SPC St. Petersburg College

EPI-TECH CENTER

Boiler Replacement

Specifications

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DIVISION 22—PLUMBING

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SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

This Section includes the following:

A. Basic plumbing requirements specifically applicable to Division 22 Sections, in addition to Division 1—General Requirements, General Conditions and Supplementary General Conditions.

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Plumbing demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.

2. CPVC: Chlorinated polyvinyl chloride plastic.

3. PE: Polyethylene plastic.

4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.4 INTENT

A. It is the intention of these specifications and drawings to call for finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

C. The term “Basis of Design” used throughout this document shall be understood to mean a particular manufacturer’s equipment (as scheduled specifically on the drawings or specifications) has been used as the basis by the Design Engineer to establish physical dimensions, quality, and performance required, in addition to providing a basis for interaction with other ancillary components and/or other trades. Therefore, it shall be understood that use of a piece of equipment other than that identified as the Basis of Design may impact performance of an overall engineered system or may require revisions to ancillary interfacing equipment, and thus any manufacturer’s equipment other than that listed as Basis of Design shall require written approval via Addendum prior to bid except where the manufacturer’s name is specifically listed in these specifications as a pre-approved substitute or an accepted manufacturer. All substitutes, pre-approved substitutes, accepted manufacturers, and/or Basis of Design are subject to all requirements of quality, physical characteristics (i.e., dimension, sound, etc), and performance, etc., as set forth in these specifications and contract documents.

1.5 SURVEYS AND MEASUREMENTS

A. Base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work. All material take-offs for the site shall be field measured prior to bids.

1.6 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the contract. Drawings are not to be scaled. The architectural drawings and details shall be examined for exact location of fixtures and equipment. Where they are not definitely located, this information shall be obtained from the Architect.

B. If directed by the Architect or Engineer, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

C. At the time of each shop drawing submission, the Contractor shall call the Engineer's attention (in writing) to, and plainly mark on shop drawings, any deviations from the Contract Documents. (See Paragraph 1.06, B.)

D. Samples, drawings, specifications, and catalogs submitted for approval shall be properly labeled indicating specific service for which material or equipment is to be used, location, section and article number of specifications governing, Contractor's name, and name of job. All equipment shall be labeled to match labeling on contract documents.

E. Catalogs, pamphlets, or other documents submitted to describe items on which approval is being requested, shall be specific and identification in catalog, pamphlet, etc. of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.

F. Approval rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are approved, said approval does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract drawings and specifications.

G. All shop drawings shall be submitted to the A/E by Contractor no later than 30 days from the day of contract award.

H. Failure of the Contractor to submit shop drawings in ample time for checking shall not entitle him to an extension of contract time, and no claim for extension by reason of such default will be allowed.

I. Submit all Division 22 submittals at one time in one integral group. Piece-by-piece submission of individual items will not be acceptable. Engineer may check contents of each submittal set upon initial delivery; if not complete as set forth herein, submittal sets may be returned to Contractor without review and approval and will not be accepted until made complete.

J. Routing and methods of support of piping shall be shown on shop drawings and shall have the review of the Engineer prior to fabrication and installation. Spacing of supports shall be as specified in Section 22 05 29, or if not specified, shall not exceed the suggested maximum spacing recommended in ANSI B31.1 for each type of line. Supports shall be fabricated as detailed on reviewed shop drawings. Provide supports so located that temporary supports are not required during removal of valves or equipment. Insofar as possible, support lines directly from Building structure.

K. At the close of the job, prior to final review, five (5) bound copies of the following shall be submitted by transmittal letter to the Engineer for review and acceptance:

1. Equipment warranties;

2. Contractor's warranty;

3. Parts list and manuals for all equipment;

4. Balance and test readings;

5. Operating instructions (in writing);

6. Written instructions on maintenance and care of the system.

1.7 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.

2. Dielectric fittings.

3. Mechanical sleeve seals.

4. Escutcheons.

B. Welding certificates.

C. Submit Manufacturer's published technical data, catalog cuts, wiring diagrams, shop drawings, samples and testing and balancing logs for all elements of the plumbing work. Submit under provisions of General Conditions and Supplementary General Conditions.

D. No equipment, piping, ductwork or components shall be fabricated, delivered, erected, or connected other than from shop drawings reviewed and approved by the Engineer.

E. It shall be understood that review of shop drawings by the Engineer does not supersede the requirement to provide a complete and functioning system in compliance with the Contract Documents.

F. Equipment Supports: Submit detailed shop drawings indicating equipment weight and dimensions, support material, connections, anchoring, and vibration isolation.

G. Submittals shall include, but not be limited to the following:

1. All equipment; water heaters, plumbing, pumps, etc.

2. Voltage, phase, and amps of each electrical item, such as motors, etc.

3. All auxiliary equipment.

4. Pipe, valves, insulation, etc.

1.8 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

3. Welded pipe joints shall be made by the oxyacetylene or electric process in accordance with the Code of Pressure Piping ASA B31.1.

4. Welding shall be done with good quality modern welding equipment, by competent operators, and in thorough, first class manner, conforming to AWS Standards.

5. The Contractor shall be required to furnish proof of the competency of each welding operator for both field and shop welds and shall at the request of the Architect/Engineer have all or any of such welding operators pass a standard qualification test such as ASME, AWS, or Hartford Insurance Company procedure and tests.

6. Filler-metal for the welding process shall conform to ASTM A233 "Specification for Mild Steel Arc-Welding Electrodes". Classification of electrodes shall be one of the following: E6010, E6015, E7016, E7018.

7. When welding is to be performed, precautionary measures must be taken to prevent fire. Remove flammable materials and debris from the area. Provide an appropriate extinguisher nearby.

8. Pipes shall be cut short and cold sprung into place before welding or fabricating to compensate for expansion of lines when hot.

9. Welds shall be of the single vee butt type. Pipe end shall be shop beveled to 45 degrees to within 1/16 inch of the inside wall surface.

10. The abutting ends of the joints shall be separated before welding to permit complete fusion, tacked in two or more points to maintain alignment, and welded. Welding shall be continuous around the pipe.

11. Welds shall be of sound weld metal, thoroughly fused into the ends of the pipe and to the bottom of the vee, and shall be built up in excess of the pipe wall to give a reinforcement of one-quarter (1/4) the pipe wall thickness and in such a manner that one weld metal will present a gradual increase in thickness from the surface of the pipe to the center of the weld. The minimum width of the weld shall be 2-1/2 times the pipe wall thickness.

12. The fillet welds from the flanges of fittings shall be fused into the pipe and plate for minimum distance of 1-1/2 times the pipe wall thickness and shall be built up to present a minimum throat thickness of depth of weld of 1-1/4 times the pipe wall thickness.

13. Branch connections shall be fabricated by welding. Openings cut into pipe for welded connections shall be accurately made to give carefully matched intersections and welding fittings shall be carefully welded into the pipe system.

14. Welding ells shall be used at all turns in welded pipe lines; no mitered ells will be approved.

15. Where branch piping is three times smaller than the main, branch connections shall be made up with the appropriate manufactured weld-on fitting. Welded tees shall be used for all other branch connections, unless otherwise approved by the Architect/Engineer for a specific case.

    a. Approved Manufacturers

        1) Allied Piping Products.

        2) Bonney Forge.

        3) Branch Connections.

        4) Branchlets.

        5) Tube Turn.

        6) Thread-O-Lets.

16. Welds in piping shall be annealed after welding to remove the welding strains. The temperature need not exceed that causing a dull red, and shall be uniform around the pipe. Welds made in place shall be annealed, but the pipe shall be free to expand and shall be properly supported so as to avoid stresses. Annealing shall always be followed by slow cooling.

D. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.9 SUBSTITUTIONS

A. Materials and equipment are specified herein by a single or by multiple Manufacturers to indicate quality and performance required. The drawings are based upon equipment scheduled on drawings and specified. If another Manufacturer is considered for substitution during the bidding process, the Mechanical Contractor shall be responsible for coordinating all electrical, mechanical, structural, or architectural changes. Comparable equipment Manufacturers which are listed below equipment indicated as “Basis of Design” shall be considered as substitutes. Manufacturers other than the Basis of Design shall submit catalog information and 1/4" scale plan and section drawings showing proper fit and all clearances for maintenance items.

B. Substitutions of other Manufacturer's will be considered for use if, in the Engineers opinion, the item requested for substitution is equal to that specified. The Contractor shall provide to the Engineer a typed comparative list of the basis of design and the proposed substitute. The comparative shall list capacities, pressure drops, horse power, electrical requirements, etc.

Request for approval of substitutions shall be made in writing no less than ten (10) days (unless otherwise directed in Division 1) prior to bid. Substitutions shall not be considered approved unless the approval appears in an Addendum or unless so named in the specifications as a pre-approved substitute. The approval of any substitutions or equals prior to bid shall not be construed as a shop drawing approval. The substitute or equal must be submitted as described in the specifications and meet all the requirements of the specifications and drawings.

C. All requests for substitutions shall be submitted as described in paragraph 1.06, B., and specifically indicate any and all differences or omissions between the product specified as basis of design and the product proposed for substitution. Differences shall include, but shall not be limited to, data as follows for both the specified and substituted products.

1. Principle of operation;

2. Materials of construction or finishes;

3. Thickness or gauge of materials;

4. Weight of item;

5. Deleted features or items;

6. Added features or items;

7. Changes in other Contractor's work caused by the substitution;

8. Physical dimensions;

9. Electrical requirements.

D. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawing, which requires any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the plumbing or electrical, all such redesign, and all new drawings and detailing required therefore, shall be prepared by the Subcontractor at his own expense and submitted to the Architect/Engineer for approval.

E. Where such approved deviation requires quantity and arrangement of piping, wiring, conduit, and equipment from that specified or indicated on the drawings, the Contractor shall furnish and install any such ductwork, piping, structural supports, insulation, motors, starters, electrical wiring and conduit, and any other additional equipment required by the system, at no additional cost to the Owner.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.11 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Give full cooperation to other trades and furnish in writing to the General Contractor, with copies to the Architect, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.

E. When work installed under this Division will be in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer/Architect, prepare composite working drawings and sections at a suitable scale not less than 1/4" = 1'0", clearly showing how work is to be installed in relation to the work of other trades. If the work is installed before coordinating with other trades, or so as to cause any interference with work of other trades, make all the necessary changes in work to correct the condition without extra charge.

F. Furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.12 PROTECTION

A. Protect all work and material provided under this Division from damage. All damaged equipment work or material provided under this Division shall be replaced with new. Re-builts are not acceptable.

B. Protect all work and equipment until inspected, tested, and accepted. Protect work against theft, injury, or damage; and carefully store material and equipment received on site which are not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

1.13 SCAFFOLDING, RIGGING, AND HOISTING

A. Provide all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

1.14 REMOVAL OF RUBBISH

A. This Contractor shall at all times keep premises free from accumulations of waste materials or rubbish caused by his employees or work. At completion of work he shall remove all his tools, scaffolding, materials, and rubbish from the building and site. He shall leave the premises and his work in a clean, orderly, and acceptable condition.

B. All plaster, concrete, cement, etc. shall be removed from all pipe, hangers, and equipment prior to painting and/or concealment.

1.15 SAFETY

A. This Contractor shall comply with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.333), Title 29—Labor, Chapter XIII, Bureau of Standards, Department of Labor, Part 1518—Safety and Health Regulations for Construction; and that his housekeeping and equipment be maintained in such a manner that they comply with the Florida Industrial Commission Safety Code and Regulations of the Federal Williams—Steiger Occupational Safety and Health Act of 1970 (OSHA), wherein it states that the Contractor shall not require any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health and safety.

1.16 SUPERVISION

A. This Contractor shall provide a competent, experienced, full time superintendent who is acceptable to the Architect/Engineer and Owner, and who is authorized to make decisions on behalf of the Contractor.

1.17 LUBRICATION

A. Where necessary, provide means for lubricating all bearings and other machine parts. If a part requiring lubrication is concealed or inaccessible, extend a lubrication tube with suitable fitting to an accessible location and suitably identify it.

B. After installation, properly lubricate all parts requiring lubrication and keep them adequately lubricated until final acceptance by the Owner.

1.18 VALVE CHARTS, TAGS, AND NAMEPLATES

A. Provide at a location designated by the Engineer and the Owner, a valve chart enclosed in an aluminum frame with clear plastic shield. Chart shall show the designated number of each valve, its location and service. Valve numbers shall be same as those shown on the "As-Built" drawings.

B. Each valve shown on the chart shall have a 1-1/2" diameter, 18 gauge brass tag with clearly visible stamped numbers, securely fastened to the valve stem or handle with a heavy brass hook or chain.

C. Each panel mounted switch, thermometer, gauge, or controller for fans, pumps, or other electrically operated equipment shall be clearly designated by a black plastic nameplate of size approved by the Engineer securely fastened with metal pins or screws to the panel directly under the item designated.

D. Refer to Section 22 05 53 for additional information.

1.19 WIRING DIAGRAMS

A. Furnish for use under Division 16 all wiring diagrams as may be required for the installation of the wiring to insure proper operation and control of the equipment provided under this Division. Provide the diagrams in time to avoid delays.

1.20 MATERIAL AND WORKMANSHIP

A. All materials and apparatus required for the work, except as specifically specified otherwise, shall be new, of first-class quality, and shall be furnished, delivered, erected, connected and finished in every detail, and shall be so selected and arranged as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article as approved by the Engineer shall be furnished. Refer to substitutions in this Section.

B. Unless otherwise specifically indicated on the plans or specifications, all equipment and materials shall be installed with the approval of the Architect and Engineer in accordance with the recommendations of the Manufacturer. This includes the performance of such tests as the Manufacturer recommends.

1.21 QUIET OPERATION AND VIBRATION

A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer and the Owner. In case of moving machinery, sound, or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer and the Owner shall be corrected in an approved manner at no additional expense to the Owner. Vibration control shall be by means of approved vibration eliminators in a manner as specified in Section 23 05 48.

1.22 ACCESSIBILITY

A. This Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in double partitions and hung ceilings for the proper installation of his work. He shall cooperate with all other Contractors whose work is in the same space, and shall advise them of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.

B. This Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to, valves, traps, clean-outs, motors, controllers, switchgear, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility.

C. This Contractor shall provide the access panels for concealed mechanical equipment, valves, controls, dampers, or other device requiring service. (Refer to Paragraph 1.24 of this section.)

1.23 FOUNDATIONS, SUPPORTS, PIERS, AND ATTACHMENTS

A. This Contractor shall furnish and install all necessary foundations, supports, pads, bases and piers required for all air conditioning equipment, piping, pumps, tanks, compressors, and for all other equipment furnished under this Division, and shall submit drawings to the Architect and Engineer for approval before purchase, fabrication or construction of same.

B. For pumps, compressors, and other rotating machinery, and for all equipment where foundations are indicated, provide concrete pads as shown. All pads shall be extended six inches (6") beyond machine base in all directions with top edge chamfered. Inset six inch (6") steel dowel rods into floors to anchor pads. All pads shall have a minimum of 6 x 6 W2.9/W2.9 WWF unless otherwise noted. Shop drawings of all foundations and pads shall be submitted to the Architect and Engineer for approval before same are constructed.

C. Construction of foundations, supports, pads, bases, and piers where mounted on the floor, shall be the same materials and same quality of finish as the adjacent and surrounding flooring material.

D. All equipment, unless shown otherwise, shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Architect and the Engineer, not strong enough shall be replaced as directed.

1.24 ACCESS DOORS FOR WALLS AND CEILINGS

A. Provide flush panel access doors with a 16 gauge steel frame and a 14 gauge steel door panel.

B. Finish is to be primed painted steel.

C. Provide concealed hinges which allow the door to open 175 degrees and have a removable pin.

D. Provide access doors with a locked flush mounted vandal proof spanner head operated steel cams.

E. Provide 1-1/2 hour "B" label door for rated chase walls.

F. Furnish masonry anchors for installation in masonry walls and metal lath wings with casing bead for plaster installation.

G. Provide a minimum 2'-0" by 2'-0" access doors unless shown or noted otherwise on the drawings.

H. Access doors for chase walls shall be mounted 16" off the finish floor.

I. Access doors for mechanical equipment shall be a minimum of 12" larger than equipment all around.

1.25 VALVE BOXES

A. All exterior underground valves shall be provided with exterior valve boxes equipped with removable covers appropriately labeled.

B. Valve boxes shall be manufactured of reinforced fiberglass plastic or heavy duty PVC as approved by the Architect/Engineer, unless otherwise noted on the drawings.

1.26 REGULATORY REQUIREMENTS

A. Conform to applicable Codes and Standards as follows:

1. Standard

a. Certain standard materials and installation requirements are described by reference to standard specifications. These standards are as follows:

1) ASA ..... American Standards Association.

2) ASTM..... American Society for Testing Materials.

3) ASME ..... American Society of Mechanical Engineers Code of Unfired Pressure Vessels.

4) NEMA ..... National Electrical Manufacturers Association.

5) UL ..... Underwriters Laboratories.

6) ANSI ..... American National Standards Institute.

7) ASHRAE..... American Society of Heating, Refrigerating and Air Conditioning Engineers.

8) SMACNA ..... Sheet Metal and Air Conditioning Contractor's National Association.

9) AMCA ..... Air Moving and Conditioning Association.

10) ARI..... Air Conditioning and Refrigeration Institute.

11) AMA..... Acoustical Materials Association.

For additional standards and requirements see other sections of the specifications.

Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition at the time project is bid unless otherwise specified herein.

2. Codes And Rules

a. All material furnished and all work installed shall comply with the following codes as they apply to this project:

1) National Electric Code.

2) Regulations of the Florida Industrial Commission Concerning Safety.

3) Applicable County, State and Local Building Codes.

4) Local and State Fire Marshal Rules and Regulations.

5) Occupational Safety and Health Agency Standards (OSHA).

6) Florida State Board of Health Rules and Regulations.

7) Florida Building Code—Mechanical.

8) Chapter 4A-47, Florida Administrative Code - Uniform Fire Safety Standards for Elevators.

9) State Requirements for Educational Facilities (SREF) and Schools, Colleges and Universities, Chapter 4, Section 453 and 468, respectively, of the Florida Building Code.

Applicable codes shall be those adopted by the authority having jurisdiction at the time project is bid.

3. Permits, Fees And Inspections

a. The Contractor shall give all necessary notices, obtain all permits and pay all government fees, sales taxes and other costs, including utility connections or extensions, in connection with this work; file all necessary approvals of all governmental departments having jurisdiction.

b. Obtain all required certificates of inspection for his work and deliver to the Owner/Engineer the same certificates before request for acceptance and final payment for the work.

c. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations.

d. The Contractor shall inform the Engineer of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

1.27 SCOPE OF WORK

A. The scope of the work included under this Division of the Specifications shall include complete plumbing systems as shown on the plans and as specified herein. The General Conditions and Special Conditions of these specifications shall form a part and be included under this Section of the Specifications. Provide all supervision, labor, material, equipment, machinery, plant, and any and all other items necessary to complete the plumbing systems. All items of equipment are specified in the singular; however, provide and install the number of items of equipment as indicated on the drawings, and as required for complete systems.

B. Systems shall include all appurtenances as required to achieve the operating conditions as shown and specified and shall result in a superior installation.

C. Scope of work shall include, but not be limited to, the following:

1. New Work

a. Modify the existing sanitary and roof drainage systems as shown on drawings.

b. Modify existing gas, domestic hot and cold water system as shown on drawings. Provide new water heaters where indicated on drawings.

c. Provide new plumbing fixtures where indicated on drawings.

d. Final connections of piping (domestic and HVAC make-up) to equipment and plumbing fixtures.

D. All electrical work required to support plumbing equipment or is otherwise necessary to operate mechanical equipment, shall be the responsibility of the Plumbing Contractor (including, but not limited to) electrical motors for all motor-operated equipment required under this Division, motor controllers, all starters not provided by the Electrical Contractor (coordinate with Electrical Contractor), pilot lights and relays, line and low voltage control wiring, raceways, connections to switches, and other electrical devices furnished with temperature control systems except as otherwise provided for in other Divisions of this Specification.

E. Any equipment submitted for prior approval shall be submitted with the following written information specifically for the submitted project application: specific model numbers, dimensional data, performance data and other data as requested by the Engineer. General or ambiguous submittals will not be considered for prior approval.

1.28 REMOVALS, RELOCATIONS, RECONNECTIONS, AND RESTORATIONS

A. Demolition of existing piping, equipment, etc., shall be done as indicated on the Drawings. Existing piping and/or equipment to be removed shall be offered to the Owner. If the Owner wishes to utilize the existing equipment elsewhere, this Contractor shall move the equipment to a site designated by the Owner. All material to be removed shall be discarded by the Contractor and they shall not be used again.

B. All demolition work shall be completely coordinated with the Owner. Demolition and reconnections requiring shut-down of existing systems shall be scheduled with the Owner/Engineer. If shut-down can only be accommodated on the weekend, or after normal working hours, such work shall be done at no additional cost to the Owner. If it is not possible to schedule sufficient Owner coordinated and approved downtime to complete the entire demolition and reconnection scope such that all or a part of the facility's service(s) will be disrupted, affecting the normal business operation of the facility (i.e., loss of plumbing), the Contractor shall provide temporary accommodations (i.e., temporary portable toilets, etc), for the duration of the shutdown at no additional cost to the Owner.

C. Location, capacity, size, etc. of existing equipment, piping, etc., was obtained from field survey and as built drawings. Verify all conditions at site prior to commencing with work. Notify Engineer of any discrepancies prior to starting work or ordering material.

D. Survey existing facilities and utilities as necessary to determine location of shut-off or disconnect devices, drains, vents, etc. Drain, refill, and purge existing water piping circuits to make new piping connections. It is the Contractor's responsibility to verify the existing piping and identify which is supply and return, chilled water, and hot water, prior to starting demolition for new piping connections.

E. Temporarily store all items to be relocated, if required. Contractor shall be responsible for safe storage of all such items and shall replace any items lost or damaged during storage removal or reinstallation.

1.29 PROJECT/SITE CONDITION

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Owner/Engineer before proceeding.

1.30 TRENCHING AND BACKFILLING

A. For requirements for trenching and backfilling, refer to specifications.

1.31 CLOSE-OUT DOCUMENTS

A. This Contractor shall furnish Operating and Maintenance (O&M) manuals and As-built drawings before final payment will be issued.

1. O&M manuals shall be submitted in accordance with Division 1, General Requirements, and shall consist of the following (at a minimum):

a. All Contractor and Manufacturer warranties.

b. List of Contractors and Parts and Equipment Suppliers—complete with contact person, proper company name, address, and telephone numbers.

c. Parts list for supplied equipment—including a checklist of recommended components to be stocked on-site.

d. Maintenance and replacement parts manuals.

e. Start-up and shutdown operating instructions.

f. Manufacturer's literature describing the equipment, which shall include wiring diagrams and operating specifications.

g. Control system sequence of operation, system diagram, and backup disks of the system configuration.

h. Copies of final test and balance reports.

2. The Contractor shall provide AutoCAD as-built drawings and copies of each AutoCAD file on CD before final payment will be issued.

1.32 PAINTING

A. Provide painting and touch-up painting of all exposed piping, ductwork, support structures, etc., and all unfinished equipment (concealed or exposed). Refer to Section 15190 for color scheme requirements of pipes and identification markers.

B. Deliver materials to job site in new, original, and unopened containers bearing manufacturer's name, trade name, and label analysis. Store where indicated in accordance with manufacturer's instructions.

C. Do not apply paint in snow, rain, fog or mist or when relative humidity exceeds 85%. Do not apply paint to damp or wet surfaces.

D. Protect work of other trades. Correct any painting related damages by cleaning, repairing, or replacing, and refinishing, as directed by Engineer.

E. Provide finish coats which are compatible with prime paints used. Provide barrier coats over incompatible primers where required. Notify Engineer in writing of anticipated problems using specified coatings with substrate primed by others.

F. Perform preparation and cleaning procedures in strict accordance with coating manufacturer's instructions for each substrate condition.

G. Remove hardware and accessories, machined surfaces, plates, lighting fixtures and similar items in place and not to be finish-painted or provide surface-applied protection. Re-install removed items and remove protective coverings at completion of work.

H. Prepare cementitious surfaces of concrete, concrete block, and similar materials to be painted by removing efflorescence, chalk, dust, dirt, grease and oils, and by roughing to remove glaze. Determine alkalinity and moisture content of surfaces to be painted before beginning painting. Do not paint over surfaces where alkalinity or moisture content exceeds manufacturer's recommendations.

I. Clean ferrous surfaces which are not galvanized or shop-coated. Remove oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning. Touch-up shop-applied prime coats wherever damaged. Clean galvanized surfaces free of oil and surface contaminants with non-petroleum based solvent. Completely paint all welds prior to application of insulation or other protective covering. Non-insulated piping shall be painted entirely.

J. Mix, prepare, and store painting and finishing materials in accordance with manufacturer's directions. Use applicators, and techniques best suited for materials and surfaces to which applied.

K. Application

1. Apply painting and finishing materials in accordance with manufacturer's directions. Use applicators, and techniques best suited for materials and surfaces to which applied.

2. Apply additional coats when undercoats, stains or other conditions show through final paint coat, until paint film is of uniform finish, color, and appearance.

3. Paint interior surfaces of ducts, where visible through registers or grilles, flat, non-specular black.

4. Paint back sides of access panels, and removable or hinges covers to match exposed surfaces. Finish exterior doors on tops, bottoms, and edges same as exterior faces, unless otherwise indicated.

5. Sand lightly between succeeding enamel or varnish coats.

6. Apply prime coat to material which is required to be painted or finished, and which has not been prime coated by others.

7. Apply each material at not less than the manufacturer's recommended spreading rate, to provide a total dry film to thickness of not less than 4.0 mils for an entire coating system of prime and finish coats for 3-coat work.

8. Provide a total dry film thickness of not less than 2.5 mils for entire coating system of prime and finish coat for 2-coat work.

9. Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

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

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.

