make all electrical connections indicated or required. Make connections and terminations for all stranded AWG conductors using crimp, clamp, or box type connectors and terminators. Enclose all strands of stranded conductors in connectors, and lugs.

G. Color: Conductors #10 and smaller shall be factory color-coded by integral pigmentation with a separate color for each phase and neutral. #8 and larger shall have stripes, bands, hash marks or color pressure-sensitive plastic tape. Color code all branch circuit and feeder conductors as follows:

1. 208/120 Volts:

PHASE	**COLOR**
A	Black
B	Red
C	Blue
Neutral	White

2. 480/277 Volts:

PHASE	**COLOR**
A	Brown
B	Orange
C	Yellow
Neutral	Gray

3. Equipment Grounding Conductors: Green

H. Phase Arrangement: Arrange phases in all electrical equipment as follows:

1. A, B, C: Front to Rear.
2. A, B, C: Top to Bottom.
3. A, B, C: Left to Right When Facing Established Front of Equipment.

I. Provide conductors with not less than 90□C rated insulation when branch circuit wiring is attached to high temperature light fixtures (e.g. fluorescent & HID), boilers, incinerators, ovens, ranges, kitchen exhaust fans, other heat-producing equipment, and "100% Rated" overcurrent protective devices. Use special higher temperature wire as required for connection to specialty equipment as required by equipment manufacturer.

3.18 EQUIPMENT CONNECTIONS

A. Connect complete, all equipment requiring electrical connections, furnished as part of this Contract or by others, unless indicated otherwise.

B. Equipment Variations: Note that equipment sizes and capacities as shown on the Contract Documents are for bidding purposes and as such may not be the exact unit actually furnished. Contractor shall anticipate minor variations in equipment and shall include in his Bid all costs required to properly connect the equipment actually furnished.

C. Verification: Obtain and review shop drawings, product data and manufacturer's instructions for equipment furnished by others. Examine actual equipment to verify proper connection locations and requirements.

D. Coordination: Sequence electrical rough-in and final connections to coordinate with installation and start-up schedule and work by other trades.

E. Rough-In: Provide all required conduit, boxes, fittings, wire, connectors and miscellaneous accessories, etc., as necessary to rough in and make final connections to all equipment requiring electrical connections. In general, motors and equipment shall be wired in conduit to a junction box (or safety switch) near the unit, and from there to the unit in flexible metal or liquid-tight flexible steel conduit.

F. Connections: Provide properly sized overload and short circuit protection for all equipment connected, whether furnished under this Contract or by others. Verify proper connections with manufacturer's published diagrams and comply with same. Verify that equipment is ready for electrical connections, wiring and energization, prior to performing same.

G. Control Wiring: Provide all control wiring to remote devices or equipment as indicated or required. Modify equipment control wiring, install or disconnect jumpers, etc., as required.

3.19 HANGERS AND SUPPORTS

A. General: Rigidly support and secure all electrical materials, raceway and equipment to building structure using hangers, supports and fasteners, suitable for the use, materials and loads encountered. Provide all necessary hardware.

B. Overhead Mounting: Attach overhead mounted equipment to structural framework or supporting metal framework. Do not make attachments to steel roofing, steel flooring or ceiling mineral tile.

C. Wall Mounting: Support wall mounted equipment by masonry, concrete block, metal framing or sub-framing.

D. Exterior Walls: Mount all electrical equipment located on the interior of exterior building walls, at least one inch away from wall surface, using suitable spacers.

E. Structural Members: Do not cut, drill or weld any structural member.

F. Independent Support: Do not support electrical materials or equipment from other equipment, piping, ductwork or supports for same.

G. Temporary Conditions: Do not attach to or support electrical work from removable or knockout panels or temporary walls or partitions.