2. CPVC Piping: ASTM F 493.

3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.

b. Dresser Industries, Inc.; DMD Div.

c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.

d. JCM Industries.

e. Smith-Blair, Inc.

f. Viking Johnson.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.

3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.

4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Available Manufacturers:

a. Eslon Thermoplastics.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Available Manufacturers:

a. Thompson Plastics, Inc.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Available Manufacturers:

a. NIBCO INC.

b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.

b. Fernco, Inc.

c. Mission Rubber Company.

d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

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

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Available Manufacturers:

a. Capitol Manufacturing Co.

b. Central Plastics Company.

c. Eclipse, Inc.

d. Epco Sales, Inc.

e. Hart Industries, International, Inc.

f. Watts Industries, Inc.; Water Products Div.

g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Available Manufacturers:

a. Capitol Manufacturing Co.

b. Central Plastics Company.

c. Epco Sales, Inc.

d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Available Manufacturers:

a. Calpico, Inc.

b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Available Manufacturers:

a. Perfection Corp.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Co., Inc.

d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Plastic. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated and rough brass.

E. One-Piece, Stamped-Steel Type: With spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS—COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type with spring clips.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.

f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.

g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.

h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.

b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.

c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.

d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.

e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with rough-brass finish.

f. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.

g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof 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 above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.

3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

5. PVC Nonpressure Piping: Join according to ASTM D 2855.

6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.

2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION—COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

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

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.10 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

*** END OF SECTION 22 05 00 ***

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Iron ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze lift check valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Chainwheels.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.1 for power piping valves.

3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set angle, gate, and globe valves closed to prevent rattling.

4. Set ball and plug valves open to minimize exposure of functional surfaces.

5. Set butterfly valves closed or slightly open.

6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.

2. Handwheel: For valves other than quarter-turn types.

3. Handlever: For quarter-turn valves NPS 6 and smaller[except plug valves].

4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

2. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.

2. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

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

a. Conbraco Industries, Inc.; Apollo Valves.

b. Hammond Valve.

c. Milwaukee Valve Company.

d. NIBCO INC.

2. Description:

a. Standard: MSS SP-110.

b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.

d. Body Design: Three piece.

e. Body Material: Bronze.

f. Ends: Threaded.

g. Seats: PTFE or TFE.

h. Stem: Stainless steel.

i. Ball: Stainless steel, vented.

j. Port: Full.

2.3 IRON BALL VALVES

A. Class 150, Iron Ball Valves:

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

a. American Valve, Inc.

b. Conbraco Industries, Inc.; Apollo Valves.

c. NIBCO.

d. Sure Flow Equipment Inc.

e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

f. Crane.

g. Grinnell.

h. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-72.

b. CWP Rating: 200 psig.

c. Body Design: Split body.

d. Body Material: ASTM A 126, gray iron.

e. Ends: Flanged.

f. Seats: PTFE or TFE.

g. Stem: Stainless steel.

h. Ball: Stainless steel.

i. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

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

a. Crane.

b. Grinnell.

c. NIBCO INC.

d. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-67, Type I.

b. CWP Rating: 200 psig.

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.

e. Seat: EPDM.

f. Stem: One- or two-piece stainless steel.

g. Disc: Aluminum bronze.

2.5 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

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

a. Crane.

b. Grinnell.

c. NIBCO INC.

d. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-80, Type 1.

b. CWP Rating: 200 psig.

c. Body Design: Vertical flow.

d. Body Material: ASTM B 61 or ASTM B 62, bronze.

e. Ends: Threaded.

f. Disc: Bronze.

2.6 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

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

a. Crane.

b. Grinnell.

c. NIBCO INC.

d. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-80, Type 3.

b. CWP Rating: 300 psig.

c. Body Design: Horizontal flow.

d. Body Material: ASTM B 62, bronze.

e. Ends: Threaded.

f. Disc: Bronze.

2.7 IRON SWING CHECK VALVES

A. Class 250, Iron Swing Check Valves with Metal Seats:

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

a. Crane.

b. Grinnell.

c. NIBCO INC.

d. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-71, Type I.

b. CWP Rating: 500 psig.

c. Body Design: Clear or full waterway.

d. Body Material: ASTM A 126, gray iron with bolted bonnet.

e. Ends: Flanged.

f. Trim: Bronze.

g. Gasket: Asbestos free.

2.8 IRON, CENTER-GUIDED CHECK VALVES

A. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:

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

a. Crane.

b. Grinnell.

c. NIBCO INC.

d. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 400 psig.

c. Body Material: ASTM A 126, gray iron.

d. Style: Compact wafer, spring loaded.

e. Seat: EPDM.

2.9 WATER PRESSURE REDUCING VALVES

A. Up to 2 Inches: Bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, and single union.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

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

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

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for ball, butterfly, gate, globe, and plug valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: With stem upright and plumb.

G. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

H. Install unions downstream of valves and at equipment or apparatus connections.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or butterfly valves.

2. Butterfly Valve Dead-End Service: Single-flange (lug) type.

3. Throttling Service: ball, or butterfly valves.

4. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.

b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.

c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: swing check valves with lever and weight or spring unless otherwise noted on the drawings.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.

2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3. For Steel Piping, NPS 2 and Smaller: Threaded ends.

4. For Steel Piping, NPS 2-1/2 and Larger: Flanged ends.

3.5 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (UP TO 200 PSIG)

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.

2. Ball Valves: Three piece, regular port, bronze with stainless steel trim.

3. Bronze Lift Check Valves: Class 125, bronze disc.

4. Bronze Swing Check Valves: Class 150, bronze disc.

5. Bronze Gate Valves: Class 150, NRS.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.

2. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze disc.

3. Iron, Grooved-End Butterfly Valves: 300 CWP.

4. Iron Swing Check Valves: Class 250, metal seats.

5. Iron, Grooved-End Swing Check Valves: 300 CWP.

6. Iron, Center-Guided Check Valves: Class 250 resilient seat.

7. Iron, Plate-Type Check Valves: Class 250; single plate; resilient seat.

8. Iron Gate Valves: Class 250, NRS.

3.6 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: Threaded ends.

2. Ball Valves: Three piece, full port, bronze with stainless steel trim.

3. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.

2. Iron Ball Valves: Class 150.

3. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.

4. Iron Swing Check Valves: Class 250, metal seats.

5. Iron, Center-Guided Check Valves: Class 250, resilient seat.

*** END OF SECTION 22 05 23 ***

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.
3. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
4. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.

2. Fiberglass pipe hangers.

3. Thermal-hanger shield inserts.

4. Powder-actuated fastener systems.

5. Pipe positioning systems.

B. Shop Drawings: Show fabrication and installation details for the following:

1. Trapeze pipe hangers. Include Product Data for components.

2. Metal framing systems. Include Product Data for components.

3. Fiberglass strut systems. Include Product Data for components.

4. Pipe stands. Include Product Data for components.

5. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

2. AWS D1.2, "Structural Welding Code--Aluminum."

3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."

4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.

2. Empire Industries, Inc.

3. Globe Pipe Hanger Products, Inc.

4. Grinnell Corp.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts. Provide cast iron roll and stand for hot pipe sizes 6" and over.

2.4 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers: Similar to MSS Type 1, steel pipe hanger except hanger is made of fiberglass and continuous-thread rod and nuts are made of stainless steel.

1. Available Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.

b. Champion Fiberglass, Inc.

c. Unistrut Corp.; Tyco International, Ltd.

B. Strap-Type, Fiberglass Pipe Hangers: Made of fiberglass loop with stainless-steel continuous-thread rod, nuts, and support hook.

1. Available Manufacturers:

a. Plasti-Fab, Inc.

2.5 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.

2. GS Metals Corp.

3. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 FIBERGLASS STRUT SYSTEMS

A. Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-3, made of fiberglass channels and other components.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.

2. Champion Fiberglass, Inc.

3. Seasafe, Inc.

2.7 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Available Manufacturers:

1. Carpenter & Paterson, Inc.

2. ERICO/Michigan Hanger Co.

3. PHS Industries, Inc.

C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.

D Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.8 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

a. Hilti, Inc.

b. ITW Ramset/Red Head.

c. Masterset Fastening Systems, Inc.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.

b. Empire Industries, Inc.

c. Hilti, Inc.

2.9 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Floor Support for Hot Pipe Sizes up to 4" and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.

C. Floor Support for Hot Pipe Sizes 6" and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

1. Available Manufacturers:

a. ERICO/Michigan Hanger Co.

b. MIRO Industries.

D. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Available Manufacturers:

a. MIRO Industries.

E. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Available Manufacturers:

a. ERICO/Michigan Hanger Co.

b. MIRO Industries.

c. Portable Pipe Hangers.

2. Base: Stainless steel.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

F. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Available Manufacturers:

a. Portable Pipe Hangers.

2. Bases: One or more plastic.

3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.

5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

G. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.10 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Available Manufacturers:

1. C & S Mfg. Corp.

2. HOLDRITE Corp.; Hubbard Enterprises.

3. Samco Stamping, Inc.

2.11 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.12 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

2.13 WALL SUPPORT FOR PIPE 3" AND UNDER

A. Cast Iron Hook.

2.14 WALL SUPPORT FOR PIPE 4" AND OVER

A. Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll for hot pipe 6" and over.

B. Offset Pipe Clamp: Carbon steel, hot dipped galvanized finish (copper plated for copper pipe) for supporting vertical pipe away from wall.

2.15 HANGER RODS

A. Hanger Rods: Threaded both ends, threaded one end, or continuous threaded. Hanger rods shall be zinc plated steel.

2.16 INSERTS

A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.17 FLASHING

A. Metal Flashing: 22 gage galvanized steel.

B. Lead Flashing: 5 lb/sq.ft. sheet lead for waterproofing; one lb/sq.ft. sheet lead for soundproofing.

C. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

2.18 SLEEVES

The following are the minimum acceptable requirements for this project. Refer to the plans for more stringent methods and requirements.

A. Sleeves for Pipes Through Non-fire Rated Floors: Form with 18 gage galvanized steel, unless otherwise directed on the drawings with a more stringent requirement.

B. Sleeves for Pipes through Non-fire Walls or Footings. Form with steel pipe or 18 gage galvanized steel, unless otherwise directed on the drawings with a more stringent requirement.

C. Sleeves through outside walls shall be made with 18 gauge galvanized steel and fitted with chrome escutcheon covers at all finished surfaces.

D. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Prefabricated fire rated sleeves including seals, UL Listed. Contractor shall submit manufacturer's UL approved methods for firesafing all types required for the project as coordinated with the methods of floor and wall construction. Refer to the plans for further requirements.

E. Sleeves for Round Ductwork: Form with galvanized steel.

F. Sleeves for Rectangular Ductwork: Form with galvanized steel.

G. Caulk: Silicone sealant of top quality.

2.19 FABRICATION

A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

B. Design hangers without disengagement of supported pipe.

C. Provide copper plated hangers and supports for copper piping.

2.20 MATERIAL/FINISH

A. General Locations: Steel pipe hangers, miscellaneous steel supports, hardware, bolts, washers, nuts, screws, etc., not specified to be plated or coated shall be hot dipped galvanized with a minimum of 1.50 oz/ft. on all sides and all field cuts shall be zinc coated.

B. Located In or Around Cooling Tower Yards: Pipe hangers, equipment supports, miscellaneous structure components, hardware, bolts, washers, nuts, screws, etc., shall be non-metallic polyester resin, vinyl ester resin, fiberglass, glass reinforced polyurethane or 316 stainless steel.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Carbon Steel, Adjustable, Swivel Split-Ring Hangers (MSS Type 6): Copper plated for copper pipe, hot dipped galvanized coating on non-copper pipe. For suspension of noninsulated stationary pipes, NPS 1/2" to NPS 2".

2. Carbon Steel, Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 2" to NPS 4" and cold pipe sizes 6" and over. Copper plated for copper pipe, hot dipped galvanized coating on non-copper pipe.

3. Adjustable Steel Yoke-Type Pipe Clamps with Cast Iron Roll, Double Hanger (Hot Dipped Galvanized Coating) (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 6" and over requiring up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

9. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.

10. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.

11. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.

12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

13. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.

14. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

15. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

16. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.

17. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

18. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

19. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

20. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.

    b. Medium (MSS Type 32): 1500 lb.

    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

4. Shield for Insulated Piping 2 Inches and Smaller: 18 gage galvanized steel shield over insulation in 180 degree segments, minimum 12 inches long at pipe support.

5. Shield for Insulated Piping 2-1/2 Inches and Larger (Except Cold Water Piping): Pipe covering protective saddles.

6. Shields for Insulated Cold Water Piping 2-1/2 Inches and Larger: Hard block non-conducting saddles in 90 degree segments, 12 inch minimum length, block thickness same as insulation thickness.

7. Shields for Vertical Copper Pipe Risers: Sheet lead.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.

b. Vertical (MSS Type 55): Mounted vertically.

c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

I. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

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

M. Install lateral bracing with pipe hangers and supports to prevent swaying.

N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

Q. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

    c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

   b. NPS 4: 12 inches long and 0.06 inch thick.

   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

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

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

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

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

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

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7 INSERTS

A. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

B. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

C. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.

3.8 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as follows:

PIPE SIZE (INCHES)	MAXIMUM HANGER SPACING	HANGER ROD DIAMETER
1/2 to 1-1/4	6'-6"	3/8"
1-1/2 to 2	9'-0"	3/8"
2-1/2 to 3	10'-0"	1/2"
4 to 6	10'-0"	3/4"
8 to 12	14'-0"	7/8"
14 to 18	20'-0"	1"
PVC (All Sizes)	4'-0"	3/8"

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place a hanger within 12 inches of each horizontal elbow.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

F. Support vertical piping at every floor and support from wall midway between ceiling and floor or at 12 feet maximum spacing, whichever is less. Support vertical cast iron pipe at each floor and at each hub.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. All auxiliary steel required for pipe supports shall be furnished and installed by this Contractor. Where building structure is not usable for pipe supports, provide steel members, channels, angles, or "UNISTRUT" components for piping support. All auxiliary steel exposed to weather shall be galvanized.

J. Provide all steel required for support of pipes other than steel shown on structural Engineer's drawings.

K. Interior Pipe Guides, Expansion Loops, and Anchors: Provide pipe guides, expansion loops, and anchors on hot water heating pipes installed above the ceiling. Expansion loops shall be installed every 50 feet and supported from building structure with pipe guides on 10 feet spacing. Piping shall be anchored to the structure as necessary for directional expansion control.

3.9 EQUIPMENT BASES AND SUPPORTS

A. Provide equipment bases and supports of concrete type under all mechanical equipment and as shown on drawings.

B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct support of steel members. Brace and fasten with flanges bolted to structure.

D. Provide rigid anchors for pipes after vibration isolation components are installed.

E. Refer to Section 23 05 00, Paragraph 1.19, Foundations, Supports, Piers, Attachments, for additional requirements.

3.10 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash and seal.

C. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with Manufacturer's instructions for sound control.

3.11 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Extend sleeves through floors one inch above finished floor level. Caulk sleeves full depth and provide floor plate.

C. Where piping penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk seal. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

D. Install chrome plated steel escutcheons at finished surfaces.

E. Sleeves installed in exterior walls with exposed ends shall be non-corrosive type sleeves (i.e., stainless steel).

*** END OF SECTION 22 05 29 ***

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

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

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

4. Fasteners: Stainless-steel rivets or self-tapping screws.

5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

2. Letter Color: Comply with ANSI A13.1.

3. Background Color: Comply with ANSI A13.1.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Comply with ANSI A13.1.

C. Background Color: Comply with ANSI A13.1.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.

2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section High-Performance Coatings."

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 20 feet along each run.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Cold Water: 1-1/2 inches.

b. Hot Water: 1-1/2 inches.

c. Low-Pressure Compressed Air: 1-1/2 inches.

d. High-Pressure Compressed Air: 1-1/2 inches.

2. Valve-Tag Color:

a. Cold Water: Natural.

b. Hot Water: Natural.

c. Low-Pressure Compressed Air: Natural.

d. High-Pressure Compressed Air: Natural.

3. Letter Color:

a. Cold Water: Black.

b. Hot Water: Black.

c. Low-Pressure Compressed Air: Black.

d. High-Pressure Compressed Air: Black.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.6 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.7 INSTALLATION

A. Metal Tags: Install with heavy brass hook or chain.

B. Plastic Tape Pipe Markers: Install complete around pipe in accordance with manufacturer's instructions.

C. Equipment: Identify pumps, heat transfer equipment, tanks, and water treatment devices with plastic equipment markers. Small devices, such as in-line pumps, may be identified with metal tags.

D. Controls: Identify control panels and major control components outside panels with plastic equipment tags.

E. Valves: Identify valves in main and branch piping with tags.

F. Piping: Identify piping, concealed or exposed, with plastic pipe markers. Tags may be used on small diameter piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and "T", at each side of penetration of structure or enclosure, and at each obstruction.

G. Provide signage for gas vents to indicate the following: "Warning: Flammable Gas Vent".

3.8 VALVE CHART AND SCHEDULE

A. Provide valve chart and schedule in aluminum frame with clear plastic shield. Install at location as directed.

*** END OF SECTION 22 05 53 ***

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.

2. Encasement for piping.

3. Specialty valves.

4. Flexible connectors.

5. Escutcheons.

6. Sleeves and sleeve seals.

7. Wall penetration systems.

1.3 REFERENCES

A. ANSI/ASME B16.29—Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings—DWV.

B. ANSI/ASTM B32—Solder Metal.

C. ASTM A74—Cast Iron Soil Pipe and Fittings.

D. ASTM A-518—Acid Resistant Close Grained Cast Iron.

E. ASTM B88—Seamless Copper Water Tube.

F. ASTM C564—Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

G. AWWA C601—Standard Methods for the Examination of Water and Waste Water.

1.4 SUBMITTALS

A. Product Data: For the following products:

1. Specialty valves.

2. Transition fittings.

3. Dielectric fittings.

4. Flexible connectors.

5. Escutcheons.

6. Sleeves and sleeve seals.

7. Water penetration systems.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

C. Water Samples: Specified in "Cleaning" Article.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.

C. Comply with NSF 61 for potable domestic water piping and components.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of water service.

2. Do not proceed with interruption of water service without Owner's written permission.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

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

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.

2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

5. Copper Pressure-Seal-Joint Fittings:

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

1) Elkhart Products Corporation; Industrial Division.

2) NIBCO INC.

3) Viega; Plumbing and Heating Systems.

b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.

c. NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

6. Copper Push-on-Joint Fittings:

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

1) NVent LLC.

b. Description: Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22; with stainless-steel teeth and EPDM-rubber O-ring seal in each end instead of solder-joint ends.

7. Copper-Tube Extruded-Tee Connections:

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

1) T-DRILL Industries Inc.

b. Description: Tee formed in copper tube according to ASTM F 2014.

8. Grooved-Joint Copper-Tube Appurtenances:

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

1) Anvil International.

2) Shurjoint Piping Products.

3) Victaulic Company.

b. Copper Grooved-End Fittings: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.

c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

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

1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2. Copper Pressure-Seal-Joint Fittings:

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

1) Elkhart Products Corporation; Industrial Division.

2) NIBCO INC.

3) Viega; Plumbing and Heating Systems.

2. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.

3. NPS 3 and NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.

a. Gaskets: AWWA C111, rubber.

2. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.

a. Gaskets: AWWA C111, rubber.

2.4 CPVC PIPING

A. CPVC Pipe: ASTM F 441/F 441M Schedule 80.

1. CPVC Socket Fittings: ASTM F 439 for Schedule 80.

2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.

B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.

C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

2.5 PVC PIPE AND FITTINGS

A. PVC Pipe: ASTM D 1785, Schedule 40.

1. PVC Socket Fittings: ASTM D 2466 for Schedule 40.

2. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

2.6 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

E. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

1. Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.7 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Form: Sheet.

C. Material: LLDPE film of 0.008-inch minimum thickness or high-density, cross-laminated PE film of 0.004-inch minimum thickness.

D. Color: Black.

2.8 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

C. CPVC Union Ball Valves:

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

a. American Valve, Inc.

b. Asahi/America, Inc.

c. Colonial Engineering, Inc.

d. Fischer, George Inc.

e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.

f. IPEX Inc.

g. NIBCO INC.

h. Sloane, George Fischer, Inc.

i. Spears Manufacturing Company.

j. Thermoplastic Valves Inc.

2. Description:

a. Standard: MSS SP-122.

b. Pressure Rating: 150 psig at 73 deg F.

c. Body Material: CPVC.

d. Body Design: Union type.

e. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.

f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded.

g. Ball: CPVC; full port.

h. Seals: PTFE or EPDM-rubber O-rings.

i. Handle: Tee shaped.

D. PVC Union Ball Valves:

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

a. American Valve, Inc.

b. Asahi/America, Inc.

c. Colonial Engineering, Inc.

d. Fischer, George Inc.

e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.

f. IPEX Inc.

g. Jomar International, LTD.

h. King Bros. Industries.

i. Legend Valve.

j. McDonald, A.Y. Mfg. Co.

k. NIBCO INC.

l. Sloane, George Fischer, Inc.

m. Spears Manufacturing Company.

n. Thermoplastic Valves Inc.

2. Description:

a. Standard: MSS SP-122.

b. Pressure Rating: 150 psig at 73 deg F.

c. Body Material: PVC.

d. Body Design: Union type.

e. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.

f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded.

g. Ball: PVC; full port.

h. Seals: PTFE or EPDM-rubber O-rings.

i. Handle: Tee shaped.

E. CPVC Non-Union Ball Valves:

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

a. American Valve, Inc.

b. Asahi/America, Inc.

c. King Bros. Industries.

d. Legend Valve.

e. NIBCO INC.

f. Spears Manufacturing Company.

g. Thermoplastic Valves Inc.

2. Description:

a. Standard: MSS SP-122.

b. Pressure Rating: 150 psig at 73 deg F.

c. Body Material: CPVC.

d. Body Design: Non-union type.

e. End Connections: Socket or threaded.

f. Ball: CPVC; full or reduced port.

g. Seals: PTFE or EPDM-rubber O-rings.

h. Handle: Tee shaped.

F. PVC Non-Union Ball Valves:

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

a. American Valve, Inc.

b. Asahi/America, Inc.

c. Colonial Engineering, Inc.

d. Hayward Flow Control Systems; Hayward Industrial Products, Inc.

e. IPEX Inc.

f. Jomar International, LTD.

g. King Bros. Industries.

h. Legend Valve.

i. McDonald, A.Y. Mfg. Co.

j. NIBCO INC.

k. Sloane, George Fischer, Inc.

l. Spears Manufacturing Company.

m. Thermoplastic Valves Inc.

2. Description:

a. Standard: MSS SP-122.

b. Pressure Rating: 150 psig at 73 deg F.

c. Body Material: PVC.

d. Body Design: Non-union type.

e. End Connections: Socket or threaded.

f. Ball: PVC; full or reduced port.

g. Seals: PTFE or EPDM-rubber O-rings.

h. Handle: Tee shaped.

G. CPVC Butterfly Valves:

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

a. Fischer, George Inc.

b. Hayward Flow Control Systems; Hayward Industrial Products, Inc.

c. NIBCO INC.

d. Sloane, George Fischer, Inc.

e. Spears Manufacturing Company.

f. Thermoplastic Valves Inc.

2. Description:

a. Pressure Rating: 150 psig at 73 deg F.

b. Body Material: CPVC.

c. Body Design: Lug or wafer type.

d. Seat: EPDM rubber.

e. Seals: PTFE or EPDM-rubber O-rings.

f. Disc: CPVC.

g. Stem: Stainless steel.

h. Handle: Lever.

H. PVC Butterfly Valves:

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

a. American Valve, Inc.

b. Asahi/America, Inc.

c. Colonial Engineering, Inc.

d. Fischer, George Inc.

e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.

f. IPEX Inc.

g. Legend Valve.

h. NIBCO INC.

i. Sloane, George Fischer, Inc.

j. Spears Manufacturing Company.

k. Thermoplastic Valves Inc.

2. Description:

a. Pressure Rating: 150 psig at 73 deg F.

b. Body Material: PVC.

c. Body Design: Lug or wafer type.

d. Seat: EPDM rubber.

e. Seals: PTFE or EPDM-rubber O-rings.

f. Disc: PVC.

g. Stem: Stainless steel.

h. Handle: Lever.

I. CPVC Ball Check Valves:

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

a. American Valve, Inc.

b. Asahi/America, Inc.

c. Colonial Engineering, Inc.

d. Fischer, George Inc.

e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.

f. IPEX Inc.

g. NIBCO INC.

h. Sloane, George Fischer, Inc.

i. Spears Manufacturing Company.

j. Thermoplastic Valves Inc.

2. Description:

a. Pressure Rating: 150 psig at 73 deg F.

b. Body Material: CPVC.

c. Body Design: Union-type ball check.

d. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.

e. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded.

f. Ball: CPVC.

g. Seals: EPDM- or FKM-rubber O-rings.

J. PVC Ball Check Valves:

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

a. American Valve, Inc.

b. Asahi/America, Inc.

c. Colonial Engineering, Inc.

d. Fischer, George Inc.

e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.

f. IPEX Inc.

g. Legend Valve.

h. NIBCO INC.

i. Sloane, George Fischer, Inc.

j. Spears Manufacturing Company.

k. Thermoplastic Valves Inc.

2. Description:

a. Pressure Rating: 150 psig at 73 deg F.

b. Body Material: PVC.

c. Body Design: Union-type ball check.

d. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.

e. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded.

f. Ball: PVC.

g. Seals: EPDM- or FKM-rubber O-rings.

K. CPVC Gate Valves:

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

a. Sloane, George Fischer, Inc.

b. Spears Manufacturing Company.

2. Description:

a. Pressure Rating: 150 psig at 73 deg F.

b. Body Material: CPVC.

c. Body Design: Nonrising stem.

d. End Connections for Valves NPS 2 and Smaller: socket or threaded.

e. End Connections for Valves NPS 2-1/2 to NPS 4: socket or threaded.

f. Gate and Stem: Plastic.

g. Seals: EPDM rubber.

h. Handle: Wheel.

L. PVC Gate Valves:

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

a. Asahi/America, Inc.

b. King Bros. Industries.

c. Sloane, George Fischer, Inc.

d. Spears Manufacturing Company.

2. Description:

a. Pressure Rating: 150 psig at 73 deg F.

b. Body Material: PVC.

c. Body Design: Nonrising stem.

d. End Connections for Valves NPS 2 and Smaller: socket or threaded.

e. End Connections for Valves NPS 2-1/2 to NPS 4: socket or threaded.

f. Gate and Stem: Plastic.

g. Seals: EPDM rubber.

h. Handle: Wheel.

2.9 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.

2. Pressure rating at least equal to pipes to be joined.

3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

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

a. Cascade Waterworks Manufacturing.

b. Dresser, Inc.; Dresser Piping Specialties.

c. Ford Meter Box Company, Inc. (The).

d. JCM Industries.

e. Romac Industries, Inc.

f. Smith-Blair, Inc; a Sensus company.

g. Viking Johnson; c/o Mueller Co.

D. Plastic-to-Metal Transition Fittings:

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

a. Charlotte Pipe and Foundry Company.

b. Harvel Plastics, Inc.

c. Spears Manufacturing Company.

2. Description: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socketend.

E. Plastic-to-Metal Transition Unions:

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

a. Colonial Engineering, Inc.

b. NIBCO INC.

c. Spears Manufacturing Company.

2. Description: CPVC four-part union. Include brass threaded end, solvent-cement-joint, plastic end, rubber O-ring, and union nut.

2.10 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

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

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. EPCO Sales, Inc.

d. Hart Industries International, Inc.

e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

f. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description:

a. Pressure Rating: 150 psig at 180 deg F.

b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. EPCO Sales, Inc.

d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Factory-fabricated, bolted, companion-flange assembly.

b. Pressure Rating: 150 psig.

c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

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

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.

b. Pressure Rating: 150 psig.

c. Gasket: Neoprene or phenolic.

d. Bolt Sleeves: Phenolic or polyethylene.

e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

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

a. Calpico, Inc.

b. Lochinvar Corporation.

2. Description:

a. Galvanized-steel coupling.

b. Pressure Rating: 300 psig at 225 deg F.

c. End Connections: Female threaded.

d. Lining: Inert and noncorrosive, thermoplastic.

F. Dielectric Nipples:

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

a. Perfection Corporation; a subsidiary of American Meter Company.

b. Precision Plumbing Products, Inc.

c. Victaulic Company.

2. Description:

a. Electroplated steel nipple complying with ASTM F 1545.

b. Pressure Rating: 300 psig at 225 deg F.

c. End Connections: Male threaded or grooved.

d. Lining: Inert and noncorrosive, propylene.

2.11 FLEXIBLE CONNECTORS

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

1. Flex-Hose Co., Inc.

2. Flexicraft Industries.

3. Flex Pression, Ltd.

4. Flex-Weld, Inc.

5. Hyspan Precision Products, Inc.

6. Mercer Rubber Co.

7. Metraflex, Inc.

8. Proco Products, Inc.

9. Tozen Corporation.

10. Unaflex, Inc.

11. Universal Metal Hose; a Hyspan company

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.

2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.

3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.

2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.

3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.12 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

2.13 SLEEVES

A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

2.14 SLEEVE SEALS

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

1. Advance Products & Systems, Inc.

2. Calpico, Inc.

3. Metraflex, Inc.

4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2.15 WALL PENETRATION SYSTEMS

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

1. SIGMA.

B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.

1. Carrier-Pipe Deflection: Up to 5 percent without leakage.

2. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.

3. Housing-to-Sleeve Gasket: EPDM rubber.

4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.

5. Pipe Sleeve: ASTM A 53/A 53M, Schedule 40, zinc-coated steel pipe.

2.16 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

H. Install domestic water piping with 0.25 percent slope downward toward drain and plumb.

I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

J. Install seismic restraints on piping. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

N. Install piping adjacent to equipment and specialties to allow service and maintenance.

O. Install piping to permit valve servicing.

P. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

Q. Install piping free of sags and bends.

R. Install fittings for changes in direction and branch connections.

S. Install PEX piping with loop at each change of direction of more than 90 degrees.

T. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

U. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

V. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.

W. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

X. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

Y. Route piping in orderly manner and maintain gradient.

Z. Install piping to conserve building space and not interfere with use of space.

AA. Group piping whenever practical at common elevations.

BB. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

CC. Provide clearance for installation of insulation and access to valves and fittings.

DD. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with General Contractor.

EE. Slope water piping and arrange to drain at low points.

FF. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover, or as existing piping connections require.

GG. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

HH. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.

II. Copper piping installed below grade shall be wrapped with ¾" Armaflex pipe insulation. Seal all edges and seams to prevent moisture intrusion.

JJ. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum. Maintain gradients.

KK. Excavate in accordance with sections on Excavation and Backfill.

LL. Install bell and spigot pipe with bell end upstream.

MM. Install valves with stems upright or horizontal, not inverted.

NN. Install silicon iron waste and vent pipe in accordance with manufacturer's recommendations.

OO. Pipe cold water to both hand mixing valves of sinks and lavatories when only cold water is designated for connection unless otherwise noted on the drawings.

PP. Use grooved mechanical couplings and fasteners only in accessible locations.

QQ. Install unions downstream of valves and at equipment or apparatus connections.

RR. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

SS. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

TT. Install globe valves for throttling, bypass, or manual flow control services.

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

D. Apply appropriate tape or thread compound to external pipe threads.

E. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

F. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

G. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

H. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

I. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

J. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

K. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.

L. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.

M. Steel-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

N. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

O. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

P. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.

Q. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

R. PVC Piping: Join according to ASTM D 2855.

S. PEX Piping Joints: Join according to ASTM F 1807.

T. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.

2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.5 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

C. NPS 1-1/2 and Smaller: Fitting-type coupling.

D. NPS 2 and Larger: Sleeve-type coupling.

E. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump.

B. Install bronze-hose flexible connectors in copper domestic water tubing.

C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.8 WATER METER INSTALLATION

A. Rough-in domestic water piping for water meter installation according to utility company's requirements.

B. Water meters will be furnished and installed by utility company.

C. Install water meters according to AWWA M6, utility company's requirements.

3.9 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.

2. Individual, Straight, Horizontal Piping Runs:

3. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

4. Longer Than 100 Feet. MSS Type 43, adjustable roller hangers.

5. Longer Than 100 Feet. If Indicated: MSS Type 49, spring cushion rolls.

6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

7. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch od.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

G. Install supports for vertical steel piping every 15 feet.

H. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
5. NPS 6: 48 inches with 3/4-inch rod.
6. NPS 8: 48 inches with 7/8-inch rod.

I. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

J. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.

K. Install hangers for vertical PEX piping every 48 inches.

L. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.

2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.

3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.

4. NPS 6: 48 inches with 3/4-inch rod.

5. NPS 8: 48 inches with 7/8-inch rod.

M. Install supports for vertical PVC piping every 48 inches.

N. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.10 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.

2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.

4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.11 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.

2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with rough-brass finish.

5. Bare Piping in Equipment Rooms: One piece, cast brass

6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

C. Escutcheons for Existing Piping:

1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.

2. Insulated Piping: Split plate, stamped steel with concealed hinge and spring clips.

3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.

4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.

5. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with rough-brass finish.

6. Bare Piping in Equipment Rooms: Split casting, cast brass.

7. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

3.12 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.

2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.

    a. Extend sleeves 2 inches above finished floor level.

    b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

3. Sleeves for Piping Passing through Gypsum-Board Partitions:

    a. PVC pipe sleeves for pipes smaller than NPS 6.

    b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.

    c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.

5. Sleeves for Piping Passing through Exterior Concrete Walls:

    a. Steel pipe sleeves for pipes smaller than NPS 6.

    b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.

    c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.

    d. Do not use sleeves when wall penetration systems are used.

6. Sleeves for Piping Passing through Interior Concrete Walls:

a. Steel pipe sleeves for pipes smaller than NPS 6.

b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestop materials and installations.

3.13 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.14 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.15 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

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

3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

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

6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.16 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.

2. Open shutoff valves to fully open position.

3. Open throttling valves to proper setting.

4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.

b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

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

3.17 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

b. Fill and isolate system according to either of the following:

1. Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.

2. Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.18. PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be the following:

1. Soft copper tube, ASTM B 88, Type K, wrought copper solder joint and brazed joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be the following:

1. Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.

F. Under-building slab, combined domestic water, building-service, and fire-service-main piping, or domestic water piping, NPS 6 to NPS 12, shall be the following:

1. Mechanical-joint, ductile-iron pipe; standard-pattern mechanical-joint fittings; and mechanical joints.

G. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:

1. Soft copper tube, ASTM B 88, Type K, ASTM B 88M, Type B; wrought-copper solder-joint fittings; and brazed fittings; and pressure-sealed joints.

H. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type L copper solder-joint fittings; and soldered joints.

I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:

1. Hard copper tube, ASTM B 88, Type L copper solder-joint fittings; and soldered joints.

J. Aboveground domestic water piping, NPS 5 to NPS 8, shall be the following:

1. Hard copper tube, ASTM B 88, Type L copper solder-joint fittings; and soldered joints.

K. Aboveground, combined domestic-water-service and fire-service-main piping, NPS 6 to NPS 12, shall be the following:

1. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

3.19 VALVE SCHEDULE

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

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.

2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.

3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.

4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

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SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose stations.
9. Hose bibbs.
10. Wall hydrants.
11. Ground hydrants.
12. Post hydrants.
13. Drain valves.
14. Water hammer arresters.
15. Air vents.
16. Trap-seal primer valves.
17. Trap-seal primer systems.

B. Related Sections include the following:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.

2. Division 22 Section "Domestic Water Piping" for water meters.

3. Division 22 Section "Domestic Water Filtration Equipment" for water filters in domestic water piping.

4. Division 22 Section "Healthcare Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.

5. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.

6. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

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

1. Vacuum breakers.

2. Backflow preventers.

3. Water pressure-reducing valves.

4. Balancing valves.

5. Temperature-actuated water mixing valves.

6. Water hammer arresters.

7. Air vents.

8. Trap-seal primer valves.

9. Trap-seal primer systems.

B. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.

2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

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

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

a. Watts Industries, Inc.; Water Products Div.

b. Zurn Plumbing Products Group; Wilkins Div.

3. Standard: ASSE 1001.

4. Size: NPS 1/4 to NPS 3, as required to match connected piping.

5. Body: Bronze.

6. Inlet and Outlet Connections: Threaded.

7. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

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

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

a. Watts Industries, Inc.; Water Products Div.

b. Woodford Manufacturing Company.

c. Zurn Plumbing Products Group; Light Commercial Operation.

d. Zurn Plumbing Products Group; Wilkins Div.

3. Standard: ASSE 1011.

4. Body: Bronze, nonremovable, with manual drain.

5. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.

6. Finish: Chrome or nickel plated.

C. Laboratory-Faucet Vacuum Breakers:

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

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

a. Watts Industries, Inc.; Water Products Div.

b. Woodford Manufacturing Company.

c. Zurn Plumbing Products Group; Wilkins Div.

3. Standard: ASSE 1035.

4. Size: NPS 1/4 or NPS 3/8 matching faucet size.

5. Body: Bronze.

6. End Connections: Threaded.

7. Finish: Chrome plated.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

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

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

3. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

a. Flomatic Corporation.

b. Watts Industries, Inc.; Water Products Div.

c. Zurn Plumbing Products Group; Wilkins Div.

4. Standard: ASSE 1013.

5. Operation: Continuous-pressure applications.

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

7. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.

8. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

9. Configuration: Designed for horizontal, straight through flow. ANSI/ASSE 1013; bronze body with bronze and plastic internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve which opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

10. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

    b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators for Water Piping Less Than 1":

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

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

    a. Honeywell Water Controls.

    b. Watts Industries, Inc.; Water Products Div.

    c. Zurn Plumbing Products Group; Wilkins Div.

3. Standard: ASSE 1003.

4. Pressure Rating: Initial working pressure of 150 psig.

5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.

6. Include integral thermal expansion bypass.

7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

8. Include stainless steel integral strainer, renewable stainless steel seat, high temperature diaphragm, and 160# gauge and tapping.

B. Water Control Valves for Water Piping 1" and Greater:

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

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

3. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

a. Watts Industries, Inc.; Ames Fluid Control Systems.

b. Watts Industries, Inc.; Watts ACV.

c. Zurn Plumbing Products Group; Wilkins Div.

4. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with integral thermal expansion bypass.

5. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.

6. Main Valve Body: Bronze body with AWWA C550 or FDA-approved, interior epoxy coating.

a. Pattern: Globe-valve design.

b. Trim: Stainless steel.

7. Include stainless steel integral strainer, renewable stainless steel seat, high temperature diaphragm, and 160# gauge and tapping.

2.4 BALANCING VALVES

A. Memory-Stop Balancing Valves:

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

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

a. Crane Co.; Crane Valve Group; Crane Valves.

b. Hammond Valve.

c. Milwaukee Valve Company.

d. NIBCO INC.

e. Red-White Valve Corp.

3. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.

4. Pressure Rating: 400-psig minimum CWP.

5. Size: NPS 2 or smaller.

6. Body: Copper alloy.

7. Port: Standard or full port.

8. Ball: Chrome-plated brass.

9. Seats and Seals: Replaceable.

10. End Connections: Solder joint or threaded.

11. Handle: Vinyl-covered steel with memory-setting device.

2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves:

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

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

3. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

a. Armstrong International, Inc.

b. Lawler Manufacturing Company, Inc.

c. Leonard Valve Company.

d. Powers; a Watts Industries Co.

e. Symmons Industries, Inc.

4. Standard: ASSE 1017.

5. Pressure Rating: 125 psig.

6. Type: Cabinet-type, thermostatically controlled water mixing valve.

7. Material: Bronze body with corrosion-resistant interior components.

8. Connections: Threaded union inlets and outlet.

9. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

10. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.

11. Valve Finish: Rough bronze.

12. Piping Finish: Copper.

13. Cabinet: Factory-fabricated, stainless steel, for surface mounting and with hinged, stainless-steel door.

B. Individual-Fixture, Water Tempering Valves:

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

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

a. Leonard Valve Company.

b. Powers; a Watts Industries Co.

c. Watts Industries, Inc.; Water Products Div.

d. Zurn Plumbing Products Group; Wilkins Div.

3. Standard: ASSE 1016, thermostatically controlled water tempering valve.

4. Pressure Rating: 125 psig minimum, unless otherwise indicated.

5. Body: Bronze body with corrosion-resistant interior components.

6. Temperature Control: Adjustable.

7. Inlets and Outlet: Threaded.

8. Finish: Rough or chrome-plated bronze.

2.6 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

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

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

   a. Josam Company.

   b. Sioux Chief Manufacturing Company, Inc.

   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

   d. Watts Drainage Products Inc.

   e. Zurn Plumbing Products Group; Specification Drainage Operation.

3. Standard: ASSE 1010 or PDI-WH 201.

4. Type: Metal bellows or copper tube with piston.

5. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.7 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.

2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.

3. Float: Replaceable, corrosion-resistant metal.

4. Mechanism and Seat: Stainless steel.

5. Size: NPS 3/8 minimum inlet.

6. Inlet and Vent Outlet End Connections: Threaded.

2.8 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

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

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

   a. Sioux Chief Manufacturing Company, Inc.

   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

   c. Watts Industries, Inc.; Water Products Div.

3. Standard: ASSE 1018.

4. Pressure Rating: 125 psig minimum.

5. Body: Bronze.

6. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.

7. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.

8. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Valves:

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

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

a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

3. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.

4. Size: NPS 1-1/4 minimum.

5. Material: Chrome-plated, cast brass.

2.9 THERMOMETERS

A. Provide thermometers with needle type shut-off valves. They shall be installed so that they can be clearly read from the floor.

B. Industrial stem thermometers shall have a scale not less than 9" long and shall be red-reading mercury type with white background and black etched graduations and numerals.

C. Thermometers shall be suitable for the service intended and the range shall be selected to span from approximately 10 degrees below through 10 degrees above the operating range of the fluid.

D. Thermometers shall have a guaranteed accuracy of within 1% of the range scale and shall be provided with 1 degree graduations. Thermometers shall be provided with brass separable socket wells.

E. Provide thermometer wells and necessary fittings where specified or indicated. Wells installed in insulated piping shall be provided with lagging extensions of appropriate length to accommodate insulation. Where wells are provided without thermometers or thermostats, a plug and chain shall be provided. The insertion length of wells shall be compatible with the pipe diameter in which they are installed. Wells shall be provided with graphite mixture.

F. Thermometers shall be as manufactured by Weksler, Marsh Instruments, or Ametek.

2.10 ESCUTCHEONS

A. Chrome plated or stainless steel with set screws for holding securely in place.

2.11 DIELECTRIC FITTINGS

A. Metal parts of union or flange shall be installed to prevent current flow between dissimilar metals. EPCO Dielectric pipe fittings or equivalent.

2.12 VENT FLASHING

A. 16 ounce copper or 4 pound lead flashing and counter flashing.

2.13 T&P RELIEF VALVES

A. Valve shall have bronze body, non-mechanical seat-to-disc alignment and shall have a stainless steel thermostat.

B. Valve shall contain an emergency back-up fusible plug.

C. The valves shall be sized on the AGA temperature steam rating.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.

3. Do not install bypass piping around backflow preventers.

C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

D. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

E. Install balancing valves in locations where they can easily be adjusted.

F. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install thermometers and water regulators if specified.

2. Install cabinet-type units recessed in or surface mounted on wall as specified.

G. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve and pump.

H. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

I. Install water hammer arresters in water piping according to PDI-WH 201.

J. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

K. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

L. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Reduced-pressure-principle backflow preventers.

2. Water pressure-reducing valves.

3. Primary, thermostatic, water mixing valves.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 PREPARATION

A. Coordinate forming of roof and floor construction to receive drains to required invert elevations.

3.5 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer's instructions to permit intended performance.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install water hammer arresters complete with isolation valve. The water hammer arresters and isolation valve shall be installed in a location accessible through the ceiling. Provide access doors as necessary. Coordinate location of access doors with Architect/Engineer and other trades. Access door shall be sized to allow removal and replacement of concealed device or equipment.

E. Locate trap primer under lavatory on CW supply and/or flush valve as per manufacturer’s recommendations.

F. Use escutcheons on pipes passing through walls, floors, and ceilings of finished areas.

G. Seal all openings in sleeves for piping penetrations with UL listed caulk. Refer to detail on drawings.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each reduced-pressure-principle according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.7 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

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SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:

1. Pipe, tube, and fittings.

2. Special pipe fittings.

3. Encasement for underground metal piping.

B. Related Sections include the following:

1. Division 22 Section "Sanitary Sewerage Pumps."

2. Division 22 Section "Chemical Waste-Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.4 REFERENCES

A. ANSI/ASME B16.29—Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings—DWV.

B. ANSI/ASTM B32—Solder Metal.

C. ASTM A74—Cast Iron Soil Pipe and Fittings.

D. ASTM A-518—Acid Resistant Close Grained Cast Iron.

E. ASTM B88—Seamless Copper Water Tube.

F. ASTM C564—Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

G. AWWA C601—Standard Methods for the Examination of Water and Waste Water.

1.5 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

2. Sanitary Sewer, Force-Main Piping: 50 psig .

1.6 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

C. Shop Drawings:

1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.

2. Sovent Drainage System: Include plans, elevations, sections, and details.

D. Field quality-control inspection and test reports.

1.7 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. An other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. Shielded Couplings: ASTMC, 1277 assembly of metal shield on housing, corrosion resistant fasteners, and rubber sleeve with integral center pipe stop.

1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

a. Manufacturers:

1) ANACO.

2) Clamp-All Corp.

3) Ideal Div.; Stant Corp.

4) Mission Rubber Co.

5) Tyler Pipe; Soil Pipe Div.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

B Solvent Cement and Adhesive Primer:

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 SILICON IRON WASTE AND VENT PIPE (SCIENCE CLASSROOM WASTE SYSTEM)

A. Pipe (under floor)—Close Grained Cast Iron Pipe—ASTM A-518. Joints: Bell and Spigot.

B. Pipe (above grade)—Close Grained Cast Iron Pipe—ASTM A-518. Joints: Mechanical.

C. Joints:

1. Bell and Spigot: Acid resistant rope packing equal to Sealite Acid-Resistant Red Stripe No. 312. Caulk by hand.

2. Mechanical Joint: Durco Type MJ mechanical coupling with continuous, one-piece, sintered, non-porous, PFTE liner.

D. Pipe and fittings shall be as manufactured by Duriron or approved equal.

E. Polypropylene, PVC, and other plastic pipe may be used as an accepted product subject to the following:

1. It should not be used to transport hot water or installed in return air plenums.

2. Piping used for laboratory acid waste disposal shall be Schedule 40 Polypropylene meeting Underwriters Laboratories certification of V-2 when tested under UL Subject 94 in thickness of O.150 and over, and meeting ASTM D635, and when appropriate ASTM D2843. Piping shall be manufactured from polypropylene material conforming to ASTM D4101.

a. For above slab piping provide flame resistant mechanical joint connections. Following products are approved, subject to compliance with above:

1) Orion – Blueline.

2) Enfield - Acid Waste Piping.

3) G.S.R. Sloane - Fuseal II.

3. For beneath ground piping, following products with heat socket fusion or coil resistant fusion, are approved, subject to compliance with pertinent portions of paragraph B:

a. Orion – Brownline.

b. Enfield - Acid Waste Piping.

c. G.S.R. Sloane - Fuseal II.

F. "Glass Piping" for acid waste chains only shall be accepted subject to the following:

1. No "glass piping" for acid waste drains shall be installed beneath concrete slabs-on-grade nor within frame wall thickness nor within masonry wall thickness. Such may occur only in cabinet work or within accessible plumbing chases.

2. Following "glass pipe" products are approved subject to use of stainless steel mechanically bolted couplings and the piping shall be installed per the manufacturer's recommendations.

a. KIMAX - Schott Process Systems, Inc.

PART 3 EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Aboveground, soil and waste piping NPS 5 and larger shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Aboveground, vent piping NPS 4 and smaller shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

E. Aboveground, vent piping NPS 5 and larger shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:

1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

G. Underground, soil and waste piping NPS 5 and larger shall be the following:

1. Solid-wall, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.

H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be the following:

1. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.

2. Steel pipe, pressure fittings, and threaded joints.

I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be the following:

1. Hard copper tube, Type L (Type B); wrought copper pressure fittings; and soldered joints.

2. Steel pipe, pressure fittings, and threaded joints.

3. Grooved-end steel pipe, grooved-joint system fittings and couplings, and grooved joints.

J. Underground sanitary-sewage force mains NPS 4 and smaller shall be the following:

1. Hard copper tube, Type L (Type B); wrought copper pressure fittings; and soldered joints.

K. Underground sanitary-sewage force mains NPS 5 and larger shall be the following:

1. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical-joint joints.

L. Underground sanitary-sewage for dishwashers (first 20 feet):

1. Cast iron pipe and fittings; Joints: No hub pipe and fittings with ASTM C1277, CISPI-310 heavy-duty, double banded couplings.

3.3 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

E. Install underground, steel, force-main piping. Install encasement on piping according to ASTM A 674 or AWWA C105.

F. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside the building between wall and floor penetrations and connection to sanitary sewer piping outside the building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Install encasement on piping according to ASTM A 674 or AWWA C105.

G. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

1. Install encasement on piping according to ASTM A 674 or AWWA C105.

H. Install underground, ductile-iron, special pipe fittings according to AWWA C600.

1. Install encasement on piping according to ASTM A 674 or AWWA C105.

I. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

J. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

K. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

L. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

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

N. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.

3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

O. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.

3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

P. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

Q. Install ABS soil and waste drainage and vent piping according to ASTM D 2661.

R. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

S. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

U. Route piping in orderly manner and maintain gradient.

V. Install piping to conserve building space and not interfere with use of space.

W. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover, or as existing piping connections require.

X. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum. Maintain gradients.

Y. Excavate in accordance with sections on Excavation and Backfill.

Z. Install bell and spigot pipe with bell end upstream.

AA. Install silicon iron waste and vent pipe in accordance with manufacturer's recommendations.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

D. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

E. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

F. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

G. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.

C. Install gate or full-port ball valve for piping NPS 2 and smaller.

D. Install gate valve for piping NPS 2-1/2 and larger.

E. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

F. Backwater Valves: Install backwater valves in piping subject to sewage backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.

2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.

3. Install backwater valves in accessible locations.

4. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.

2. Install individual, straight, horizontal piping runs according to the following:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

b. Longer Than 100 Feet : MSS Type 43, adjustable roller hangers.

c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Plumbing Piping and Equipment."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.

2. NPS 3: 60 inches with 1/2-inch rod.

3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

4. NPS 6: 60 inches with 3/4-inch rod.

5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

G. Install supports for vertical cast-iron soil piping every 15 feet .

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.

2. NPS 1-1/2: 108 inches with 3/8-inch rod.

3. NPS 2: 10 feet with 3/8-inch rod.

4. NPS 2-1/2: 11 feet with 1/2-inch rod.

5. NPS 3: 12 feet with 1/2-inch rod.

6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

7. NPS 6: 12 feet with 3/4-inch rod.

8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 84 inches with 3/8-inch rod.

2. NPS 3: 96 inches with 1/2-inch rod.

3. NPS 4: 108 inches with 1/2-inch rod.

4. NPS 6: 10 feet with 5/8-inch rod.

K. Install supports for vertical stainless-steel piping every 10 feet.

L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.

2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

3. NPS 2-1/2: 108 inches with 1/2-inch rod.

4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

5. NPS 6: 10 feet with 5/8-inch rod.

6. NPS 8: 10 feet with 3/4-inch rod.

M. Install supports for vertical copper tubing every 10 feet.

N. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.