H. Raceway Supports: Rigidly support all raceway with maximum spacings per NEC, and so as to prevent distortion of alignment during pulling operation. Use approved hangers, clamps and straps for individual runs. Do not use perforated straps or tie wires. Where multiple parallel raceways are run together, use trapeze type hanger arrangement made from U-channel and accessories, suspended by threaded rods, and allow at least 25% spare capacity for future installation of additional raceways. Rigidly anchor vertical conduits serving floor-mounted or "island" type equipment mounted away from walls with metal bracket or rigid steel conduit extension secured to floor.

I. Miscellaneous Supports: Provide any additional structural support steel brackets, angles, fasteners and hardware as required to adequately support all electrical materials and equipment.

J. Seismic restraints and supports: Provide as indicated and/or as required per seismic zone indicated.

3.20 ELECTRICAL IDENTIFICATION

A. General: Locate nameplate, marking, or other identification means on outside of equipment or box front covers when above ceilings and when in mechanical or electrical equipment rooms or other unfinished areas, and on inside of front cover when in finished rooms/areas. Use Contract Document designations for identification unless indicated otherwise.

B. Nameplates: Provide nameplate engraved with equipment designation for each safety switch, panelboard, transformer, motor starter, and all other electrical cabinets, etc.

C. Underground Warning Tape: During trench backfilling for each underground electrical, telephone, signal and communications line, provide a continuous underground warning tape located directly above line, at six to eight inches below finished grade.

D. Marking Pen Labeling: Mark each junction and pull box indicating source designation and circuit number(s) for the enclosed conductors.

E. Wire Tags: For power circuits, apply wire tag indicating appropriate circuit or feeder number to each conductor present in distribution panel and panelboard gutters, and to each conductor in pull and junction boxes where more than one feeder or multi-wire branch circuit is present. Where only a single feeder or multi-wire branch circuit is present, box cover labeling and conductor color coding is sufficient. For control, communications and signal circuits, apply wire tag indicating circuit or termination number at all terminations and at all intermediate locations and boxes where more than one circuit is present.

F. Panelboard Circuit Directories: At completion of project, accurately complete each panelboard circuit directory card, identifying load served or "spare" or "space" for each circuit pole. When modifying, adding or deleting circuits at an existing panelboard, update the existing (or provide new) circuit directory card to accurately reflect final conditions.

G. Abandoned Equipment: Label all abandon equipment as "Abandon as of _____." For conduits and conductors include opposite end location.

3.21 ELECTRIC SERVICE

A. General: Arrange with the local electric utility company, and pay all associated costs for providing temporary electric service (if required) and permanent electric service for the project as indicated and required. Comply with and coordinate all requirements of the utility company.

B. Grounding: Provide grounding electrode system for the service, per the NEC and utility company requirements.

3.22 GROUNDING

A. General: Provide all system and equipment grounding as indicated and as required by the NEC.

B. Equipment Grounding: Provide a green equipment grounding conductor, sized per NEC 250-122 (larger if so indicated) with each feeder and branch circuit run.

C. Provide exothermic welded connections where indicated.

3.23 DRY TYPE TRANSFORMERS

A. Mounting: Install outdoor pad mounted transformers on concrete pad as required. .

B. Conduit Connections: Make all conduit connections to transformer cases using sealtight conduit.

C. Ventilation Openings: Do not obstruct transformer ventilation openings.

D. Taps: Set transformer taps for proper secondary voltage.

3.24 PANELBOARDS

A. Secure rough-in boxes to support channel steel framing, independent of conduits. Install with top of cabinet at 7'-0" above floor, but with minimum 8" clearance above floor unless so doing would exceed maximum 6'-6" disconnect height allowed by NEC.

B. Cover all unused overcurrent protective device spaces.

3.25 INDIVIDUAL MOTOR CONTROLLERS

A. General: Make all connections to motors and control equipment complete and verify that equipment is in proper operating order. Connect power to motors for correct direction of rotation. Verify nameplate ratings of all motors. Report any deviations or discrepancies.