2. NPS 3: 48 inches with 1/2-inch rod.

3. NPS 4 and 5: 48 inches with 5/8-inch rod.

4. NPS 6: 48 inches with 3/4-inch rod.

5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.

6. Install supports for vertical PVC piping every 48 inches.

O. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main or sanitary manhole.

2. Sewage Pumps: To sewage pump discharge.

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

1. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

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

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

4. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

5. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

6. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

7. Prepare reports for tests and required corrective action.

D. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

3.9 CLEANING

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

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

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PROTECTION

A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

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SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Trench drains.
5. Channel drainage systems.
6. Air-admittance valves.
7. Roof flashing assemblies.
8. Through-penetration firestop assemblies.
9. Miscellaneous sanitary drainage piping specialties.
10. Flashing materials.
11. FOG disposal systems.
12. Grease interceptors.
13. Grease removal devices.
14. Oil interceptors.
15. Solids interceptors.

B. Related Sections include the following:

1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
2. Division 22 Section "Plumbing Fixtures" for hair interceptors.
3. Division 22 Section "Healthcare Plumbing Fixtures" for plaster sink interceptors.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1. Boiler water valves.

2. Grease interceptors.

3. Air admittance valves.

4. Oil interceptors.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

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

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

3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. Josam Company; Josam Div.

    b. Watts Drainage Products Inc.

    c. Zurn Plumbing Products Group; Specification Drainage Operation.

4. Standard: ASME A112.14.1.

5. Size: Same as connected piping.

6. Body: Cast iron.

7. Cover: Cast iron with bolted access check valve.

8. End Connections: Hub and spigot or hubless.

9. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.

10. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

1. 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:

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

    a. Josam Company; Josam Div.

    b. Watts Drainage Products Inc.

    c. Zurn Plumbing Products Group; Specification Drainage Operation.

3. Size: Same as floor drain outlet.

4. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.

5. Check Valve: Removable ball float.

6. Inlet: Threaded.

7. Outlet: Threaded or spigot.

C. Horizontal, Plastic Backwater Valves:

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

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

a. Plastic Oddities; a division of Diverse Corporate Technologies.

b. Sioux Chief Manufacturing Company, Inc.

c. Zurn Plumbing Products Group; Light Commercial Operation.

3. Size: Same as connected piping.

4. Body: PVC.

5. Cover: Same material as body with threaded access to check valve.

6. Check Valve: Removable swing check.

7. End Connections: Socket type.

2.2 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

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

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

a. Oatey.

b. ProSet Systems Inc.

c. RectorSeal.

d. Studor, Inc.

3. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.

4. Housing: Plastic.

5. Operation: Mechanical sealing diaphragm.

6. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

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

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

a. Durgo, Inc.

b. Oatey.

c. Studor, Inc.

3. Standard: ASSE 1050 for vent stacks.

4. Housing: Plastic.

5. Operation: Mechanical sealing diaphragm.

6. Size: Same as connected stack vent or vent stack.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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

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

3. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

a. Acorn Engineering Company; Elmdor/Stoneman Div.

b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.

2. Low-Silhouette Vent Cap: With vandal-proof vent cap.

3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

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

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

   a. ProSet Systems Inc.

3. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.

4. Size: Same as connected soil, waste, or vent stack.

5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

6. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

2.5 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.

2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.

3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft. thickness.

2. Vent Pipe Flashing: 8 oz./sq. ft. thickness.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.

2. Locate at each change in direction of piping greater than 45 degrees.

3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

4. Locate at base of each vertical soil and waste stack.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

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

F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.

2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.

b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.

c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

G. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

H. Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.

I. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

J. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

K. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

L. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

M. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

N. Assemble open drain fittings and install with top of hub 1 inch above floor.

O. Install deep-seal traps on floor drains and other waste outlets, if indicated.

P. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.

2. Size: Same as floor drain inlet.

Q. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

R. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

S. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

T. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.

2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.

3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.

4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

U. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain with Division 23 Section "Facility Fuel-Oil Piping."

V. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

W. Install wood-blocking reinforcement for wall-mounting-type specialties.

X. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

Y. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.

D. Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.

3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

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

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

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

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

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

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

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

3.6 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer's instructions to permit intended performance.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Use escutcheons on pipes passing through walls, floors, and ceilings of finished areas.

E. Seal all openings in sleeves for piping penetrations with UL listed caulk. Refer to detail on drawings.

*** END OF SECTION 22 13 19 ***

SECTION 22 16 16

NATURAL GAS PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Mechanical sleeve seals.
7. Grout.
8. Concrete bases.

1.3 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, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 100 psig minimum unless otherwise indicated.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.

2. Corrugated, stainless-steel tubing with associated components.

3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.

4. Pressure regulators. Indicate pressure ratings and capacities.

5. Dielectric fittings.

6. Mechanical sleeve seals.

7. Escutcheons.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot (1:50).

2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.

C. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

D. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

E. Qualification Data: For qualified professional engineer.

F. Welding certificates.

G. Field quality-control reports.

H. Operation and Maintenance Data: For motorized gas valves and pressure regulators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.

2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.

2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.

3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.

    b. End Connections: Threaded or butt welding to match pipe.

    c. Lapped Face: Not permitted underground.

    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.

    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

6. Mechanical Couplings:

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

        1) Dresser Piping Specialties; Division of Dresser, Inc.

        2) Smith-Blair, Inc.

    b. Steel flanges and tube with epoxy finish.

    c. Buna-nitrile seals.

    d. Steel bolts, washers, and nuts.

    e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

    f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

B. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.

2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.

b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.

c. Aboveground Portion: PE transition fitting.

d. Outlet shall be threaded or flanged or suitable for welded connection.

e. Tracer wire connection.

f. Ultraviolet shield.

g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

4. Transition Service-Line Risers: Factory fabricated and leak tested.

a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.

b. Outlet shall be threaded or flanged or suitable for welded connection.

c. Bridging sleeve over mechanical coupling.

d. Factory-connected anode.

e. Tracer wire connection.

f. Ultraviolet shield.

g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.

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

1) Lyall, R. W. & Company, Inc.

2) Mueller Co.; Gas Products Div.

3) Perfection Corporation; a subsidiary of American Meter Company.

b. PE body with molded-in, stainless-steel support ring.

c. Buna-nitrile seals.

d. Acetal collets.

e. Electro-zinc-plated steel stiffener.

6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

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

        1) Lyall, R. W. & Company, Inc.

        2) Mueller Co.; Gas Products Div.

        3) Perfection Corporation; a subsidiary of American Meter Company.

    b. Fiber-reinforced plastic body.

    c. PE body tube.

    d. Buna-nitrile seals.

    e. Acetal collets.

    f. Stainless-steel bolts, nuts, and washers.

7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

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

        1) Dresser Piping Specialties; Division of Dresser, Inc.

        2) Smith-Blair, Inc.

    b. Steel flanges and tube with epoxy finish.

    c. Buna-nitrile seals.

    d. Steel bolts, washers, and nuts.

    e. Factory-installed anode for steel-body couplings installed underground.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.

2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.

3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.

4. Corrugated stainless-steel tubing with polymer coating.

5. Operating-Pressure Rating: 0.5 psig.

6. End Fittings: Zinc-coated steel.

7. Threaded Ends: Comply with ASME B1.20.1.

8. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.

2. Nitrile seals.

3. Hand operated with automatic shutoff when disconnected.

4. For indoor or outdoor applications.

5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig.

D. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig.

E. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.

2. End Connections: Grooved ends.

3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.

4. CWP Rating: 750 psig.

F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 3/4" and Smaller: Comply with ASME B16.33.

1. CWP Rating: 150 psig.

2. Threaded Ends: Comply with ASME B1.20.1.

3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.

4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.

6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 1 and Larger: Comply with ASME B16.38.

1. CWP Rating: 150 psig.

2. Flanged Ends: Comply with ASME B16.5 for steel flanges.

3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

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

a. McDonald, A. Y. Mfg. Co.

b. Milliken Valve Company.

c. Mueller Co.; Gas Products Div.

2. Body: Cast iron, complying with ASTM A 126, Class B.

3. Plug: Bronze or nickel-plated cast iron.

4. Seat: Coated with thermoplastic.

5. Stem Seal: Compatible with natural gas.

6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

7. Operator: Square head or lug type with tamperproof feature where indicated.

8. Pressure Class: 125 psig.

9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Valve Boxes:

1. Cast-iron, two-section box.

2. Top section with cover with "GAS" lettering.

3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.

4. Adjustable cast-iron extensions of length required for depth of bury.

5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 SOLENOID GAS VALVES

A. Automatic Gas Valves: Comply with ANSI Z21.21.

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

a. ASCO Power Technologies, LP; Division of Emerson.

b. Dungs, Karl, Inc.

c. Eaton Corporation; Controls Div.

d. Maxon.

2. Body: Brass.

3. Seats and Disc: Nitrile rubber.

4. Springs and Valve Trim: Stainless steel.

5. Normally closed.

6. Visual position indicator.

7. Electrical operator for actuation by automatic shutoff device.

8. Provide normally closed, manual reset solenoid valves with open-shut indicator, auxiliary switches and terminal block, suitable for gas service and exterior weatherproof applications. Coordinate location of valves with other trades. Coordinate requirements for power circuiting and control circuiting to fire alarm system and/or kitchen hood (whichever applies). Valves shall be Maxon Series SMM or approved equal. Coordinate power source and required voltage with Electrical Contractor and Fire Alarm System Contractor prior to ordering valves.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.

2. Steel jacket and corrosion-resistant components.

3. Elevation compensator.

4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

5. Provide gas pressure regulators as required and shown on the plans to maintain the required food service equipment pressure and flow, despite inlet pressure fluctuation.

6. Regulator size shall provide maximum flow required at the highest outlet pressure needed (take into consideration incoming line losses).

7. Regulator spring shall be chosen so desired outlet pressure is centered within its range. Regulator inlet pressure cannot be exceeded at outlet. Provide a spare spring in the next higher pressure range to avoid start-up inconvenience if system pressure drops exceed those anticipated.

8. Orifice size shall be the smallest compatible with required capacity.

9. Mounting position may affect regulator performance. See manufacturer’s specific regulator data for any limitations.

10. Install gas pressure regulators per the manufacturer's installation recommendations and guidelines.

11. Gas pressure regulators shall be as manufactured by Maxon or approved equal.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

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

a. Actaris.

b. American Meter Company.

c. Fisher Control Valves and Regulators; Division of Emerson Process Management.

d. Maxon.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.

3. Springs: Zinc-plated steel; interchangeable.

4. Diaphragm Plate: Zinc-plated steel.

5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.

6. Orifice: Aluminum; interchangeable.

7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.

8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.

9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.

10. Overpressure Protection Device: Factory mounted on pressure regulator.

11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

12. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

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

a. Actaris.

b. American Meter Company.

c. Eclipse Combustion, Inc.

d. Fisher Control Valves and Regulators; Division of Emerson Process Management.

e. Maxon.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.

3. Springs: Zinc-plated steel; interchangeable.

4. Diaphragm Plate: Zinc-plated steel.

5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.

6. Orifice: Aluminum; interchangeable.

7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.

8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.

9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.

10. Overpressure Protection Device: Factory mounted on pressure regulator.

11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

12. Maximum Inlet Pressure: 10 psig.

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

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

a. Canadian Meter Company Inc.

b. Eaton Corporation; Controls Div.

c. Harper Wyman Co.

d. Maxon.

2. Body and Diaphragm Case: Die-cast aluminum.

3. Springs: Zinc-plated steel; interchangeable.

4. Diaphragm Plate: Zinc-plated steel.

5. Seat Disc: Nitrile rubber.

6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.

7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.

8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

9. Maximum Inlet Pressure: 5 psig.

2.7 DIELECTRIC FITTINGS

A. Dielectric Unions:

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

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. Hart Industries International, Inc.

d. McDonald, A. Y. Mfg. Co.

e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

f. Wilkins; Zurn Plumbing Products Group.

2. Minimum Operating-Pressure Rating: 150 psig.

3. Combination fitting of copper alloy and ferrous materials.

4. Insulating materials suitable for natural gas.

5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:

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

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

d. Wilkins; Zurn Plumbing Products Group.

2. Minimum Operating-Pressure Rating: 150 psig.

3. Combination fitting of copper alloy and ferrous materials.

4. Insulating materials suitable for natural gas.

5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

C. Dielectric-Flange Kits:

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

a. Advance Products & Systems, Inc.

b. Calpico Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Minimum Operating-Pressure Rating: 150 psig.

3. Companion-flange assembly for field assembly.

4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.

5. Insulating materials suitable for natural gas.

6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.8 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.9 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

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

a. Advance Products & Systems, Inc.

b. Calpico Inc.

c. Metraflex Company (The).

d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.

3. Pressure Plates: Carbon steel.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.10 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.

1. Finish: [Polished chrome-plated] [Rough brass] [Polished chrome-plated or rough brass].

D. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

E. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.

2.11 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.12 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 requirements for prevention of accidental ignition.

D. Piping Joints: All pipe shall be reamed to full pipe diameter before joining. Screwed joints shall be made with standard pipe thread and an approved compound applied to the male thread only. Valves and specialties shall have screwed joints.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.

2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

3. Replace pipe having damaged PE coating with new pipe.

E. Install fittings for changes in direction and branch connections.

F. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

G. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

H. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

I. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install escutcheons at penetrations of interior walls, ceilings, and floors.

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.

d. Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

e. Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.

f. Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.

g. Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw.

h. Piping in Equipment Rooms: One-piece, cast-brass type.

i. Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.

j. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

M. Verify final equipment locations for roughing-in.

N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.

4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

    b. Do not install natural-gas piping in solid walls or partitions.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Connect branch piping from top or side of horizontal piping.

U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

V. Do not use natural-gas piping as grounding electrode.

W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.

2. Cut threads full and clean using sharp dies.

3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.

4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.

5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.

2. Bevel plain ends of steel pipe.

3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.

2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.

2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.

3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.

5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.

b. Intermediate Coat: Exterior alkyd enamel matching topcoat.

c. Topcoat: Exterior alkyd enamel flat.

d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Alkyd anticorrosive metal primer.

b. Intermediate Coat: Interior latex matching topcoat.

c. Topcoat: Interior latex flat.

d. Color: Gray.

2. Alkyd System: MPI INT 5.1E.

a. Prime Coat: Alkyd anticorrosive metal primer.

b. Intermediate Coat: Interior alkyd matching topcoat.

c. Topcoat: Interior alkyd flat.

d. Color: Gray.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.13 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.14 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be one of the following:

1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.

2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping shall be one of the following:

1. Steel pipe with wrought-steel fittings and welded joints.

2. [Annealed] [Drawn]-temper copper tube with wrought-copper fittings and brazed joints.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:

1. Steel pipe with steel welding fittings and welded joints.

C. Underground, below building, piping shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.17 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground:

1. PE valves.

2. NPS 2 and Smaller: Bronze plug valves.

3. NPS 2-1/2 and Larger: Cast-iron, lubricated plug valves.

3.18 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:

1. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:

1. Bronze plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:

1. Bronze lubricated plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:

1. Bronze lubricated plug valve.

E. Valves in branch piping for single appliance shall be the following:

1. Bronze lubricated plug valve.

3.19 INSTALLATION—GENERAL

A. Installation shall be in accordance with NFPA 54 and Florida Building Code—Fuel Gas.

B. Exposed or readily accessible piping shall be graded at not less than 1/4" in 15 feet to secure drainage.

C. Install accessible 6" long drip pockets at the bottoms of all vertical risers and such other points as required. Pockets shall be made of a full size pipe tee with one leg capped.

D. Install branch shut-off cocks ahead of all appliances, burners, etc., see plans for size of lines and cocks.

E. Provide shut-off valves where noted on plans, and as required for complete regulation or control of all systems and at each piece of equipment.

F. Underground piping shall be coated with coal tar enamel and wrapped with pressure sensitive tape equal to tapecoat CT.

G. Gas pipe shall be tested for tightness. Refer to Section 15400, Pressure Testing of Piping Systems.

H. All pipe shall be supported from the building structure in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze type hangers. Vertical risers shall be supported at each floor line with steel pipe clamps. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes will not be permitted. Spacing of pipe supports shall not exceed 8 feet for pipes up to 1-1/4" and 10 feet on all other piping.

I. Provide a master manual emergency shut-off valve at the instructors station unless noted otherwise on the drawings.

J. Provide one (1) emergency automatic shut-off valve at each classroom served with gas unless otherwise noted on the drawings. Provide electrical power and control circuiting for intended operation, coordinate circuiting and voltage requirements the Electrical Contractor. Valves shall be designed for exterior service.

K. All gas piping below floor shall be welded steel and shall be sleeved and vented as required by the Florida Building Code—Fuel Gas unless otherwise noted on the drawings.

L. Assemble all fixtures and equipment shipped loose which this Contractor is required to make final connections to, whether furnished by this Contractor or by others (i.e., science cabinet gas fixtures, etc.).

M. Provide regulators on each gas service branch pipe termination at appliance or equipment as necessary for proper operation of appliance or equipment. Coordinate requirements with shop drawings and gas service. Refer to equipment manufacturer's recommendations. Provide independent gas piping from each pressure regulator relief vent to exterior of building.

N. Provide one (1) emergency automatic shut-off valve at exterior wall of kitchen served with gas unless otherwise noted on the drawings. Provide electrical power and control circuiting for intended operation, coordinate circuiting and voltage requirements the Electrical Contractor. Valves shall be designed for exterior service.

*** END OF SECTION 22 16 16 ***

DIVISION 23—MECHANICAL

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SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. HVAC demolition.
7. Equipment installation requirements common to equipment sections.
8. Painting and finishing.
9. Concrete bases.
10. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

2. PE: Polyethylene plastic.

3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.

2. Mechanical sleeve seals.

B. Welding certificates.

C. Submit Manufacturer's published technical data, catalog cuts, wiring diagrams, shop drawings, samples and testing and balancing logs for all elements of the HVAC work. Submit under provisions of General Conditions and Supplementary General Conditions.

D. No equipment, piping, ductwork or components shall be fabricated, delivered, erected, or connected other than from shop drawings reviewed and approved by the Engineer.

E. It shall be understood that review of shop drawings by the Engineer does not supersede the requirement to provide a complete and functioning system in compliance with the Contract Documents.

F. Equipment Supports: Submit detailed shop drawings indicating equipment weight and dimensions, support material, connections, anchoring, and vibration isolation.

G. Submittals shall include, but not be limited to the following:

1. All equipment; cooling, heating, plumbing, electrical motors, starters, controls, etc.

2. Voltage, phase, and amps of each electrical item, such as motors, etc.

3. All auxiliary equipment.

4. Pipe, ductwork, valves, insulation, etc.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.8 INTENT

A. It is the intention of these specifications and drawings to call for finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

C. The term “Basis of Design” used throughout this document shall be understood to mean a particular manufacturer’s equipment (as scheduled specifically on the drawings or specifications) has been used as the basis by the Design Engineer to establish physical dimensions, quality, and performance required, in addition to providing a basis for interaction with other ancillary components and/or other trades. Therefore, it shall be understood that use of a piece of equipment other than that identified as the Basis of Design may impact performance of an overall engineered system or may require revisions to ancillary interfacing equipment, and thus any manufacturer’s equipment other than that listed as Basis of Design shall require written approval via Addendum prior to bid except where the manufacturer’s name is specifically listed in these specifications as a pre-approved substitute or an accepted manufacturer. All substitutes, pre-approved substitutes, accepted manufacturers, and/or Basis of Design are subject to all requirements of quality, physical characteristics (i.e., dimension, sound, etc), and performance, etc., as set forth in these specifications and contract documents.

1.9 SUBSTITUTIONS

A. Materials and equipment are specified herein by a single or by multiple Manufacturers to indicate quality and performance required. The drawings are based upon equipment scheduled on drawings and specified. If another Manufacturer is considered for substitution during the bidding process, the Mechanical Contractor shall be responsible for coordinating all electrical, mechanical, structural, or architectural changes. Comparable equipment Manufacturers which are listed below equipment indicated as “Basis of Design” shall be considered as substitutes. Manufacturers other than the Basis of Design shall submit catalog information and 1/4" scale plan and section drawings showing proper fit and all clearances for maintenance items.

B. Substitutions of other Manufacturer's will be considered for use if, in the Engineers opinion, the item requested for substitution is equal to that specified. The Contractor shall provide to the Engineer a typed comparative list of the basis of design and the proposed substitute. The comparative shall list capacities, pressure drops, horse power, electrical requirements, etc., (refer to Submittal requirements).

C. Request for approval of substitutions shall be made in writing no less than ten days (unless otherwise directed in Division 01) prior to bid. Substitutions shall not be considered approved unless the approval appears in an Addendum or unless so named in the specifications as a pre-approved substitute. The approval of any substitutions or equals prior to bid shall not be construed as a shop drawing approval. The substitute or equal must be submitted as described in the specifications and meet all the requirements of the specifications and drawings.

D. All requests for substitutions shall specifically indicate any and all differences or omissions between the product specified as basis of design and the product proposed for substitution. Differences shall include, but shall not be limited to, data as follows for both the specified and substituted products.

1. Principle of operation;

2. Materials of construction or finishes;

3. Thickness or gauge of materials;

4. Weight of item;

5. Deleted features or items;

6. Added features or items;

7. Changes in other Contractor's work caused by the substitution;

8. Physical dimensions;

9. Electrical requirements.

E. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawing, which requires any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical or electrical, all such redesign, and all new drawings and detailing required therefore, shall be prepared by the Subcontractor at his own expense and submitted to the Architect/Engineer for approval.

F. Where such approved deviation requires quantity and arrangement of ductwork, piping, wiring, conduit, and equipment from that specified or indicated on the drawings, the Contractor shall furnish and install any such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit, and any other additional equipment required by the system, at no additional cost to the Owner.

1.10 COOPERATION WITH OTHER TRADES

A. Give full cooperation to other trades and furnish in writing to the General Contractor, with copies to the Architect, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.

B. When work installed under this Division will be in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer/Architect, prepare composite working drawings and sections at a suitable scale not less than 1/4" = 1'0", clearly showing how work is to be installed in relation to the work of other trades. If the work is installed before coordinating with other trades, or so as to cause any interference with work of other trades, make all the necessary changes in work to correct the condition without extra charge.

C. Furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

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

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.

2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC or PVC (as required) one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Eslon Thermoplastics.

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Thompson Plastics, Inc.

C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC or PVC (as required) four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Manufacturers:

a. NIBCO INC.

b. NIBCO, Inc.; Chemtrol Div.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

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

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:

a. Capitol Manufacturing Co.

b. Central Plastics Company.

c. Eclipse, Inc.

d. Epco Sales, Inc.

e. Hart Industries, International, Inc.

f. Watts Industries, Inc.; Water Products Div.

g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Capitol Manufacturing Co.

b. Central Plastics Company.

c. Epco Sales, Inc.

d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Calpico, Inc.

b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Perfection Corp.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Co., Inc.

d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 HVAC DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

5. Equipment to Be Removed: Disconnect and cap services and remove equipment.

6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS—COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Select system components with pressure rating equal to or greater than system operating pressure.

H. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Insulated Piping: One-piece, stamped-steel type with spring clips.

c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

e. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.

f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.

b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.

c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.

d. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.

e. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

I. Install piping to allow application of insulation.

J. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof 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 above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.

b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

M. Verify final equipment locations for roughing-in.

N. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION—COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

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

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.10 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

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SECTION 23 05 23

GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Iron, single-flange butterfly valves.
3. High-performance butterfly valves.
4. Bronze lift check valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Iron, center-guided swing check valves.
8. Iron, plate-type check valves.
9. Chainwheels.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.1 for power piping valves.

3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set ball valves open to minimize exposure of functional surfaces.

4. Set butterfly valves closed or slightly open.

5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.

2. Handlever: For quarter-turn valves.

3. Handwheel: For valves other than quarter-turn types.

4. Handlever: For quarter-turn valves NPS 6 and smaller.

5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2.5-inch stem extensions and the following features:

1. Butterfly Valves: With extended neck.

2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.

2. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

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

a. Conbraco Industries, Inc.; Apollo Valves.

b. Hammond Valve.

c. Milwaukee Valve Company.

d. NIBCO INC.

2. Description:

a. Standard: MSS SP-110.

b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.

d. Body Design: Three piece.

e. Body Material: Bronze.

f. Ends: Threaded.

g. Seats: PTFE or TFE.

h. Stem: Stainless steel.

i. Ball: Stainless steel, vented.

j. Port: Full.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

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

a. Crane Co.; Crane Valve Group; Jenkins Valves.

b. Crane Co.; Crane Valve Group; Stockham Division.

c. Milwaukee Valve Company.

d. NIBCO INC.

e. Tyco Valves & Controls; a unit of Tyco Flow Control.

f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.

b. CWP Rating: 150 psig.

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.

e. Seat: EPDM.

f. Stem: One- or two-piece stainless steel.

g. Disc: Aluminum bronze.

2.4 HIGH PERFORMANCE BUTTERFLY VALVES—BELOW GROUND SERVICE

A. 10" through 24": 150 psi tight-closing , rubber seated type conforming to the design standards of ANSI/AWWA C504. Valves shall be bubble tight at the rated pressure in either direction and shall be suitable for throttling service and/or operation after long periods of inactivity in buried soil and/or submerged up to 10 feet below water.

B. Manufacturer shall have manufactured this product and have proof of satisfactory installed history for a minimum of five years and show proof of compliance with ANSI/AWWA C504. All valves shall be hydrostatic and leak tested in accordance with ANSI/AWWA C504.

C. Valve body shall be constructed of cast iron ASTM A126, Class B, with ANSI B16.1 drilled flange. Disc shall be concentric design with ductile iron ASTM A536, Grade 65-45-12 with 316 stainless edge. Shaft shall be one piece through shaft of 18-8 stainless steel, corresponding to the requirements of AWWA C504, latest revision, and shall be fastened by a threaded disc pin and provide a positive leak proof connection of the shaft to the disc. Shaft bearings shall be of the self-lubricating, corrosion-resistant, sleeve type and be designed for horizontal and/or vertical shaft load. Packing shall be self adjusting and suitable for vacuum or pressure service.

D. Valve seats shall be located in the body only and shall be of a synthetic rubber compound suitable for the service and shall be designed so that no adjustments or maintenance is required.

E. Valves shall be coated per AWWA C550 and in full compliance with NSF-61.

F. Provide gear operators furnished with AWWA 2 inch nut and sealed housing designed for buried and submerged service for depths up to 10 feet below water for valves over 6 inches. Provide buried extension shaft with AWWA nut, removable cover, and buried shaft cover and 1 inch extension shafts as necessary for the buried/submerged depth (up to 10 feet) of the valve operator. Contractor to cut shaft and provide buried shaft cover as necessary. Provide two t-handle valve wrenches for the project. Refer also to valve box detail on the drawings for further requirements.

2.5 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

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

   a. Crane Co.; Crane Valve Group; Crane Valves.

   b. Crane Co.; Crane Valve Group; Jenkins Valves.

   c. Crane Co.; Crane Valve Group; Stockham Division.

2. Description:

   a. Standard: MSS SP-80, Type 1.

   b. CWP Rating: 200 psig.

   c. Body Design: Vertical flow.

   d. Body Material: ASTM B 61 or ASTM B 62, bronze.

   e. Ends: Threaded.

   f. Disc: Bronze.

2.6 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

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

a. American Valve, Inc.

b. Crane Co.; Crane Valve Group; Crane Valves.

c. Crane Co.; Crane Valve Group; Jenkins Valves.

d. Crane Co.; Crane Valve Group; Stockham Division.

e. Kitz Corporation.

f. Milwaukee Valve Company.

g. NIBCO INC.

h. Red-White Valve Corporation.

i. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.

b. CWP Rating: 300 psig.

c. Body Design: Horizontal flow.

d. Body Material: ASTM B 62, bronze.

e. Ends: Threaded.

f. Disc: Bronze.

2.7 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Renewable Metal Seats and Disc:

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

a. Crane Co.; Crane Valve Group; Crane Valves.

b. Crane Co.; Crane Valve Group; Jenkins Valves.

c. Crane Co.; Crane Valve Group; Stockham Division.

d. Hammond Valve.

e. Milwaukee Valve Company.

f. NIBCO INC.

g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.

b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

c. NPS 14 to NPS 24, CWP Rating: 150 psig.

d. Body Design: Clear or full waterway.

e. Body Material: ASTM A 126, gray iron with bolted bonnet.

f. Ends: Flanged.

g. Trim: Bronze.

h. Gasket: Asbestos free.

2.8 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Globe, Center-Guided Silent Check Valves with Metal Seat:

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

a. Anvil International, Inc.

b. APCO Willamette Valve and Primer Corporation.

c. Crispin Valve.

d. DFT Inc.

e. GA Industries, Inc.

f. Hammond Valve.

g. Milwaukee Valve Company.

h. NIBCO INC.

i. Sure Flow Equipment Inc.

j. Val-Matic Valve & Manufacturing Corp.

2. Description:

a. Standard: MSS SP-125.

b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

c. NPS 14 to NPS 24, CWP Rating: 150 psig.

d. Body Material: ASTM A 126, gray iron.

e. Style: Globe, S.S. spring loaded.

f. Ends: Flanged.

g. Seat: Buna-N Bonded to Bronze.

2.9 IRON, PLATE-TYPE CHECK VALVES

A. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:

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

a. APCO Willamette Valve and Primer Corporation.

b. Crane Co.; Crane Valve Group; Crane Valves.

c. Mueller Steam Specialty; a division of SPX Corporation.

d. Val-Matic Valve & Manufacturing Corp.

2. Description:

a. Standard: API 594.

b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.

c. NPS 14 to NPS 24, CWP Rating: 250 psig.

d. Body Design: Wafer, spring-loaded plates.

e. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.

f. Seat: Bronze.

2.10 CHAINWHEELS

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

1. Babbitt Steam Specialty Co.

2. Roto Hammer Industries.

3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.

2. Attachment: For connection to ball and butterfly valve stems.

3. Sprocket Rim with Chain Guides: Aluminum, of type and size required for valve. Include zinc coating.

4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

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

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

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for ball and butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, or butterfly valves.

2. Butterfly Valve Dead-End Service: Single-flange (lug) type.

3. Throttling Service except Steam: ball, or butterfly valves.

4. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.

b. NPS 2-1/ and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valve, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

3. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

4. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Copper Pipe NPS 2 and Smaller:

1. Ball Valves: Two or Three piece, full port, brass with stainless-steel trim.

2. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.

2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.

3. High-Performance Butterfly Valves: Class 150, single flange.

4. Iron Swing Check Valves: Class 250, nonmetallic-to-metal seats.

5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring or iron.

6. Iron, Center-Guided Check Valves: Class 150, globe, metal seat.

7. Iron, Plate-Type Check Valves: Class 150; dual plate; metal seat.

3.6 CONDENSER-WATER VALVE SCHEDULE

A. Copper Pipe NPS 2 and Smaller:

1. Ball Valves: Two or Three piece, full port, brass with stainless-steel trim.

2. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.

2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.

3. High-Performance Butterfly Valves: Class 150, single flange.

4. Iron Swing Check Valves: Class 250, nonmetallic-to-metal seats.

5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring or iron.

6. Iron, Center-Guided Check Valves: Class 250, globe, metal seat.

7. Iron, Plate-Type Check Valves: Class 150; dual plate; metal seat.

3.7 HEATING-WATER VALVE SCHEDULE

A. Copper Pipe NPS 2 and Smaller:

1. Ball Valves: Two or Three piece, full port, brass with stainless-steel trim.

2. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.

2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.

3. High-Performance Butterfly Valves: Class 150, single flange.

4. Iron Swing Check Valves: Class 250, nonmetallic-to-metal seats.

5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring or iron.

6. Iron, Center-Guided Check Valves: Class 150, globe, metal seat.

7. Iron, Plate-Type Check Valves: Class 150; dual plate; metal seat.

*** END OF SECTION 23 05 23 ***

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
4. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
5. Division 23 Section(s) “Ductwork" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.

2. Fiberglass pipe hangers.

3. Thermal-hanger shield inserts.

4. Powder-actuated fastener systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.

2. Metal framing systems. Include Product Data for components.

3. Fiberglass strut systems. Include Product Data for components.

4. Pipe stands. Include Product Data for components.

5. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code—Steel."

2. AWS D1.2, "Structural Welding Code—Aluminum."

3. AWS D1.3, "Structural Welding Code—Sheet Steel."

4. AWS D1.4, "Structural Welding Code—Reinforcing Steel."

5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Available Manufacturers:

1. AAA Technology & Specialties Co., Inc.

2. Bergen-Power Pipe Supports.

3. B-Line Systems, Inc.; a division of Cooper Industries.

4. Carpenter & Paterson, Inc.

5. Empire Industries, Inc.

6. ERICO/Michigan Hanger Co.

7. Globe Pipe Hanger Products, Inc.

8. Grinnell Corp.

9. GS Metals Corp.

10. National Pipe Hanger Corporation.

11. PHD Manufacturing, Inc.

12. PHS Industries, Inc.

13. Piping Technology & Products, Inc.

14. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.

2. ERICO/Michigan Hanger Co.; ERISTRUT Div.

3. GS Metals Corp.

4. Power-Strut Div.; Tyco International, Ltd.

5. Thomas & Betts Corporation.

6. Tolco Inc.

7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

a. Hilti, Inc.

b. ITW Ramset/Red Head.

c. Masterset Fastening Systems, Inc.

d. MKT Fastening, LLC.

e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-Type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.

b. Empire Industries, Inc.

c. Hilti, Inc.

d. ITW Ramset/Red Head.

e. MKT Fastening, LLC.

f. Powers Fasteners.

2.6 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Available Manufacturers:

a. ERICO/Michigan Hanger Co.

b. MIRO Industries.

C. Low-Type , Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Available Manufacturers:

a. MIRO Industries.

D. High-Type , Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Available Manufacturers:

a. ERICO/Michigan Hanger Co.

b. MIRO Industries.

c. Portable Pipe Hangers.

2. Base: Stainless steel.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type , Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Available Manufacturers:

a. Portable Pipe Hangers.

2. Bases: One or more plastic.

3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.

5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.8 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: Form with 18 gage galvanized steel, unless otherwise directed on the drawings with a more stringent requirement.

B. Sleeves for Pipes through Non-fire Walls or Footings. Form with steel pipe or 18 gage galvanized steel, unless otherwise directed on the drawings with a more stringent requirement.

C. Sleeves through outside walls shall be made with 18 gauge galvanized steel and fitted with chrome escutcheon covers at all finished surfaces.

D. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Prefabricated fire rated sleeves including seals, UL Listed. Contractor shall submit manufacturer's UL approved methods for firesafing all types required for the project as coordinated with the methods of floor and wall construction. Refer to the plans for further requirements.

E. Sleeves for Round Ductwork: Form with galvanized steel.

F. Sleeves for Rectangular Ductwork: Form with galvanized steel.

G. Caulk: Silicone sealant of top quality

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

C. Structural Steel: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 degF pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.

11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-Type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 degF piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 degF piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

a. Light (MSS Type 31): 750 lb.

b. Medium (MSS Type 32): 1500 lb.

c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.

b. Vertical (MSS Type 55): Mounted vertically.

c. Trapeze (MSS Type 56): Two vertical-Type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS P-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:

1. Pipe Stand types except Curb-Mounting Type : Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

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

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

P. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

   b. NPS 4: 12 inches long and 0.06 inch thick.

   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

Q. Support horizontal piping as follows:

PIPE SIZE (INCHES)	MAXIMUM HANGER SPACING	HANGER ROD DIAMETER
1/2 to 1-1/4	6'-6"	3/8"
1-1/2 to 2	9'-0"	3/8"
2-1/2 to 3	10'-0"	1/2"
4 to 6	10'-0"	3/4"
8 to 12	14'-0"	7/8"
14 to 18	20'-0"	1"
PVC (All Sizes)	4'-0"	3/8"

R. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

S. Place a hanger within 12 inches of each horizontal elbow.

T. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

U. Support vertical piping at every floor and support from wall midway between ceiling and floor or at 12 feet maximum spacing, whichever is less. Support vertical cast iron pipe at each floor and at each hub.

V. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

W. Support riser piping independently of connected horizontal piping.

X. All auxiliary steel required for pipe supports shall be furnished and installed by this Contractor. Where building structure is not usable for pipe supports, provide steel members, channels, angles, or "UNISTRUT" components for piping support. All auxiliary steel exposed to weather shall be galvanized.

Y. Provide all steel required for support of pipes other than steel shown on structural Engineer's drawings.

Z. Interior Pipe Guides, Expansion Loops, and Anchors: Provide pipe guides, expansion loops, and anchors on hot water heating pipes installed above the ceiling. Expansion loops shall be installed every 50 feet and supported from building structure with pipe guides on 10 feet spacing. Piping shall be anchored to the structure as necessary for directional expansion control.

AA. Located In or Around Cooling Tower Yards: Pipe hangers, equipment supports, miscellaneous structure components, hardware, bolts, washers, nuts, screws, etc., shall be non-metallic polyester resin, vinyl ester resin, fiberglass, glass reinforced polyurethane or 316 stainless steel.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor. Brace and fasten with flanges bolted to structure.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide equipment bases and supports of concrete Type under all mechanical equipment and as shown on drawings.

D. Provide lateral bracing, to prevent swaying, for equipment supports. Provide rigid anchors for pipes after vibration isolation components are installed.

E. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

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

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

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

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.7 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash and seal.

C. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with Manufacturer's instructions for sound control.

3.8 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Extend sleeves through floors one inch above finished floor level. Caulk sleeves full depth and provide floor plate.

C. Where piping penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk seal. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

D. Install chrome plated steel escutcheons at finished surfaces.

E. Sleeves installed in exterior walls with exposed ends shall be non-corrosive type sleeves (i.e., stainless steel).

*** END OF SECTION 23 05 29 ***

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SECTION 23 05 48

VIBRATION AND WIND RESTRAINT CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Elastomeric hangers.
3. Spring hangers.
4. Pipe riser resilient supports.
5. Resilient pipe guides.
6. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: Refer to Structural Drawings.
2. Building Classification Category: Refer to Structural Drawings.
3. Refer to structural drawings for minimum load requirements.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

B. Delegated-Design Submittal: Equipment mounted outdoors shall comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation wind forces required to select wind restraints.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.

2. Riser Supports for Building Hot Water Heating Piping: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. HVAC Pumps Located on floor level other than grade level: Provide Vibration Isolation Base Details with detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

4. Wind-Restraint Details:

a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.

c. Coordinate wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS

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. Amber/Booth Company, Inc.

2. Isolation Technology, Inc.

3. Kinetics Noise Control.

4. Mason Industries.

5. Vibration Eliminator Co., Inc.

6. AVNEC Incorporated.

7. Kevflex.

B. Isolation Pads—A double deflection pad-type mounting consisting of two layers of 3/8" thick ribbed or waffled Neoprene pads bonded to a 16 gage galvanized steel separator plate. Pads shall be sized for approximately 20 to 40 psi load and a deflection of 0.12" to 0.16".

C. Elastomeric Hangers Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

D. Spring Hangers Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

E. Flanged Pump Piping Isolator, spherical rubber expansion joint constructed of molded neoprene, nylon cord reinforced, with integral steel floating flanges, suitable for pressure up to 225# (4 to 1 safety factor) and temperatures up to 225°F. Connectors shall have minimum movement capability of 1/2" compression, 3/8" extension 1/2" lateral and 15° angular. Where allowable movements will be exceeded or where operating pressures exceed the following, control rods shall be installed at each connector to limit elongation to 3/8".

through 4"..... 200 psi
5" to 10"..... 150 psi
12" to 14"..... 100 psi
16" to 24"..... 50 psi

Control units shall be of the spring isolated design through 8" and neoprene isolated for 10" and larger to limit noise and vibration transmission through the control rods.

F. Pipe Riser Resilient Support All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

G. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

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. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Isolation Technology, Inc.
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibration Eliminator Co., Inc.
7. Vibration Isolation.
8. Vibration Mountings & Controls, Inc.

B. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

b. Provide Spring Isolators on Piping Connected to Isolated Equipment as follows: Up to 4 inch diameter, first three points of support; 5 to 8 inch diameter, first four points of support; 10 inch diameter and over, first six points of support. Static deflection of first point shall be twice deflection of isolated equipment.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.

2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.

3. Baked enamel or powder coat for metal components on isolators for interior use.

4. Color-code or otherwise mark vibration isolation and wind-control devices to indicate capacity range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

3.3 VIBRATION-CONTROL AND WIND-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install wind restraints on outdoor HVAC equipment.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

3. Install wind-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

3.4 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.5 HVAC VIBRATION-CONTROL DEVICE SCHEDULE

A. Supported or Suspended Equipment: Install vibration isolators and flexible connectors for the following motor driven equipment.

1. Pumps: Flanged Pump Piping Isolator (mount on suction and discharge side of pump piping).

2. Chillers, Cooling Towers, Condensing Units, and Chilled Water Air Handling Units: Neoprene Isolation Pads.

3. Suspended Split System Air Handling Units and Power Ventilators: Elastomeric or Spring Hangers.

*** END OF SECTION 23 05 48 ***

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

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

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

4. Fasteners: Stainless-steel rivets.

5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

2. Letter Color: White.

3. Background Color: Black.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2 by 4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2 by 4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive. Colors shall comply with ANSI A13.1. Size markers and letters as follows:

OUTSIDE DIAMETER OF INSULATION OR PIPE	LENGTH OF COLOR FIELD	SIZE OF LETTERS
¾" - 2"	1" x 8"	¾"
2½" - 6"	2¼" x 13"	1¾"
8" - 10"	4" x 24"	2½"
Over 10"	4" x 32"	3½"
Ductwork and Equipment	All	3½"

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2 by 4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.5 VALVE TAGS

A. Valve Tags: 1-1/2 inch diameter, stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.

2. Fasteners: Reinforced grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic equipment markers. Small devices, such as in-line pumps, may be identified with metal tags.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 20 feet along each run including risers and drops, adjacent to each valve and “T”, at each side of penetration of structure or enclosure, and at each obstruction.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

8. Tags may be used on small diameter piping.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue : For cold-air supply ducts.

2. Yellow : For hot-air supply ducts.

3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels at air handlers, near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system. Identify as to air handling unit number and service (supply air , return air, exhaust, outside air, etc.).

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Provide a valve chart and schedule in aluminum frame with clear plastic shield. Install at location as directed.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 EQUIPMENT LOCATOR TACK

A. Equipment Located Above Ceiling (i.e., VAV boxes, fans, air handlers, fire dampers, smoke dampers, etc.): Provide equipment locator tack, located on the ceiling directly below the equipment, to be spot marked and so mark is easily visible from the floor. Use a permanent marker and label each tag with the name of the equipment. Color code equipment by type as follows:

EQUIPMENT ABOVE CEILING	COLOR
Air Handlers/Fan Coil Units	Light Blue
Exhaust Fans	Green
VAV Boxes	Yellow
Duct Heaters	Orange
Fire Dampers	Red
Smoke Dampers	Red

B. Ductwork Volume Dampers Above the Ceiling: Tie an orange tape flag, minimum 18” long, from each volume damper. Let tape hang down vertically.

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SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

b. Dual-duct systems.

c. Variable-air-volume systems.

d. Multizone systems.

e. Induction-unit systems.

2. Balancing Hydronic Piping Systems:

a. Constant-flow hydronic systems.

b. Variable-flow hydronic systems.

c. Primary-secondary hydronic systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

A. LEED Submittal:

1. Air-Balance Report for LEEDPrerequisiteEQ1: Documentation of work performed for ASHRAE62.1, Section7.2.2, "Air Balancing."

B. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

C. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part3.

D. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

E. Certified TAB reports.

F. Sample report forms.

G. Instrument calibration reports, to include the following:

1. Instrument type and make.

2. Serial number.

3. Application.

4. Dates of use.

5. Dates of calibration.

H. The test and balance firm will submit two (2) copies of data for the testing and balancing for the approval of the Project Architect/Engineer and three (3) file copies to the Owner and two (2) copies to this Contractor.

I. All data and information shall be compiled in a neat, orderly format on 8-1/2" x 11" test forms and shall be signed and sealed by the certified individual as previously described.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.

2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.

B. TAB Conference: Meet with Contractor on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.

b. The TAB plan.

c. Coordination and cooperation of trades and subcontractors.

d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Owner. Written report submitted to the Engineer a minimum of 15 days prior to Substantial Completion of each project phase. The Owner will then perform a verification TAB. If discrepancies are found, they will be corrected by this Contractor and the contractor will responsible to pay for additional trips for the Owner’s TAB representatives to verify.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE111, Section5, "Instrumentation." All instruments used shall be accurately calibrated within six months of testing and balancing and shall be maintained in good working order.

F. The final result of balancing shall be to provide uniform air temperatures within a two (2) degree F spread in the conditioned space at peak load conditions.

G. In the event of dispute, the Owner or Contractor or Project Architect/Engineer may choose to provide verification of test and balance reports, and such verification shall be by a second independent agency selected by the Engineer. Reports found to be inaccurate will be disallowed, and the Contractor's test and balance firm will be required to repeat operations under the supervision of the second independent agency until accurate reports are completed and agreed upon, provided the Contractor's TAB firm is found to be at fault in the judgment of the Engineer. The cost of disputed test and balance work shall be borne by the Owner or Contractor (whichever is found to be at fault).

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 SCOPE

A. Description

1. The Contractor shall, at the Contractor's expense, procure the services of an independent testing and balance firm which specializes in the balancing and testing of heating, ventilating and air conditioning systems. This specialty services firm shall balance, adjust and test water circulation, air moving equipment, air distribution and/or exhaust systems as herein specified.

2. Test and balance work shall not begin until all systems have been completed and are in full working order to the satisfaction of the Project Architect/Engineer and the Owner. This Contractor shall make all preliminary tests and adjustments before advising in writing that test and balance work is ready to begin and shall place all systems and equipment into full operation during each working day of testing and balancing.

B. Replacement pulleys (adjustable and non-adjustable), additional balancing dampers, pressure taps, balancing valves, cocks and fittings, etc., required to effect proper air and water balance shall be furnished and installed by this Contractor at no additional cost to the Owner. This Contractor shall do this work as soon as possible so as not to delay the completion of the test and balance work.

C. Air filters shall be replaced and strainers shall be cleaned by this Contractor before proceeding with test and balance and thereafter as required by the test and balance firm.

D. Systems shall be placed into service using approved start up procedures. This (mechanical) contractor shall be responsible for proper initial setting and adjustment of HVAC equipment, air handlers, VAV boxes, exhaust fans, etc. furnished and installed by him.

E. This Contractor shall provide test openings as required; shall operate HVAC equipment and provide trades persons to assist and make adjustments for test and balance during the process.

F. When the Owner's verification test and balance firm is ready to test according to the established schedule, but is prevented from testing and balancing, making adjustments or taking measurements due to incompleteness of the work, all extra charges for test and balance attributable to the delay may be back charged to this Contractor. The Project Architect/Engineer shall be the judge as to whether a delay has occurred and back charges due the Owner, and which, if judged proper, shall be effected through a Change Order reducing the Contract Sum.

G. The Contractor's test and balance firm shall periodically visit the site during construction of the HVAC system. No less than two visits per phase will be made. Should methods, materials or workmanship being used adversely affect balancing and adjusting work, the test and balance agency shall report its findings in writing to the Contractor with recommendations for correction.

H. The Contractor's test and balance firm has agreed or shall agree to carry out the test and balance in accordance with the AABC National Standards for Total Systems Balance or the NEBB Procedural Standards for Testing, Adjusting and Balancing or Environmental Systems, Fourth edition, and in conformance with ASHRAE Handbook, Chapter 34, Testing, Adjusting and Balancing and as outlined in this Specification Section.

I. This Contractor shall furnish to the testing and balancing agency a complete set of plans and specifications, addenda, shop drawings, schedules and change orders as may be required.

PART 2 PRODUCTS

(NOT APPLICABLE)

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Ductwork" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.

2. Hydronic systems are filled, clean, and free of air.

3. Automatic temperature-control systems are operational.

4. Equipment and duct access doors are securely closed.

5. Balance, smoke, and fire dampers are open.

6. Isolating and balancing valves are open and control valves are operational.

7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance," NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE62.1, Section7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."

3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Ductwork."

3.5 BUILDING PRESSURIZATION TESTING AND BALANCING

A. This Contractor shall measure the building static pressure relative to the outdoor static pressure (differential pressure measurement) and balance each air delivery system (system) to obtain 0.03 inches of water column positive pressure within that portion of the building with all exterior openings (doors and windows) closed.

B. This Contractor shall make preliminary field differential pressure measurements of the building upon completion of the initial testing and balancing of the entire building or buildings HVAC systems. This shall be accomplished once the air delivery systems have been fully tested and balanced to within 10 percent of the scheduled air flow rates per the Contract Documents. A preliminary test and balance report (hand written copies are satisfactory) shall be submitted to the Engineer of Record at this point in the project. Based upon the initial building differential pressure measurements, the Contractor shall proceed with the Building Pressurization Testing and Balancing final field adjustments. If there are any questions regarding the building pressurization testing and balancing requirements, the Contractor should contact the Engineer and clarify the intended process prior to making the final field adjustments.

C. This Contractor shall review the drawings and ventilation schedule for each system to determine whether the system ventilation outside air flow rate is determined by the number of occupants “people” or determined by the minimum exhaust “exhaust” requirements. If the ventilation outside air is determined by “people”, this contractor shall adjust the building pressure by readjusting the relief fan volumetric flow rate for that system as directed by the Engineer. If the ventilation outside air is determined by “exhaust”, the building pressure shall be revised by adjusting the volumetric flow rate of outside air for that system as directed by the Engineer. Where the system design employs the use of barometric dampers in addition to or in lieu of relief fans for building pressurization control, the Contractor shall also adjust the barometric damper to obtain the stated building pressure.

D. In either building pressurization balancing adjustment scenario, the ventilation rate shall not be reduced below the minimum required ventilation flow rate as determined by AHRAE 62.1 and represented on the Ventilation Schedule.

E. This Contractor shall document the final building pressurization measurements as a basic part of the test and balance report. The building pressurization measurement data and balancing methodology shall be presented in the report for each system. This shall include a narrative describing the method that was used to adjust each system, and the location of each reported differential pressure measurement.

3.6 SOUND TESTING

A. Using approved instruments, the test and balance firm shall conduct tests in selected areas of the building as specified below. Sound level readings shall be measured in decibels on the "A" and "C" scales of the General Radio Company sound level meter, or equal sound level meter that meets the current American Standards (224.3-1944) based on the acoustic reference power of D.B./RE 10.13 watts. Readings shall set forth the total random sound level of the selected rooms or areas with the system in operation, as compared to total background sound level with the system not in operation. The system increase over the background level shall be recorded in decibels on the "A" and "C" scales. If sound levels are above those listed below, adjustments shall be made by this Contractor to bring the sound level within the range set forth. If this cannot be done with the equipment as installed, recommendations shall be made by the test and balance firm to correct the sound level to within the specified range. Additions of sound traps, insulation, or dampers shall be made by this Contractor under the direction of the balance agency at no additional cost to the Owner, provided the noise is due to Contractor's fault. Sound level readings (in decibels) shall be taken at each diffuser, grille or register in occupied areas. The sound levels shall be approximately 45 degrees to the center of the diffuser, etc., on the "A" and "C" scales of a General Radio Company sound level meter. The computed equivalent sound level meter readings weighting scale "A" (DBA) shall not exceed 40 for general office type space, 35 for classroom and conference room type space and 30 for sensitive areas such as libraries or auditoriums.

B. Sound measurements shall be taken in the following locations:

1. A typical classroom remote from mechanical equipment rooms.

2. A typical classroom adjacent to mechanical equipment room.

3. Typical offices.

4. Special assembly rooms such as auditoriums, music rooms, libraries.

C. When a typical space (1, 2, or 3 above) has been tested and passed, all such spaces shall be considered complying. Conversely, if a typical space fails, all such spaces shall be considered as failed and require testing.