B. Overcurrent and Overload Protection: Provide fuses where indicated or required, and overload elements sized in accordance with the ambient temperature, the actual motor nameplate full load amperes, and service factor.

C. Power Wiring: Unless indicated otherwise, provide all required power wiring from indicated power source to each motor controller and from each motor controller to respective motor.

D. Control Wiring: Provide as indicated. Unless indicated otherwise, use No. 14 AWG wire for all control circuits. For circuits longer than 200 feet and for 120 volt motors, use No. 12 AWG wire.

3.26 LIGHTING FIXTURES

A. Lamps and Ballasts: Replace all burned out, defective and inoperative lamps, and all noisy, defective and inoperative ballasts, starters, etc. prior to Owner's acceptance.

3.27 LIGHTING CONTROL EQUIPMENT

A. Occupancy Sensor Wall Switches and Occupancy Sensors: Install sensors in general locations indicated. Adjust exact locations if required to comply with manufacturers recommendations for optimum placement. Make all required line and control wiring connections. Adjust field of views, sensitivities and time delays, and set system configuration selector switches, etc. as indicated, directed or required for optimum control.

B. Lighting Control Contactors: Connect "Auto" position of contactor H-O-A selector switch through photoswitch or other indicated control contacts, and the "HAND" position to override the automatic control.

C. Photoswitches: Adjust sensitivity for proper operation.

3.28 CHECKOUT, TESTING, AND ADJUSTING

A. General: Provide testing equipment, materials, instruments, and personnel to perform all test procedures and adjustments required by the Contract Documents and/or deemed necessary by the Engineer to establish proper performance and installation of electrical systems and equipment. All test instruments to be accurately calibrated and in good working order.

B. Scheduling: Schedule tests at least three days in advance, and so as to allow Engineer and Owner representative(s) to witness the test, unless directed otherwise. Do not schedule tests until the system installation is complete and fully operational, unless indicated or directed otherwise.

C. Manufacturer's Authorized Representatives: For all new and modified systems and equipment, arrange and pay for the services of the manufacturer's authorized representative(s) to be present at time of equipment or system start-up, to supervise the start-up, and to conduct and/or certify all required testing and adjusting.

D. Test Reports: Submit test reports neatly typewritten on 8-1/2" x 11" sheets indicating system or equipment being tested, methodology of testing, date, and time of test, witnesses of test, and test results. Submit test reports in (3) copies to the Engineer for review, within (5) days after test is performed, and include a copy with the appropriate operation and maintenance data.

E. Correction/Replacement: After testing, correct any deficiencies, and replace materials and equipment shown to be defective or unable to perform at design or rated capacity. Retest without additional cost to the Owner or Contract. Submit finalization report indicating corrective measures taken, and satisfactory results of retest.

3.29 SYSTEMS DEMONSTRATION

A. Instruct the Owner's representative(s) in the start-up, operation and maintenance of all electrical systems and equipment in accordance with Division 1, and as requested by the Owner's Representative.

3.30 CLEANING AND TOUCH-UP PAINTING

A. Perform cleaning required by Division 1.

B. General: Periodically remove from the project site, all waste, rubbish and construction debris accumulated from construction operations, and maintain order. The premises shall be left clean and free of any debris and unused construction materials, prior to final acceptance.

C. Electrical Equipment: Remove all dust, dirt, debris, mortar, wire scraps, rust, and other foreign materials from the interior and exterior of all electrical equipment and enclosures, and wipe down. Clean accessible current carrying elements and insulators prior to energizing.

D. Light Fixtures: Thoroughly clean all new or relocated light fixtures and lamps, just prior to final inspection. Fixture enclosures, reflectors, lenses, etc. shall be cleaned free of dust, dirt, fingerprints, etc. by an approved method.

E. Touch-Up Painting: Restore and refinish to original condition, all surfaces of electrical equipment scratched, marred and/or dented during shipping, handling, or installation. Remove all rust, and prime and paint as recommended by the manufacturer.

END OF SECTION