D. Unless test results indicate failure to comply with the intention of these Specifications, sound testing shall be done only once, preferably during cooling season.

E. Sound levels at maximum rates shall be listed on the TAB report on a point measured basis as required above.

3.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

    a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.

    b. Measure static pressure directly at the fan outlet or 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 the 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.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from Owner and Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

    a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.8 PROCEDURES FOR DUAL-DUCT SYSTEMS

A. Verify that the cooling coil is capable of full-system airflow, and set mixing boxes at full-cold airflow position for fan volume.

B. Measure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate controls of mixing boxes and to overcome resistance in the ducts and outlets downstream from mixing boxes.

1. If insufficient static pressure exists, increase airflow at the fan.

C. Test and adjust the constant-volume mixing boxes as follows:

1. Verify both hot and cold operations by adjusting the thermostat and observing changes in air temperature and volume.

2. Verify sufficient inlet static pressure before making volume adjustments.

3. Adjust mixing boxes to indicated airflows within specified tolerances. Measure airflow by Pitot-tube traverse readings or by measuring static pressure at mixing-box taps if provided by mixing-box manufacturer.

D. Do not overpressurize ducts.

E. Remeasure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate controls of mixing boxes and to overcome resistance in the ducts and outlets downstream from mixing boxes.

F. Adjust variable-air-volume, dual-duct systems in the same way as constant-volume, dual-duct systems; adjust maximum- and minimum-airflow setting of each mixing box.

3.9 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.

2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.

4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record final fan-performance data.

3.10 PROCEDURES FOR MULTIZONE SYSTEMS

A. Set unit at maximum airflow through the cooling coil.

B. Adjust each zone's balancing damper to achieve indicated airflow within the zone.

3.11 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow. Close all bypass valves. Set modulating valve to full coil flow.

2. Check liquid level in expansion tank.

3. Check makeup water-station pressure gage for adequate pressure for highest vent.

4. Check flow-control valves for specified sequence of operation, and set at indicated flow.

5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.

6. Set system controls so automatic valves are wide open to heat exchangers.

7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

9. Check all strainers and, if required, clean same.

10. Examine water in system and determine if water has been treated and cleaned. If water appears dirty, test and balance work shall stop and this Contractor shall reclean system as specified in the Project Specifications.

11. Check all air vents at high points of water system and determine if all are installed and operating freely. Make sure all air is removed from the system.

12. Set all temperature controls so all coils are calling for full cooling, and determine that this closes all automatic by-pass valves at coils.

13. Check operation of automatic by-pass valves.

14. Check and set operating temperatures of chillers and heat exchangers to design requirements.

15. Complete air balance work must have been accomplished and all work adjusted and corrected before actual water balance is complete.

3.12 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

a. If impeller sizes must be adjusted to achieve pump performance, turn these dimensions, along with the installed pump curves with the new pump and system curves, for review by the Engineer. Upon approval by the Engineer, the impeller dimensions shall be turned over to the installing contractor for impeller shaving.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.

2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.

3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.13 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.14 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.15 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.

B. Adjust water flow to within specified tolerances.

C. Measure inlet and outlet water temperatures.

D. Measure inlet steam pressure.

E. Check settings and operation of safety and relief valves. Record settings.

3.16 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.

2. Motor horsepower rating.

3. Motor rpm.

4. Efficiency rating.

5. Nameplate and measured voltage, each phase.

6. Nameplate and measured amperage, each phase.

7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.17 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.

2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.

3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.

4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.

5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.

6. Capacity: Calculate in tons of cooling.

7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.18 PROCEDURES FOR COOLING TOWERS

A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser-water flow to each cell of the cooling tower.

2. Measure entering- and leaving-water temperatures.

3. Measure wet- and dry-bulb temperatures of entering air.

4. Measure wet- and dry-bulb temperatures of leaving air.

5. Measure condenser-water flow rate recirculating through the cooling tower.

6. Measure cooling-tower spray pump discharge pressure.

7. Adjust water level and feed rate of makeup water system.

8. Measure flow through bypass.

3.19 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.20 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

B. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

3.21 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.

2. Water flow rate.

3. Water pressure drop.

4. Dry-bulb temperature of entering and leaving air.

5. Wet-bulb temperature of entering and leaving air for cooling coils.

6. Airflow.

7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.

2. Airflow.

3. Entering- and leaving-air temperature at full load.

4. Voltage and amperage input of each phase at full load and at each incremental stage.

5. Calculated kilowatt at full load.

6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.

2. Airflow.

3. Air pressure drop.

4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.

2. Wet-bulb temperature of entering and leaving air.

3. Airflow.

4. Air pressure drop.

5. Refrigerant suction pressure and temperature.

3.22 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.

2. Measure motor voltage and amperage. Compare the values to motor nameplate information.

3. Check the refrigerant charge.

4. Check the condition of filters.

5. Check the condition of coils.

6. Check the operation of the drain pan and condensate-drain trap.

7. Check bearings and other lubricated parts for proper lubrication.

8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.

2. Coils are clean and fins combed.

3. Drain pans are clean.

4. Fans are clean.

5. Bearings and other parts are properly lubricated.

6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.

2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.

3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

4. Balance each air outlet.

3.23 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.

3. Heating-Water Flow Rate: Plus or minus 10 percent.

4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.24 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for 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.

3.25 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.

2. Fan curves.

3. Manufacturers' test data.

4. Field test reports prepared by system and equipment installers.

5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.

2. Name and address of the TAB contractor.

3. Project name.

4. Project location.

5. Architect's name and address.

6. Engineer's name and address.

7. Contractor's name and address.

8. Report date.

9. Signature of TAB supervisor who certifies the report.

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:

a. Indicated versus final performance.

b. Notable characteristics of systems.

c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.

13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.

15. Test conditions for fans and pump performance forms including the following:

a. Settings for outdoor-, return-, and exhaust-air dampers.

b. Conditions of filters.

c. Cooling coil, wet- and dry-bulb conditions.

d. Face and bypass damper settings at coils.

e. Fan drive settings including settings and percentage of maximum pitch diameter.

f. Settings for supply-air, static-pressure controller.

g. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.

2. Water and steam flow rates.

3. Duct, outlet, and inlet sizes.

4. Pipe and valve sizes and locations.

5. Terminal units.

6. Balancing stations.

7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.

b. Location.

c. Make and type.

d. Model number and unit size.

e. Manufacturer's serial number.

f. Unit arrangement and class.

g. Discharge arrangement.

h. Sheave make, size in inches, and bore.

i. Center-to-center dimensions of sheave, and amount of adjustments in inches.

j. Number, make, and size of belts.

k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches, and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Filter static-pressure differential in inches wg.

f. Preheat-coil static-pressure differential in inches wg.

g. Cooling-coil static-pressure differential in inches wg.

h. Heating-coil static-pressure differential in inches wg.

i. Outdoor airflow in cfm.

j. Return airflow in cfm.

k. Outdoor-air damper position.

l. Return-air damper position.

m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.

b. Location.

c. Coil type.

d. Number of rows.

e. Fin spacing in fins per inch o.c.

f. Make and model number.

g. Face area in sq. ft.

h. Tube size in NPS.

i. Tube and fin materials.

j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.

b. Average face velocity in fpm.

c. Air pressure drop in inches wg.

d. Outdoor-air, wet- and dry-bulb temperatures in degF.

e. Return-air, wet- and dry-bulb temperatures in degF.

f. Entering-air, wet- and dry-bulb temperatures in degF.

g. Leaving-air, wet- and dry-bulb temperatures in degF.

h. Water flow rate in gpm.

i. Water pressure differential in feet of head or psig.

j. Entering-water temperature in degF.

k. Leaving-water temperature in degF.

l. Refrigerant expansion valve and refrigerant types.

m. Refrigerant suction pressure in psig.

n. Refrigerant suction temperature in degF.

o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.

b. Location.

c. Make and type.

d. Model number and unit size.

e. Manufacturer's serial number.

f. Fuel type in input data.

g. Output capacity in Btu/h.

h. Ignition type.

i. Burner-control types.

j. Motor horsepower and rpm.

k. Motor volts, phase, and hertz.

l. Motor full-load amperage and service factor.

m. Sheave make, size in inches, and bore.

n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.

b. Entering-air temperature in degF.

c. Leaving-air temperature in degF.

d. Air temperature differential in degF.

e. Entering-air static pressure in inches wg.

f. Leaving-air static pressure in inches wg.

g. Air static-pressure differential in inches wg.

h. Low-fire fuel input in Btu/h.

i. High-fire fuel input in Btu/h.

j. Manifold pressure in psig.

k. High-temperature-limit setting in degF.

l. Operating set point in Btu/h.

m. Motor voltage at each connection.

n. Motor amperage for each phase.

o. Heating value of fuel in Btu/h.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.

b. Location.

c. Coil identification.

d. Capacity in Btu/h.

e. Number of stages.

f. Connected volts, phase, and hertz.

g. Rated amperage.

h. Air flow rate in cfm.

i. Face area in sq. ft.

j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.

b. Air flow rate in cfm.

c. Air velocity in fpm.

d. Entering-air temperature in degF.

e. Leaving-air temperature in degF.

f. Voltage at each connection.

g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.

b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Arrangement and class.

g. Sheave make, size in inches, and bore.

h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches, and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.

b. Location and zone.

c. Traverse air temperature in degF.

d. Duct static pressure in inches wg.

e. Duct size in inches.

f. Duct area in sq. ft.

g. Indicated air flow rate in cfm.

h. Indicated velocity in fpm.

i. Actual air flow rate in cfm.

j. Actual average velocity in fpm.

k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.

b. Location and zone.

c. Apparatus used for test.

d. Area served.

e. Make.

f. Number from system diagram.

g. Type and model number.

h. Size.

i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.

b. Air velocity in fpm.

c. Preliminary air flow rate as needed in cfm.

d. Preliminary velocity as needed in fpm.

e. Final air flow rate in cfm.

f. Final velocity in fpm.

g. Space temperature in degF.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.

b. Location and zone.

c. Room or riser served.

d. Coil make and size.

e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

    a. Air flow rate in cfm.

    b. Entering-water temperature in degF.

    c. Leaving-water temperature in degF.

    d. Water pressure drop in feet of head or psig.

    e. Entering-air temperature in degF.

    f. Leaving-air temperature in degF.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

    a. Unit identification.

    b. Location.

    c. Service.

    d. Make and size.

    e. Model number and serial number.

    f. Water flow rate in gpm.

    g. Water pressure differential in feet of head or psig.

    h. Required net positive suction head in feet of head or psig.

    i. Pump rpm.

    j. Impeller diameter in inches.

    k. Motor make and frame size.

    l. Motor horsepower and rpm.

    m. Voltage at each connection.

    n. Amperage for each phase.

    o. Full-load amperage and service factor.

    p. Seal type.

2. Test Data (Indicated and Actual Values):

    a. Static head in feet of head or psig.

b. Pump shutoff pressure in feet of head or psig.

c. Actual impeller size in inches.

d. Full-open flow rate in gpm.

e. Full-open pressure in feet of head or psig.

f. Final discharge pressure in feet of head or psig.

g. Final suction pressure in feet of head or psig.

h. Final total pressure in feet of head or psig.

i. Final water flow rate in gpm.

j. Voltage at each connection.

k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.

b. Serial number.

c. Application.

d. Dates of use.

e. Dates of calibration.

3.26 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

2. Check the following for each system:

a. Measure airflow of at least 10 percent of air outlets.

b. Measure water flow of at least 5 percent of terminals.

c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.

d. Verify that balancing devices are marked with final balance position.

e. Note deviations from the Contract Documents in the final report.

B. Prepare test and inspection reports.

3.27 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

*** END OF SECTION 23 05 93 ***

SECTION 23 07 00

HVAC INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Cellular glass.

b. Flexible elastomeric.

c. Mineral fiber.

2. Insulating cements.

3. Adhesives.

4. Mastics.

5. Lagging adhesives.

6. Sealants.

7. Field-applied fabric-reinforcing mesh.

8. Field-applied cloths.

9. Field-applied jackets.

10. Tapes.

11. Securements.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail insulation application at pipe expansion joints for each type of insulation.

3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

4. Detail removable insulation at piping specialties, equipment connections, and access panels.

5. Detail application of field-applied jackets.

6. Detail application at linkages of control devices.

7. Detail field application for each equipment type.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in piping insulation application with three (3) years minimum experience.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation prior to operating to operating system. Do not use wet insulation materials or apply insulation to wet surfaces.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Block Insulation: ASTM C 552, Type I.

2. Special-Shaped Insulation: ASTM C 552, Type III.

3. Board Insulation: ASTM C 552, Type IV.

4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.

5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.

6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

H. Type A Piping Insulation:

1. Impermeable, noncombustible, closed cellular glass insulation, conforming to ASTM C 552-79, "Specification for Cellular Glass Block and Pipe Thermal Insulation."

2. Conductivity (k) equals approximately 0.29 (BTU-IN/HR, SF, degrees F) at 75 degrees F.

3. Joint sealants and coatings shall be as approved by the insulation manufacturer for the intended application and service temperature range.

4. Jacketing shall be approximately 125 mils thick, consisting of a bituminous resin reinforced with a woven, glass fabric, an integral aluminum foil layer, and a protective plastic film coating.

5. Approved Manufacturers and trade names:

   a. Pittsburgh Corning Corp. "*Foamglass Super K*" with Pittseal, Pittcote, and Pittwrap.

   b. Approved Equal.

I. Type B Piping Insulation:

1. Closed cell, flexible foamed plastic conforming to ASTM C177 or ASTM C518, "Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form."

2. Conductivity (k) equals approximately 0.27 (BTU-IN/HR, SF, Degree F) at 75 degrees F.

3. Approved Manufacturers and trade names:

   a. Armstrong "*AP Armaflex*"

   b. Rubetex Corp. "*Rubetex*"

J. Type C Piping Insulation:

1. Glass fiber, rigid molded sectional pipe covering conforming to ASTM C547, Class II, Mineral Fiber Preformed Pipe Insulation.

2. Conductivity (k) equals approximately 0.23 (BTU-IN/HR, SF, Degree F) at 75 degrees F.

3. Approved Manufacturers and Trade Names:

   a. Manville Corp. "*Micro-Lok 650-AP-T*."

   b. Owens-Corning Fiberglass Corp. "*One Piece 25 ASJ/SSL-II*"

   c. Certain-Teed "*500 Degree Snap-On*."

   d. Knauf Fiberglass "*Knauf Pipe Insulation, 850°F*."

K. Type A-D Duct Insulation:

1. Flexible glass fiber; ANSI/ASTM C553; commercial grade; 6.0 installed 'R' value (minimum) at 75 degrees F, 0.002 foil scrim facing for air conditioning ducts (nominally 2" thick).

L. Type B-D Insulation:

1. Glass fiber; UL Class 1; 'k' value of 0.24 at 75 degrees F 3 lb/cu ft minimum density; black pigmented, fire resistant coated air side for maximum 6,000 ft/min air velocity. Insulation shall be Owens-Corning Fiberglas Aeroflex Duct Liner.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; FlameChek.

b. Johns Manville; Firetemp Wrap.

c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.

d. Thermal Ceramics; FireMaster Duct Wrap.

e. 3M; Fire Barrier Wrap Products.

f. Unifrax Corporation; FyreWrap.

g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

2.3 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Insulco, Division of MFS, Inc.; Triple I.

b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.

C. Mineral-fiber, hydraulic-setting cement is suitable for temperatures from 100 to 1200 deg F (38 to 649 deg C) and for a smooth surface.

D. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Insulco, Division of MFS, Inc.; SmoothKote.

b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.

c. Rock Wool Manufacturing Company; Delta One Shot.

2.4 ADHESIVES

A Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass, Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Products, Division of ITW; CP-96. (-20 to 180)

b. Foster Products Corporation, H. B. Fuller Company; 81-33.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide the following:

a. Aeroflex USA Inc.; Aeroseal.

b. Armacell LCC; 520 Adhesive.

c. Foster Products Corporation, H. B. Fuller Company; 85-75.

d. RBX Corporation; Rubatex Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Products, Division of ITW; CP-82.

b. Foster Products Corporation, H. B. Fuller Company; 85-20.

c. ITW TACC, Division of Illinois Tool Works; S-90/80.

d. Marathon Industries, Inc.; 225.

e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Products, Division of ITW; CP-82.

b. Foster Products Corporation, H. B. Fuller Company; 85-20.

c. ITW TACC, Division of Illinois Tool Works; S-90/80.

d. Marathon Industries, Inc.; 225.

e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide the following:

a. Dow Chemical Company (The); 739, Dow Silicone.

b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

c. P.I.C. Plastics, Inc.; Welding Adhesive.

d. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Products Corporation, H. B. Fuller Company; 30-65.

b. ITW TACC, Division of Illinois Tool Works; CB-50.

c. Marathon Industries, Inc.; 590.

d. Mon-Eco Industries, Inc.; 55-40.

e. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.

5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-9.

b. ITW TACC, Division of Illinois Tool Works; CB-05/15.

c. Marathon Industries, Inc.; 550.

d. Mon-Eco Industries, Inc.; 55-50.

e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.

3. Service Temperature Range: Minus 20 to plus 200 deg F.

4. Solids Content: 63 percent by volume and 73 percent by weight.

5. Color: White.

2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-52.

b. Foster Products Corporation, H. B. Fuller Company; 81-42.

c. Marathon Industries, Inc.; 130.

d. Mon-Eco Industries, Inc.; 11-30.

e. Vimasco Corporation; 136.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.

4. Service Temperature Range: Minus 50 to plus 180 deg F.

5. Color: White.

2.7 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass: Subject to compliance with requirements, provide one of the following:

2. Childers Products, Division of ITW; CP-76.

a. Foster Products Corporation, H. B. Fuller Company; 30-45.

b. Marathon Industries, Inc.; 405.

c. Mon-Eco Industries, Inc.; 44-05.

d. Pittsburgh Corning Corporation; Pittseal 444.

e. Vimasco Corporation; 750.

3. Materials shall be compatible with insulation materials, jackets, and substrates.

4. Permanently flexible, elastomeric sealant.

5. Service Temperature Range: Minus 100 to plus 300 deg F.

6. Color: White or gray.

7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

2. Childers Products, Division of ITW; CP-76-8.

a. Foster Products Corporation, H. B. Fuller Company; 95-44.

b. Marathon Industries, Inc.; 405.

c. Mon-Eco Industries, Inc.; 44-05.

d. Vimasco Corporation; 750.

3. Materials shall be compatible with insulation materials, jackets, and substrates.

4. Fire- and water-resistant, flexible, elastomeric sealant.

5. Service Temperature Range: Minus 40 to plus 250 deg F.

6. Color: Aluminum.

7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.

5. Color: White.

6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, provide one of the following:

2. Vimasco Corporation; Elastafab 894.

B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 3 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.

1. Products: Subject to compliance with requirements, provide one of the following:

2. Childers Products, Division of ITW; Chil-Glas No. 5.

C. Woven Polyester Fabric: Approximately 3 oz./sq. yd. with a thread count of 6 strands by 5.5 meshes per inch, in a Leno weave, for duct, equipment, and pipe.

1. Products: Subject to compliance with requirements, provide one of the following:

2. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.

a. Vimasco Corporation; Elastafab 894.

b. Childers Products, Division of ITW; Chil-Glas No. 10.

c. Pittsburgh Corning, PC Fabric 79.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; Zeston.

b. P.I.C. Plastics, Inc.; FG Series.

c. Proto PVC Corporation; LoSmoke.

d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: Color-code jackets based on system..

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

2.10 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.

b. Compac Corp.; 110 and 111.

c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.

d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.

3. Thickness: 6.5 mils.

4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.

b. Compac Corp.; 120.

c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.

d. Venture Tape; 3520 CW.

2. Width: 2 inches.

3. Thickness: 3.7 mils.

4. Adhesion: 100 ounces force/inch in width.

5. Elongation: 5 percent.

6. Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products; Bands.

b. PABCO Metals Corporation; Bands.

c. RPR Products, Inc.; Bands.

2. Aluminum: ASTM B 209 Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. AGM Industries, Inc.; CWP-1.

    b. GEMCO; CD.

    c. Midwest Fasteners, Inc.; CD.

    d. Nelson Stud Welding; TPA, TPC, and TPS.

3. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; CWP-1.

        2) GEMCO; Cupped Head Weld Pin.

        3) Midwest Fasteners, Inc.; Cupped Head.

        4) Nelson Stud Welding; CHP.

4. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.

        2) GEMCO; Perforated Base.

        3) Midwest Fasteners, Inc.; Spindle.

    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

    c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.

        2) GEMCO; Press and Peel.

        3) Midwest Fasteners, Inc.; Self Stick.

    b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

    c. Spindle: Copper- or zinc-coated, low carbon steel fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

    d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; RC-150.

        2) GEMCO; R-150.

        3) Midwest Fasteners, Inc.; WA-150.

        4) Nelson Stud Welding; Speed Clips.

    b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) GEMCO.

        2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy or 0.062-inch soft-annealed, galvanized steel.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

2. C & F Wire.

3. Childers Products.

4. PABCO Metals Corporation.

5. RPR Products, Inc.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Carbon Steel: Coat carbon steel operating at a service temperature between 0 and 200 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

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

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. Provide self adhesive aluminum tape continuous along staples seams.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. Overlap wrapped insulation 12 inches beyond point of lined duct connections.

Q. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Manholes.

5. Handholes.

6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.6 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

E. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism. Refer to drawings for details

2. Fabricate boxes from aluminum, at least 0.060 inch thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

F. Interior Piping

1. Butter joints of Foamglass insulation with adhesive. Apply insulation to pipe and fittings with all joints tightly fitted. Secure with stainless steel wire so that each length of insulation shall be secured with two wires. Insulation shall be applied with all joints fitted to eliminate voids. Voids shall be eliminated by refitting or replacing insulation. Do not fill voids with joint sealer.

2. Finish with metalized polyester/scrim/bleached white Kraft or approved foil/scrim/bleached white Kraft, all service jacket (ASJ). Finish elbows and fittings with mastic reinforced with white open weave membrane with maximum mesh opening of 10 x 10 per inch.

G. Exterior and Mechanical Equipment/Storage Rooms Piping

1. Apply insulation as noted above and apply vapor barrier reinforced with white open weave membrane with maximum mesh opening of 10 x 10 per inch. Then apply a second coat of vapor barrier and finish with 0.016 inch thick aluminum jacket. Elbows and tees shall be finished with preformed 0.024 inch thick aluminum fitting covers.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

E. Interior Piping

1. Type B insulation shall be slipped on the pipe prior to connection, and the butt joints shall be sealed. Where the slip-on techniques is not possible, the insulation shall be carefully slit and applied to the pipe.

2. All joints shall be sealed with the Manufacturer's recommended adhesives.

3. Do not apply Type B insulation in multiple layers.

4. Type B insulation shall not be used in plenums nor fire wall penetrations.

5. This Contractor shall paint Type B insulation exterior to the building with two (2) coats of a vinyl lacquer paint recommended by the Insulation Manufacturer.

F. Exterior and Mechanical Equipment/Storage Rooms Piping

1. Type B insulation shall be installed as described for interior except the pipe and fitting shall be covered with .016 inch thick aluminum jacket.

2. Elbows and tees shall be finished with preformed 0.024 inch thick aluminum fitting covers.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.

2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.

3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.

2. Install lap or joint strips with same material as jacket.

3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.

5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use tape along lap seal to secure joint.

2. Repair holes or tears in jacket by placing tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.9 MINERAL FIBER PIPE INSULATION INSTALLATION

A. Interior—Type C Pipe Insulation

1. Tightly butt together sections of insulation on pipe runs sealing longitudinal seams of jacket with vapor barrier adhesive. Seal end joints with four inch (4") wide straps of vapor barrier tape. Seal off ends of insulation with vapor seal mastic at valves, fittings, and flanges. No further finish required.

B. Exterior and Mechanical Equipment/Storage Rooms—Type C Pipe Insulation

1. PVC fitting jackets shall be used for the particular application.

3.10 DUCT INSTALLATION

A. Type A-D Installation

1. Apply insulation tightly and smoothly to duct.

2. Secure insulation on the bottom of ducts and plenums and on the sides of plenums and other places where the insulation will sag.

3. Install all materials in accordance with Manufacturer's installation instructions.

4. Butt all insulation joints firmly.

5. Install duct wrap to obtain specified ‘R' value using a maximum of 25% compression.

6. All penetrations and damage to the facing shall be repaired with tape and mastic prior to system start-up.

7. Provide 3" wide (minimum) pressure sensitive tape applied with moving pressure using an appropriate sealing tool at all seams and joints. Apply vapor seal mastic over all taped seams and joints.

8. Longitudinal seam of the vapor retarder shall be overlapped a minimum of 2 inches. A 2 inch tab shall be provided for the circumferential seam.

9. Closure systems shall have a 25/50 flame spread/smoke developed rating per UL 723.

10. For rectangular ducts over 18 inches wide, the duct wrap shall be secured to the bottom side of the duct with mechanical fasteners spaced on 18 inch centers to reduce sag. Fasteners shall be installed in a manner to avoid over compressing the insulation with the retaining washer.

11. Impale insulation on the bottom of ducts and plenums and on the sides of plenums and other places where the insulation will sag.

12. Cut off protruding pin after clips are secured and seal with aluminum backed pressure sensitive tape.

13. Apply insulation with joints tightly butted.

14. Seal all ductwork joints, punctures, and fittings with a mastic type sealant containing a vapor barrier.

15. Cover all breaks, joints, punctures, and voids with a vapor seal mastic and cover with a vapor barrier material identical to vapor barrier on the insulation.

16. Bevel insulation around nameplates, access plates, and doors.

17. Insulation shall be continuous through walls and floors except at fire dampers.

B. Type B-D Installation

1. All portions of duct designated to receive duct liner shall be completely covered with Duct Liner. Transverse joints shall be neatly butted and there shall be no interruptions or gaps. Board shall be cut to assure tight, overlapped corner joints. Top pieces shall be supported by the side pieces.

2. The black coated surface of Duct Liner shall face the air stream.

3. Duct Liner shall be adhered to the sheet metal duct with 100% coverage of adhesive, all exposed leading edges and transverse joints shall also be coated with adhesive. In addition to the above, mechanical fasteners shall be used to secure the Duct Liner to the duct. All edges of duct liner shall be coated with adhesive during the fabrication of ductwork and all exposed edges shall be coated with adhesive prior to field installation of sections.

4. For horizontal runs when the duct width exceeds 12" or the duct height exceeds 16", the Duct Liner Board shall be additionally secured with mechanical fasteners starting within 3" of upstream transverse edges of the Liner and spaced at a maximum of 15" o.c. and 15" from longitudinal joints. On vertical runs, the fasteners shall be used when either dimension exceeds 12".

C. Install all materials in accordance with Manufacturer's installation.

D. Continue insulation with vapor barrier through penetrations.

3.11 FIRE-RATED PENETRATIONS

A. Install firestopping at penetrations through fire-rated assemblies.

3.12 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Owner. Vary first and second coats to allow visual inspection of the completed Work. Refer to Mechanical Identification specification.

D. Do not field paint aluminum or stainless-steel jackets.

3.13 EQUIPMENT INSULATION SCHEDULE

A. Chiller Cold Surfaces—Type 'B'—1" thick (add insulation to all surfaces which exhibit condensation).

B. Chilled Water Pumps and Heat Exchangers—Uninsulated.

C. Air Separators, Strainers, Valve Bodies etc.—Type 'A'—2" thick.

D. All Equipment Operating Below Ambient Dew Point—Type 'A'—2" thick.

E. Handicap Accessible Lavatory and Sink Traps, Cold and Hot Water Supply Piping—Type 'B'—3/4" thick, unless otherwise noted on plumbing drawings.

F. Piping system chemical shot feeder and side stream filter and interconnecting piping insulation shall be the following:

1. Flexible elastomeric—Type B—1" thick.

G. Thermal Storage Tank Insulation (not insulated at the factory)—Type 'A'—3" thick.

3.14 INDOOR PIPING INSULATION SCHEDULE

A.

SERVICE	PIPE SIZE	INSULATION TYPE AND THICKNESS
Exterior Chilled Water (including unconditioned spaces and mechanical equipment rooms)	All	2-1/2" Type A
Interior Chilled Water (Including Domestic)	2" or Less	1-1/2" Type A
Interior Chilled Water	2-1/2" to 12"	2" Type A
Interior Chilled Water	14" and Larger	2-1/2" Type A
Chilled Water 40°F and Below	2" or Less	2-1/2" Type A
Chilled Water 40°F and Below	2-1/2" to 12"	3" Type A
Chilled Water 40°F and Below	14" and Larger	3" Type A
Refrigerant Suction Pipes (except in plenums or fire wall penetrations)	All	3/4" Type B
Refrigerant Suction Pipes and Coil Condensate Lines (in plenums or fire wall or floor penetrations)	1-1/4" or Less	1-1/2" Type A
Refrigerant Suction Pipes and Coil Condensate Lines (in plenums or fire wall or floor penetrations)	1-1/4" or More	1-1/2" Type A
Condensate and Equpiment Drain Water Below 60°F	All	1" Type B
Heating Hot Water	All	2" Type A
Domestic Hot Water, Tempered Water, Recirculated Hot Water, and Service Hot Water	2" or Less	1" Type C
Domestic Hot Water, Tempered Water, Recirculated Hot Water, and Service Hot Water	2-1/2" or More	1-1/2" Type C
Roof Drain Bodies	All	1-1/2" Type C
Horizontal Rain Water Conductors	All	1-1/2" Type C

B. Refer to Section 23 21 13, Hydronic Piping, for description of underground piping system.

3.15 DUCT INSULATION SCHEDULE

A. Outside Air Intake and Supply and Return Ductwork—Type A-D (nominally 2" thick).

B. Flex Connections at Air Handling Units and Other Transitions—Type A-D (nominally 2" thick).

C. All Equipment and Ductwork Operating Below Ambient Dew Point—Type A-D (nominally 2" thick).

D. Central Station AHU Supply and Return Ductwork (excluding multizone AHUS)—First forty (40) feet, unless noted otherwise on the drawings, before and after air handler—Type B-D (1" thick) sandwiched inside double wall duct. Refer to Ductwork specification for more information.

E. Supply and Return Ductwork—Exposed in Occupied Spaces— Type B-D (1" thick) sandwiched inside double wall duct. Refer to Ductwork specification for more information.

F. Air Transfer Ductwork—Type B-D (1" thick).

G. Tops of All Supply Diffusers—Type A-D (nominally 2" thick).

H. Pre-Conditioned Outside Air—Type A-D (nominally 2" thick).

I. Relief Air Duct Between ERV and AHU—Type B-D (1" thick) sandwiched inside double wall duct.

J. Multizone AHU Supply Duct—Type A-D (nominally 2" thick).

K. Multizone Return Duct—First forty feet (40') downstream of AHU unless otherwise noted on drawings—Type B-D (1" thick) sandwiched inside double wall duct. Refer to Ductwork specification for more information.

3.16 UNINSULATED DUCT

A. Exhaust air and relief air ducted directly from space to building exterior.

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SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The General and Supplementary Conditions and General Requirements apply to the work specified in this section—Automatic Temperature Control System (ATCS).

1.2 SCOPE

A. Provide materials, equipment, labor and supervision necessary to install a Trane Tracer Summit building management and digital electronic automatic control system. Pneumatic controls are not acceptable.

B. The system is based on a Trane Tracer Summit control system. Refer to the equipment schedules, flow diagrams, sequence of operation and input/output summary list as applicable to this project. This project shall be installed under the EMBCS Pre-Purchase Agreement between The School Board of Sarasota County and The Trane Company. The Owner (The School Board of Sarasota County), shall assign, via addendum, a dollar allowance to be carried by the Mechanical Contractors for the automatic temperature control system. A purchase order shall be issued to The Trane Company (by the owner) for the dollar amount listed in the addendum. The Mechanical Contractor is responsible for all coordination and scheduling of the control sub-contractor (Tampa Bay Trane). The Mechanical contractor shall include in his bid all costs (mark-ups, overhead and profit) associated with managing/coordinating the controls subcontractor in addition to the assigned dollar amount listed in the addendum.

C. The system shall consist of a distributed processor direct digital control system utilizing electronic actuation. The system shall be fully integrated with the air handling units, VAV boxes, chillers, pumps, cooling towers and boilers. Every DDC control panel shall be listed by underwriters laboratory under "UL Standard 916 Energy Management Equipment".

D. All electric control and interlock wiring in connection with the controls and instrumentation system shall be furnished by this Contractor. Power wiring to the various control devices shall be provided by the Electrical Contractor, coordinated by this Contractor prior to Bid. Failure of this Contractor to coordinate requirements with other Divisions shall require this Contractor to be responsible for any non-coordinated items. Control power to operate VAV boxes (other than duct heaters or fan power) shall be the responsibility of this Contractor (if applicable). The Electrical Contractor (Division 26) is to provide dedicated 120 VAC power or higher to each control panel.

E. Include the cost of providing a system interface or graphics board (if required) and the required software to Engineering Matrix so that phone modem connection may be made between the project and the Engineer's office during the course of construction and throughout the warranty period. The intent is to allow the Engineer priority access during system installation, startup and demonstration. The Engineer shall also be able to use the system remotely in order to check/confirm the results of the test and balance reports in a random basis. Sufficient software shall be provided and installed at the office of the Engineer to allow full programming capability; to include: graphics programming language, module libraries, etc.

F. Control Contractor shall complete all installations including electric and electronic components—not the Mechanical Contractor.

G. DDC controllers shall be required to have been BTL (BACNET Testing Laboratory) tested and approved.

H. Provide a separate **Bid Alternate** to add the Epi-Tech Campus to the ES system. Submit the Bid Alternate with two options:

1. Using the existing BCU and MP5xx Controllers;

2. Replacing the existing controllers with SC/UC vintage controllers.

1.3 COORDINATION

A. Division 15 Mechanical Contractor shall receive, handle, mount and install automatic temperature control valves, separable wells for immersion elements and couplings for flow and pressure switches.

B. Mechanical Contractor for section 15 or the sheet metal subcontractor shall install all automatic dampers. It shall be the responsibility of the mechanical Contractor or his sheet metal subcontractor to provide and install blank-off plates when the control application requires dampers smaller than duct size.

C. The direct digital portions and automatic temperature control system shall be installed by the Temperature Control Contractor.

D. Coordination of all controls items with other trades shall be the responsibility of the Controls Contractor.

1.4 TEST

A. The Control Contractor shall test the entire system and document point by point operation of all controls. Perform all required continuity testing of conductors prior to final connection to control equipment.

1.5 CALIBRATION AND ADJUSTMENT

A. After completion of the installation, perform calibration and adjustments of the Automatic Temperature Control equipment provided under this contract, and supply services incidental to the proper performance of the temperature control system under the warranty below.

1.6 SYSTEM WARRANTY

A. System Warranty

All temperature control devices provided by this Contractor shall be warranted to be free of defects in workmanship and material for a period of two (2) years from the date of the job acceptance (Final Substantial Completion) by the Owner and/or date of beneficial use. Any equipment found to be defective during this period shall be repaired or replaced without expense to the Owner. This work shall be accomplished by the Contractor during normal working hours (8 am to 5 pm, Monday through Friday, excluding holidays).

The Controls Contractor shall be responsible for all defects or failures throughout the warranty period (parts and labor).

B. Service Organization Qualifications:

The Servicing Contractor shall meet all of the following requirements:

1. Have certified OEM factory-trained technicians experienced on the specific equipment needing repair. Service technicians to be equipped with laptop computers.

2. Provide for two (2) hour response time, 24 hours/day, 7 days/week to inspect down equipment and then repair to make equipment operational.

3. Maintain a complete stock of OEM parts, service, and repair manuals covering types and models of equipment owned by the Owner. It is unacceptable to remove a failed device and return it to the manufacturer for repair. Parts shall be replaced by local stock at the time of service call.

4. Have fully equipped service trucks and other equipment, including that necessary to comply with prudent and regulatory environmental requirements (including CFCs).

5. Maintain software library to support building automation system. Provide and install mandatory upgrades with 30 days of issue. All systems provided shall be the most current version and all units shall be the same version.

6. Provide local training on chillers, air handlers, and automation systems at no cost to Owner as stipulated herein.

1.7 SUBMITTAL REQUIREMENT

A. The following data/information shall be submitted for approval:

1. Complete description of operation. Include an overall system interconnect diagram showing all remote panels and power/surge protection locations.

2. Control system drawings including all pertinent data to provide a functional operating system.

3. Valve, humidifier and damper schedules showing size, configuration, capacity and location of all equipment.

4. Data sheets for all hardware and software control components.

5. A description of the installation materials including conduit, wire, flex, etc.

6. Thermostat/sensor locations.

7. Distributed panel locations.

8. Provide as part of the submittal five copies of all data.

9. Detailed point-to-point diagram of circuitry of all DDC panels, AHUs. Submit on a per distributed panel basis.

10. List of connected data points, including connected control unit and input or output device.

11. System graphics indicating monitored systems, data connected and calculated point addresses, and operator notations, as-built. Graphics shall be demonstrated at the office of the Engineer using live data via modem hook-up to the site. Graphics are to be demonstrated and approved prior to Substantial Completion. Not required at submittal approval time except as listed below.

12. Descriptive data and sequence of operation of operating, user, and application software.

13. Detailed documentation on the specific field equipment to be supplied by the controls Contractor shall be submitted and approved prior to installation; including, but not limited to, actuators, valves, temperature sensors, and damper operators.

14. All schemes and methods proposed to provide lightning protection entering and leaving each building shall be submitted for review and approval.

15. Locations of each control panel, gateway module, override panels on a 24” x 36” drawing or larger floor plan. Submit panel layouts for each.

16. Proposed Graphic Screens shall be submitted for approval with shop drawings. These submittals shall include a schematic of the graphics, all points which will be shown on that screen, whether such points are able to be overridden from the graphics and any such targets or macros to be accessible from that screen.

PART 2 PRODUCTS

2.1 DDC PANELS (MICROPROCESSOR BASED DDC PANELS)

Provide independent, stand alone, microprocessor based control panels in order to provide centralized control of each major piece of HVAC equipment. Provide DDC panels for each air handling unit. These panels shall communicate with the operator via the Communications Network CPU/Graphics Software. Both text and graphics interface shall be provided.

A. The DDC panel shall contain the necessary hardware and firmware to interface the building input/output devices to the CPU over a communications channel.

Each DDC panel shall be a stand alone in a standard assembly packaged in a NEMA 1 enclosure complete with power supplies, card cage, interface cards and termination points. Each remote shall be capable of accepting combinations of input sensors and output controls. Each remote AHU unit shall have its’ own timeclock.

As many DDC panels as required shall be furnished to provide the monitoring and control functions and capabilities specified. The panel shall be strategically located in areas of the building that are easily accessible for maintenance and repair.

Any software edit changes in a DDC panel by the Owner shall be available to the Owner. The Owner shall not be tied to the manufacturer for those changes.

If the manufacturer's panel does not have the ability to provide the minimum point requirement, then additional panels shall be provided adjacent to the first unit in order to meet the intent of the spec. No exception to this statement shall be acceptable in order to protect the Owner's interest for future additions.

Provide at each AHU, chillers and boiler (if applicable) a dedicated DDC panel. A key lock shall protect the internal DDC panel components.

Provide sufficient ROM, for operating system and PID algorithms. Protect processor cards and memory with internal grounding. Store setpoints and default parameters in a non-volatile memory (EEPROM). Battery back-up shall not be acceptable for AHU stand-alone DDC panel control. Locate the panel in the AHU room or at the AHU.

B. Input/Output Interface

Each point on each interface card is to be characterized as to its point type, sensor range, status, and scale range in the on-line software data base edit. Revisions or modifications to these parameters shall be entered by the system operator through the PC keyboard.

To gather sensor data and interface with controlled equipment, the DDC panel shall use an internal multiplex design. This design shall allow each panel to accommodate different types of points using any of the following input/output options:

- ❑ Digital Input Options—Monitor the open/closed status of a switch or relay.
- ❑ Analog Input Options—Monitor analog values of voltage, current and resistance from temperature, pressure and humidity sensors, etc.
- ❑ Digital Output Options—Control on/off, start/stop relays.
- ❑ Analog Output Options—Supply voltage or current outputs to controllers.

C. Digital Input (DI)

The digital inputs must be isolated contact closures and can either be normally open (NO) or normally closed (NC).

Points must be transient protected on all points to meet IEEE C37.90a-1974.

Digital input points shall monitor the open/close status of switches or relays. Digital inputs must be isolated contact closures, but normally open or normally closed contacts can be intermixed.

Monitoring voltage is 12 VDC at 12 mA per zone. Two #18 AWG wires are required per point. Points are to be transient protected to meet IEEE 472-1974.

D. Analog Input

The analog inputs can be voltage, current or resistance.

The analog input cards monitor values from temperature, pressure, humidity, and other analog sensors.

Analog inputs can be linear or non-linear. Points shall include a 10-bit A/D converter and an analog power supply. All points shall be wired to the card using #18 AWG twisted, shielded pair cables (Belden 8760 or equivalent) or larger.

E. Digital Output

The digital outputs shall drive control on/off, start/stop relays which have low voltage coils. The control relays must have a minimum contract rating of 120 VAC, 5 amp, and 1/3 HP. Provide manual override switches in order to enable the operator to override the control status of each load.

F. Analog Output

The analog outputs supply voltage or current outputs to devices. The analog outputs shall be a standard 4-20 mA proportional signal. The analog output D/A conversion shall have 10-bit resolution minimum. All output points to valves shall read as a percent open.

G. Packaging And Environment

Distributed DDC panel enclosures shall be locking type, metal cabinet, with common keying. The panels have a metal print pocket suitable for storing wiring, service and log information.

The panel, when required, must functionally operate over the temperature range -30 degrees F to 120 degrees F and the humidity range 10 - 90% non-condensing. Storage temperature shall be -50 degrees F to 150 degrees F.

DDC panels shall come with a minimum of six pre-existing available knockouts for ease of wiring during installation. Panels shall have an on/off switch and shall be fused for power protection. AHU DDC panels shall be provided with the required knock-outs.

The electrical requirements shall be provided by this Contractor. Any 120 VAC requirements are to be coordinated with the Division 16 Contractor prior to bid. Power circuit to each panel shall be provided by Division 16 Contractor.

H. Distributed Control Modules (DCMs)

The Distributed Control Module (referred to as DCMs) shall be distributed standalone controller specifically designed to control the various HVAC equipment as specified herein.

Each DCM shall be capable of communicating with main DDC controller panels over a twisted pair of wires. Provide at each panel an operator interface in the form of a front panel liquid crystal display with keypad. The display and keypad shall allow display and local adjustment of DCMs operating parameters and setpoints.

Each DCM shall have a minimum of 6 programmable/configurable PID loops.

The analog inputs shall be individually selectable for resistance inputs, 4 to 20 mA, 200 ohm input impedance and 0 to 10 VDC.

The binary outputs shall drive dry contact low coil voltage relays with normally open and normally closed (Form C) contacts. The contacts shall be rated at 120 VAC, 5 amps.

The analog outputs shall provide a continuous signal and are individually selectable as either 0-10 VDC or a 0-20 mA or 4-20 mA (both into a 500 ohm impedance).

Provide at each DCM address dip switches for setting the communication link address. In addition, provide at each DCM an RS 232 interface port for connection of a DCM edit software for use with a portable laptop computer.

Damper operators shall be of two (2) types; modulating or two-position depending on the sequence of operation. Two-position operators shall be spring return type and the modulating operators shall be capable of accepting a 0-10 VDC or 4-20 mA signal with a gear de-engagement clutch on the operator cover.

I. Main Direct Digital Controller (MDDC)

The Main Direct Digital Controller shall provide the capability for local loop control. The capability for direct digital control to maintain desired setpoints shall be available. The setpoint values shall be determined manually by the operator's input or by an application program. These values shall be established via the operator input locally or be set via the communications link to another MDDC. The MDDC shall be capable of retrieving data and setting data values from connected DCMs.

The MDDC panel shall have in firmware direct digital control PID loop algorithms for calculations to maintain a setpoint accurately. The algorithm shall utilize this desired setpoint value, mode factors, and feedback to maintain the setpoint. The factors for the mode used in the direct digital control process shall include proportional, integral and derivative value. Each MDDC shall have a minimum of 16 PID loops.

See the point list (I/O summary) for the required number and type of points at each piece of equipment.

2.2 TRANSIENT PROTECTION

A. All communication channels between CPU, MDDC panels, and DCMs whether in conduits or overhead runs, shall have transient suppression networks installed. The transient protection must meet IEEE standard C37.90a-1974. The suppression network shall be automatic, self-restoring and be on duty at all times.

B. Surge suppression shall comply at minimum with manufacturers requirements and is to include suppression on all lines entering/leaving each building.

2.3 SOFTWARE

Provide the following software features for the operation of the system:

A. Password Security

The system security software shall provide the means for ensuring secure operation of the system. In doing so, the system security software shall perform the following:

1. All system editing, control operations, and alarm acknowledgment shall be subject to access authorization prior to allowing such operations to take place.

2. Defining and modifying system password and access assignments shall only be accomplished by the Building Owner, Engineer, or Designee.

3. Associated with each password shall be an access code and level of authorization.

B. Application Software

The application software includes in general the control functions which permit the operator to control the system, and access the associated application parameters. In addition, the interaction between application programs provides the strategy for orderly management of the system as well as the following:

1. Maximum energy conservation

2. Minimum occupant discomfort

3. Unnecessary equipment cycling

All application program editing must be accessible to the Owner and the Owner's personnel who have the proper password authority. All displays necessary to create and edit the system are provided. All editing is done in English by using the menu format and by answering prompted questions. All software programming of sequences shall be done in text and shall be on-line with no intermediate compilations required.

C. Programmed Scheduling

The system shall provide the ability to automatically start up and shut down individual pieces of equipment by zone grouping based on a particular time of day. In addition, the ability to disable alarming and application control for a particular load as a function of the time-of-day is also required. All time programmed control will be done in accordance with the operator specified schedules.

There shall be a minimum of 32 master zone schedules of eight days each.

There shall be at least one schedule for each day of the week. The capability to schedule holidays and special days a minimum of one year in advance shall be included. The priorities of the time program functions relative to the other application programs shall be operator definable. The program shall have the capability of being down-loaded to all programmable remotes.

D. Demand Limiting And Load Shedding

Peak demand control shall be accomplished by monitoring the power consumption of each metered power feed device. The program shall constantly compare the actual peak demand to the operator established limits. Upon reaching limits, configurable priority loads as defined by user shall be shed on a rolling basis.

The program shall use an averaging technique that will offset the effects of demand spikes and the resultant over-shedding of loads.

The operator shall have the ability to define each load to be used for load shedding. In addition, the demand limiting program shall have as a minimum four priority groups. Each load in a particular group shall be rotated with other loads in the same group.

The program shall accommodate time of day demand limits.

There shall be a minimum of 2 time of day intervals with independent, unique limits for weekdays, Saturdays, and Sundays.

The program shall accommodate multiple meters as inputs to the software. It shall be capable of treating each independently. Associated system software shall be capable of treating them as a single sum.

E. Run Time And Maintenance

The system shall provide the ability to accumulate equipment run time for operator specified equipment.

When equipment run time exceeds an operator-specified limit, the system shall alarm the condition and print and sequentially number the maintenance order automatically for the specific piece of equipment. The system shall provide a summary of all points currently assigned to the run time program as well as their current run time values. Run time limits shall be enforceable on either an hourly or calendar date basis.

The operator shall have the ability to define or modify any of the maintenance messages to be used by the run time program.

F. Reports And Logs

The system shall provide management reports and logs detailing certain system performance characteristics.

The system shall have the ability to history trend a minimum of 250 different I/O or internally calculated points. The points shall be operator selectable and shall be a mix/match of the system points as selected by the operator. The operator shall also be able to select the sampling/storage trending time frequency. The minimum sample time frequency must be no greater than 10 minute intervals for 25 of the points and 5 minutes for the remaining points. A minimum of 200 samples for each point shall be trended.

The data or the trend history must be capable of being stored in a spreadsheet compatible file format (EXCEL Version 5.0).

G. Electronic VAV Control Software

The system shall provide a software program to control the VAV boxes which shall have the following minimum features:

1. The VAV terminal units shall be individually controlled by a DDC VAV controller which shall be furnished by the ATCS Contractor.

   The cost to ship and mount, calibrate and test the DDC equipment shall be coordinated prior to bid day and included in the ATCS price.

   Sensor installation to terminal unit and communications wiring to ATCS to be provided under this section. Coordination with the terminal unit provider shall be done by this Contractor prior to bid.

2. The ATCS shall perform the following VAV terminal unit control strategies and provide the points as listed on the DDC/VAV point list and the specified monitoring and diagnostics.

   a. AHU Grouping—The ATCS shall be able to group VAV boxes for each AHU via keyboard commands. These groups shall make it possible for the operator to send a common command to all boxes in a group to operate in the same mode. Also, each box can individually be commanded as well. ATCS shall also compile on a group basis, the following:

      - ✦ Minimum group temperature
      - ✦ Maximum group temperature
      - ✦ Average group temperature

   b. Setpoint Control—The ATCS shall control the zone to space temperature setpoint of each VAV box. The zone temperature setpoint shall be operator adjustable. Individual zone setpoint and control logic shall reside at the zone level, and not be dependent upon the ATCS for control. In the event of communication loss, the box will continue to control the VAV damper valve to maintain current setpoints.

   c. Cooling/Heating Valve Control—The ATCS shall control the cooling/heating air valve to a fully open, fully closed, maximum CFM, or minimum CFM position based on operator commands. The operator shall also have the capability to adjust the maximum and minimum airflow limits of the air valve through the ATCS, as well as command each valve to a current position. Heating and cooling shall each have their own unique maximum and minimum CFM adjustable setpoints.

   d. Operating Mode—The ATCS shall place the box in either the occupied or unoccupied mode based on an operator adjustable time schedule. Separate heating and cooling setpoints shall be enterable for each mode through the ATCS. Other modes available for special applications shall include full open, full closed, maximum flow, and minimum flow.

   e. Control Offset—The ATCS shall be capable of offsetting the cooling or heating setpoints of one or more groups of boxes by an operator adjustable amount. This capability will allow for automatic zone setpoint changes based on system requirements, such as demand limiting.

   f. Automatic Recalibration—The system shall automatically recalibrate its air flow sensing and air valve position measurement system at system startup, on a scheduled basis, or on demand.

   g. Terminal Unit Status Report—For each terminal unit, the ATCS shall provide an operating status summary of all unit sensed values (zone temperature, CFM, etc.), setpoints, and modes.

   h. Terminal Unit Group Report—For each AHU group of VAV terminal units, the ATCS shall report the group mode, heating or cooling, airflow, average zone temperature, minimum zone temperature, and maximum zone temperature. The report shall also display for each terminal unit in the group the present temperature control setpoints and the current zone temperature.

3. Terminal Box Diagnostics

   a. If zone temperature sensor input fails above its high range, unit shall control at its maximum CFM setpoint. If sensor input fails below its low range, unit shall control to its minimum CFM setpoint.

   b. If flow measuring system fails, unit shall automatically convert to a pressure dependent, damper position-based algorithm. Diagnostic message shall be displayed upon operator inquiry.

   c. If communications are lost, controller shall continue to operate in the current mode of operation. All setpoints shall be retained in nonvolatile memory. If communications are not restored within 15 minutes, unit shall automatically initiate a reset-recalibrate.

4. Cooling Mode VAV Terminal Sequence:

   a. On a rise in space temperature, the unit shall modulate up toward its maximum CFM.

   b. On a drop in space temperature, the unit shall modulate toward its minimum CFM.

5. Heating Mode VAV Terminal Sequence:

   a. On a rise in space temperature, the unit shall modulate down toward its minimum CFM.

   b. On a drop in space temperature, the unit shall modulate toward its maximum CFM.

6. The control system shall include the capability of operating all of the VAV boxes and VAV air handlers in "Critical Zone Reset" mode. Supply air temperature of the AHU shall be reset via average AHU group space temperature.

H. Graphics Generation Package

1. Provide an updated version of the dynamic color graphics package to operate in the PC. The graphics package shall work in conjunction with the ATCS as described in Paragraph 2.01 A, B, C. The graphics package shall allow the operator to call up dynamic graphics and to create graphics in the following different methods.

   ❒ Drawing graphics from scratch with dimensions not exceeding 636 x 360 pixels.

   ❒ Redrawing an existing graphic (duplication).

   ❒ Using a library file from the graphics library. The graphics library shall contain as a minimum static pictures of AHUs, fans, chillers, valves, coils, dampers, fan coil units, and ductwork.

   The graphics package shall be setup in SVGA mode with 256 colors and the ability to create/select fonts, text entry dialogue boxes, icons, etc.

2. Dynamic Graphic Software

Provide as part of this program an adjustable automatic refresh rate for all graphic displays. The automatic refresh rate shall be adjustable down to a minimum of five (5) seconds for all system points being displayed. A graphic mode's pop-up menu shall be provided for accessible selection of all available functions in a tiered top/down structure.

3. Color Graphic Display Linkage Editor

Provide, as part of the graphics generation program, a color graphic display linkage editor which assigns ("links") the appropriate graphic display files to the correct ATCS remotes. The linkage editor shall also provide the operator with the ability to define the display sequence that is followed when the next and previous function keys are utilized.

4. Graphic Requirements

As a part of the requirements of this section, provide a series of logically ordered dynamic graphics as described in paragraph H.1 for each ATCS remote. There shall be as a minimum a dynamic graphic for each of the following:

a. Site Plan Graphic

Provide a site plan of the project indicating location of chiller plant, major mechanical equipment, PCs, and electric power meter(s). The site plan graphics shall also have easily identifiable ICONS and target points.

b. Chiller Plant Graphics Group

The chiller plant graphics group shall consist of dynamic graphics of:

1) Chiller Plant Overlay

☒ All chillers

☒ System chilled water temperature(s) Deg.F. (supply and return)

☒ Chiller status (each chiller) on/off

2) Air Cooled Reciprocal, Helical Rotary or Scroll Chiller

☑ Chilled water supply temperature Deg.F.

☑ Chilled water return temperature Deg.F.

☑ Compressor (one required per compressor On/Off (status)

☑ Chilled water return (or supply) setpoint Deg. F.

c. Air Side

1) Air Handling Units - Constant Volume

- Fan start/stop control
- Fan status (On/Off)
- Return air temperature Deg.F.
- Supply air temperature Deg.F.
- Space temperature Deg.F.
- Space temperature setpoint Deg.F.
- Chilled water valve % open
- Heating water valve % open
- Cooling coil discharge temperature Deg.F.

2) Air Handling Units – Variable Volume

- Fan status (On/Off)
- Static Pressure (In.WG)
- Supply air temperature Deg.F.
- VFD position % frequency
- Chilled water valve % open
- Heating water valve % open
- Return air temperature Deg.F.
- Supply air temperature setpoint Deg.F.
- Static pressure setpoint Deg.F.
- Cooling coil discharge temperature Deg.F.
- Outside air CFM
- Outside air damper % open
- Return air damper % open

3) VAV Boxes

- Space temperature Deg.F.
- CFM max setting (heating/cooling)
- CFM min setting (heating/cooling)
- Cooling setpoint Deg.F. (occ/unocc)

- ✳ Heating setpoint Deg.F. (occ/unocc)
- ✳ Air valve % open
- ✳ Delivered CFM
- ✳ Fan status (on/off)
- ✳ Electric heating coils (on/off)

2.4 AUXILIARY CONTROL DEVICES

A. Automatic Control Dampers and Operators

1. Automatic control dampers shall have interlocking blades and frames. Dampers shall be designed and constructed so that the blades, frames and linkage mechanism shall present a rigid assembly with free and easy action. Dampers shall be of galvanized steel blades and welded steel frame. The damper bearings shall be brass or oil impregnated nylon with brass bearing shafts. Where the damper blades are installed in a vertical position, a thrust type ball bearing shall be provided for the lower bearing. All bearings in ducts or casings to the outside shall have the top and bottom edges on both ends trimmed with replaceable neoprene seal fastened in an approved manner, so as to be practically air tight when closed. Closed dampers shall have leakage of not more than one-half percent at 4" of water column (10.2 cm) static pressure and 2,000' per minute velocity.

2. Submit leakage and flow characteristics of dampers to Engineer to specify performance. Test leakage reports shall be in accordance with AMCA standard 500-75.

3. When dampers are located at fan discharge they shall be designed to operate properly without fluttering, at velocities up to 4,000 fpm and against a static pressure differential developed by the fan. Maximum deflection shall be no more than 1/50 of the unsupported span distance. Each automatic damper or section of damper if too large for one motor shall be operated by the required number of modulating motors. The motors shall be of the proper size required to operate the damper with uniform and gradual movement and shall return the damper to the same position for a given signal during an opening or closing movement of the damper. Damper operators shall be of the proportional type capable of accepting 0-10 volts or 4-20 mA control signal and 2-10 VDC feedback signal. The type of operator input signal will be a function of the DDC control panel output.

4. Damper operators shall include spring return, a 0 – 5 VDC feedback signal, and shall be sized a minimum of 125 percent of the highest actual close-off operating pressure of the system (25% safety factor). Contractor shall provide feedback wiring, terminations, graphics, and control logic connected to DDC input board (analog signal), on all outside air dampers on 100% outdoor air handling units wherever it applies to this project, for positive feedback of damper position.

5. Approved damper manufacturers are: Safe-Air and Ruskin.

6. The Control Contractor shall furnish all the controlled dampers of the type and sizes indicated on the Drawings for installation by the sheet metal subcontractor.

7. All 2-position control dampers shall be sized for minimum pressure drop, at the specified duct size.

8. All modulating dampers shall be sized for an effective linear air flow control characteristics within the angle of rotation and maximum pressure drops specified. Information shall be provided to the sheet metal subcontractor for determining the proper duct reductions or baffles used.

9. Damper frames shall not be less than 13 gauge galvanized steel, formed for extra strength, with mounting holes for enclosed duct mounting.

10. All damper blades shall be of not less than 16 gauge galvanized steel formed for strength and high velocity performance. Blades on all dampers must not be over 8" in width. Blades shall be secured 1/2" diameter zinc plated axles by zinc plated bolts and nuts. Blade side edges shall be sealed off against spring stainless steel seals. Teflon coated thrust bearings shall be provided at each end of every blade to minimize torque requirements and insure smooth operation. All blade linkage hardware shall be constructed of corrosion resistant, zinc plated steel and brass.

11. Dampers shall be suitable for operation between -40 F and 200 F. The Control Manufacturer shall submit leakage and flow characteristics plus a size schedule for all controlled dampers.

12. Dampers shall be of the parallel blade design for 2- position service and opposed blade design for modulating service.

13. Approved damper operator manufacturers are: Belimo.

B. Automatic Control Valves And Operators

1. The Control Contractor shall furnish all the control valves of the type indicated on the drawings for installation by the Mechanical Contractor.

2. All modulating straight-through water valves shall be provided with equal-percentage contoured throttling plugs. All modulating three-way mixing valves shall be provided with linear V-port plugs or equal percentage flow characterized ball valve type, such that the total flow through the valve shall remain constant regardless of the valve's position. All diverting valves shall have two V-port plugs.

3. Valves 2" and smaller shall have brass or bronze bodies with screwed ends. Valves 2-1/2" and larger shall have iron bodies brass or bronze trimming with flanged ends. Valves shall be factory rated to withstand the pressures encountered. Valves shall have stainless steel stems and spring loaded teflon packing.

4. Air handling unit water valves shall be sized for a pressure drop equal to the coil they serve but not to exceed 5 psi. Valves shall have replaceable seats and discs or equal percentage flow characterized ball valve type. Valves and operators shall be capable of close-off pressures equal to or exceeding the dead head pressure of the largest pump within the system or 60 psi, whichever is greater and shall be sized a minimum of 125 percent of the highest actual operating pressure of the system (25% safety factor).

5. All automatic control valves shall be fully modulating type unless specified otherwise in the Sequence of Operations or on the drawings.

6. All control valves shall be designed to fail as follows:

   ❑ Cooling - Fail fully open to coil

❑ Heating - Fail fully closed to coil

7. Each valve operator shall be 4-20 mA type Contractor shall provide feedback wiring, terminations, graphics, and control logic connected to DDC input board (analog signal), on all automatic control valves in the chiller plant and/or heating plant (except at air handlers) wherever it applies to this project, for positive feedback of valve position.

8. Operators on all air handlers shall be by Belimo and shall comply with this section.

9. Operators on all automatic control valves in the chiller plant and/or heating plant shall be Belimo SY, NEMA 4X type and shall comply with this section.

C. Differential Pressure Switches

1. Differential pressure switches shall be furnished as indicated by the sequence for status purposes for either air or water applications. Provide single pole double throw switch with fully adjustable differential pressure settings. The switch shall have a snap-acting Form C contact rated for the application. The switch contact shall be rated for 5 amps at 120 volts as a minimum. Units shall be selected for ranges consistent with the application and shall be submitted for the Engineer's approval.

a. Dwyer and Cleveland products are acceptable manufacturers.

D. Electronic Temperature Sensors

1. Temperature detectors shall be 10K Ohms thermistors or a 2 wire, 4-20 mA DC output 12-35 VDC input, 1,000 or 100 Ohm platinum RTD with a minimum transmitter accuracy of +.1% of span, shall be 100% zero and span field adjustable, polarity protected. Sensors shall be calibrated to less than or equal to a 1/4 degree F resolution for the specific application. Thermistor sensors are approved for VAV zone or room sensing Substitutions must be approved by the Engineer. All sensors to be field calibration verified and if adjustments are necessary, they shall be made at the sensor and not in software. 1,000 or 100 ohm direct panel input sensors are acceptable provided 2 fixed range resistors are installed that will facilitate confirmation of proper A/D conversion.

2. Provide twisted pair lead wires and shield for input circuit.

3. Use insertion elements in ducts not affected by temperature stratification or smaller than one square meter. Use averaging elements where larger or prone to stratification sensor length 2.5 m or 5 m as required.

4. Insertion elements for liquids shall be with brass separable socket (thermowell) with minimum insertion length of 2-1/2 inches (60 mm).

5. Supply room sensors with tamper proof cover.

6. Provide outside air sensors with watertight inlet fitting, shielded from direct rays of sun, mounted on the North side of the facility.

7. The transmitter/sensor shall be field calibrated by the Installing Contractor to transmit a 4-20 mA signal at the corresponding temperature ranges. The Installing Contractor shall calibrate transmitter in field with a precision grade substitution resistance box and two (2) decimal place minimum digital ammeter test circuit. Test transmitter at three (3) temperature points minimum. Engineer will spot check verify these calibrations during walk through inspection.

8. Wall mounted sensor shall be mounted at 5'-6" above finished floor in an area which free air current is not constricted or blocked, final location shall be approved by the Owner and Engineer prior to installation.

9. Elements shall be applicable for the medium being sensed; i.e., strap-on elements, room elements, well- mounted elements, duct mounted elements and outdoor mounted elements. Range shall be from 0 to 120 degrees F.

E. Electronic Static Pressure Sensors

Static pressure sensors shall be differential pressure sensors, with the "high" output sensing the duct pressure and the "low" input sensing the atmospheric pressure.

The range for the static pressure sensor shall be matched to the static pressure of the system being sensed, 0 to 0.5 inches, 0 to 2 inches, 0 to 5 inches, or 0 to 10 inches.

Accuracy shall be plus or minus 2% of the full range being sensed.

BAPI sensor with digital read-out display.

F. Thermostats

Two position (On/Off) room thermostat with bimetallic sensing element, setpoint thumbwheel dial, room temperature indicator, surface mounting base, and hard plastic coverplate, UL listed as manufactured by Barber Coleman, Series TC, or equivalent by Honeywell or RobertShaw.

G. Humidity Sensor/Transmitter

Provide relative humidity sensor/transmitter where shown on the control drawings. Sensor and transmitter shall have:

System Accuracy.....+2% RH @ 25ºC from 20-95% RH

Output Signal.....Two wire 4-20 mA linear, proportional to 0-100% RH

The transmitter power shall be compatible with and powered by, the low voltage power supplied by this Contractor.

H. Outside Air Monitor and Control

1. Each VAV air handling unit shall have an airflow control station capable of performing constant volume control of outside air without loss of required outside air at part load.

2. Each airflow monitor and control station shall be complete with velocity pressure transmitter and air volume flow rate control.

   a. Pressure transmitter ranges shall be selected such that the velocities across the air monitor sensing element are at mid-range of the manufacturer's velocity range for the sensor.

   b. The Controls Contractor shall verify any outside air dampers not used to achieve the velocity requirements are disconnected and permanently secured shut.

   c. The Controls Contractor shall notify the Division 15 Contractor of any outside air openings that result in bypassing the air monitor sensor.

3. The major control instruments shall be capable of the following minimum performance:

   a. Differential Pressure Transducer: The differential pressure transducer shall be capable of transmitting a linear 4 to 20 ma (or 0 to 10 volts) output signal proportional to the differential (velocity) pressure input signals within the following performance and applications criteria.

      (1) Calibrated Spans .....not greater than 1-1/2 times the maximum design velocity pressure.

      (2) Calibrated Overall Accuracy .....±1.0% of span.

      (3) Repeatability .....±0.05% of output.

      (4) Operating Range of Sensor .....20°F to 150°F.

      (5) Operating Range of Transmitter ...20°F to 150°F.

      (6) The transmitter output shall be unaffected by direction (or attitude) of mounting or external vibrations, and shall be furnished with a factory calibrated span.

4. Units to comply with minimum manufacturer’s up and downstream configuration, to be coordinated with Division 15 Contractor.

5. All velocity to CFM calculations shall be done in the DDC system.

6. Where called for on the AHU specifications, the AHU manufacturer shall provide the sensing station and matched velocity to signal conversion. Linearization and conversion from velocity to CFM shall be done in the DDC system.

7. When using a duct mounted air monitoring station, the sensing station shall be the responsibility of the Controls Contractor. The velocity signal shall be brought into the DDC system. Linearization and conversion to CFM shall be accomplished in the DDC system.

I. Airflow Measuring Stations (Duct Airflow Measuring Device)

1. Each device shall be designed and built to comply with, and provide results in accordance with accepted practice as defined for system testing in the latest revision of ASHRAE Handbook of Fundamentals as well as the latest revision of the Industrial Ventilation Handbook.

2. Airflow measuring stations shall be fabricated of heavy galvanized steel welded casing with 90 degree connecting flanges in a configuration and size equal to that of the duct it is mounted into. Each station shall be complete with an air directionalizer and parallel cell profile suppresser across the entering air stream and mechanically fastened to the casing, equal-area and equal-weighted averaging total pressure sensors and manifold, bullet-nose shaped static pressure sensors with averaging manifold, internal piping, and external pressure transmitter ports. An identification label shall be placed on each unit casing listing model number, size, area, and specified airflow capacity.

3. The maximum allowable pressure loss through the unit shall not exceed 0.1"w.g. Each unit shall be capable of measuring the airflow rate within an accuracy of 2% as determined by U.S. GSA. Certification tests shall contain a minimum of one total pressure sensor per thirty-six square inches of unit measuring area.

4. Stations shall be installed in strict accordance with the manufacturer's published requirements. Final location shall be coordinated with the mechanical or the sheet metal subcontractor. These stations serve as the primary signals for the airflow control systems; therefore, it shall be the responsibility of the Contractor to verify location and installation to assure that accurate primary signals are obtained.

5. The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.

6. Stand-alone airflow measuring stations shall be Model HTA, as manufactured by EBTRON or pre-approved substitute. Refer to schedules and floor plans.

7. Each air monitor shall be tested by the Project TAB Contractor. Tests shall be conducted at full and part load fan capacity.

J. Control Wiring

1. All conductors shall be of stranded copper wire.

2. All EMT/conduit and outlet boxes shall conform to the requirements specified under Division 16, Electrical.

3. All cables run exposed in return air plenums shall be smoke rated for the application. Do not run wire in drywall without conduit.

4. All wiring cables shall have 600 volt insulation.

5. Cables shall be properly identified/tagged as to the control point.

6. All cables from ceilings to wall temperature sensors shall be installed in conduit (EMT).

K. Differential Pressure Transmitter/Orifice Flow Station

1. Transmitter: Provide a Rosemount Model 1151DP Alphaline Flange-mounted Differential Pressure Transmitter with all necessary installation hardware (seals, flanges, etc.). Unit shall be mounted at eye level for ease of calibration. Contractor shall calibrate instrument for 4-20 mA output (input into building control system). Coordinate the transmitter range with the requirements of the mechanical system prior to submitting shop drawings. The mounting flange shall be 150 psi rating class, 316 stainless steel. Sensor module and low side materials shall be 316 stainless steel. The high pressure side process fill shall be capable of air operating range of 0-200°F. Provide unit with LCD display, 0-100%. This Contractor shall provide power as required. Make all final piping connections to transmitter.

2. Orifice Plate: Furnish and install as shown on plans, a cast iron wafer-type flow meter designed for low pressure drop operation. The flow meter will be equipped with brass readout valves (with integral check valve) for taking differential pressure readings across the orifice of the flow meter. The flow meter shall be designed to operate at a maximum working pressure of 300 psig at 250°F. The flow meter must be furnished with a calibrated nameplate for determining an accurate system flowrate. Each flow meter shall be ITT Bell & Gossett Circuit Sensor Flow Meter Model No. OP-4A or approved equal.

L. Water Flow Meter

1. Furnish an in-line, bidirectional, electromagnetic flow meter. Paddle type flow meters and insertion type flow meters shall not be acceptable. Each meter shall be individually calibrated and tagged accordingly against the manufacturer's primary standards which must be traceable to the U.S. National Institute of Standards and Technology (NIST).

2. The meter shall have a maximum operating pressure of 230 PSI, maximum operating temperature of 220 degrees F. Accuracy shall be +/- 0.003% from 0.033 fps to 1.6 fps and +/-0.2% from 1.6 fps to 33 fps within actual reading.

3. The sensor shall have integral 4-20 mA current output for connection to the ATCS system. The sensor shall also include (2) isolated programmable digital/pulse outputs configurable for frequency, pulse, alarm, or directional flow.

4. The outer body shall be painted carbon steel. The flow tube shall be 304 stainless steel.

5. The meter shall have backlit 16 character display, 8 line graphic LCD display for flow rate, velocity, flow direction, totals, short term trend data and error messages.

5. Basis of design

a. Onicon Model F-3200

M. Hydronic Energy Meters, Chilled Water

1. Provide an Onicon System 10 BTU Meter at each location where chilled water enters the buildings, prior to any branches or secondary take offs. Refer to drawings for locations.

2. Furnish Onicon System-10 BTU Meters with differential temperature accuracy of +/- 0.15°F, liquid temperature range of 32° to 200°F and an alphanumeric LCD to display total energy, total flow, energy rate, flow rate, supply temperature and return temperature.

3. The BTU meter shall provide complete energy, flow and temperature data to the Control System through a single BACnet network connection.

4. Provide water flow meter as specified in Section “Water Flow Meter.”

N. Make-up Water Meter

1. Furnish an approved single turbine flow sensor complete with hot tap full port ball valve and installation hardware. Paddle type rotors will not be acceptable. Rotational sensing of the turbine shall be accomplished electronically by sensing impedance change and not with magnetic or photoelectric means. Each sensor shall be individually calibrated and tagged accordingly against the manufacturers primary standards, which must be accurate to within 0.1% traceable to the U.S. National Institute of Standards and Technology (NIST).

2. The sensor shall have a maximum operating pressure of 227 PSI, maximum operating temperature of 250 degrees F, (optional 300 degrees F) and a pressure drop of less than 1 PSI at 17 feet per second flow rate. Flow sensor shall have 32: 1 turndown ratio. Accuracy shall be +/- 1% of actual reading from 0.4 feet per second to 20.0 feet per second.

3. The sensor shall have integral analog outputs of 0 to 24 vdc and/or 4-20 m A current output for connection to the DDC system. The sensor shall also include an internal frequency output consisting of 0 to 15 VDC pulses for diagnostics purposes and for connection to peripheral equipment (local display, BTU meter, etc.). All outputs shall be linear with flow.

4. The turbine element shall have EDPM o-ring seals. be made of polypropylene (optional polsulfone) with sapphire jewel bearings and tungsten carbide shafts. The flow sensor shall be constructed of Brass for sizes ¾”- 1½” and Epoxy coated cast iron for sizes 2”-10” with aluminum electronics enclosure and gasket cover.

5. Basis of design is Niagara Model 860 (MTX or WPX depending on size) with digital pulse transmitter module.

O. Current Switches

1. Provide a solid state switch which when the current level sensed by the internal current transformer exceeds the adjustable trip point. Internal circuits are to be totally powered by induction from the line being monitored. Provide a zero off-state leakage in the solid-state relay output, while switching both AC and DC circuits. Provide an LED that will show three pieces of information (Rapid Flashing-switch is tripped, Slow Flashing-current is present but below the trip point and no Flashing-current is either off or below the bottom of the range) and permits setting the trip point adjustment prior to system connection.

P. Filter Status Transmitter

1. Provide filter status for all central station air handling units. The transmitter shall have both visual monitoring and electronic control of very low differential pressure. The transmitter shall have 4-20ma output signal to be used by the DDC system. Fan coil units shall not have filter status unless the Engineer recommends it.

2. Transmitter shall be Dwyer series 605.

Q. Variable Frequency Drive (VFD) Motor Speed Controller (Refer to Drawings for Voltage, Size, and Location found on Pump and/or Air Handling Unit Equipment Schedules)

1. Variable Frequency Drives and other Adjustable Speed Drives/Controllers are to be provided by others and interfaced by this Controls Contractor into the DDC system;

2. Provide the following minimum hard-wired discrete inputs/outputs between the drives and the DDC system:

a. AO to control drive speed;

b. AI reference to monitor actual drive speed;

c. BO to activate the drive;

d. BI for drive failure alarm (drive fault).

3. If specifically called for on the plans, provide a communications integration interface between the drive and DDC system. This requirement shall not replace the requirement for the listed minimum discrete I/O points.

R. Outside Air Monitor and Control

1. Each VAV air handling unit shall have an airflow control station capable of performing constant volume control of outside air without loss of required outside air at part load.

2. Each airflow monitor and control station shall be complete with velocity pressure transmitter and air volume flow rate control.

a. Pressure transmitter ranges shall be selected such that the velocities across the air monitor sensing element are at mid-range of the manufacturer's velocity range for the sensor.

b. The Controls Contractor shall verify any outside air dampers not used to achieve the velocity requirements are disconnected and permanently secured shut.

c. The Controls Contractor shall notify the Division 15 Contractor of any outside air openings that result in bypassing the air monitor sensor.

3. The major control instruments shall be capable of the following minimum performance:

   a. Differential Pressure Transducer: The differential pressure transducer shall be capable of transmitting a linear 4 to 20 ma (or 0 to 10 volts) output signal proportional to the differential (velocity) pressure input signals within the following performance and applications criteria.

      (1) Calibrated Spans .....not greater than 1-1/2 times the maximum design velocity pressure.

      (2) Calibrated Overall Accuracy .....±1.0% of span.

      (3) Repeatability .....±0.05% of output.

      (4) Operating Range of Sensor .....20°F to 150°F.

      (5) Operating Range of Transmitter ...20°F to 150°F.

      (6) The transmitter output shall be unaffected by direction (or attitude) of mounting or external vibrations, and shall be furnished with a factory calibrated span and be field verifiable.

4. Units shall comply with the minimum manufacturer's upstream and downstream configuration, to be coordinated with Division 15 Contractor.

5. All velocity to CFM calculations shall be done in the DDC system.

6. Where called for on the AHU specifications, the AHU manufacturer shall provide the sensing station and matched velocity to signal conversion. Linearization and conversion from velocity to CFM shall be done in the DDC system.

7. When using a duct mounted air monitoring station, the sensing station shall be the responsibility of the Controls Contractor. The velocity signal shall be brought into the DDC system. Linearization and conversion to CFM shall be accomplished in the DDC system.

S. Airflow Measuring Stations (Duct Airflow Measuring Device)

1. Each device shall be designed and built to comply with, and provide results in accordance with accepted practice as defined for system testing in the latest revision of ASHRAE Handbook of Fundamentals as well as the latest revision of the Industrial Ventilation Handbook.

2. Airflow measuring stations shall be fabricated of heavy galvanized steel welded casing with 90 degree connecting flanges in a configuration and size equal to that of the duct it is mounted into. Each station shall be complete with an air directionalizer and parallel cell profile suppresser across the entering air stream and mechanically fastened to the casing, equal-area and equal-weighted averaging total pressure sensors and manifold, bullet-nose shaped static pressure sensors with averaging manifold, internal piping, and external pressure transmitter ports. An identification label shall be placed on each unit casing listing model number, size, area, and specified airflow capacity.

3. The maximum allowable pressure loss through the unit shall not exceed 0.1"w.g. Each unit shall be capable of measuring the airflow rate within an accuracy of 2% as determined by U.S. GSA. Certification tests shall contain a minimum of one total pressure sensor per thirty-six square inches of unit measuring area.

4. Stations shall be installed in strict accordance with the manufacturer's published requirements. Final location shall be coordinated with the mechanical or the sheet metal subcontractor. These stations serve as the primary signals for the airflow control systems; therefore, it shall be the responsibility of the Contractor to verify location and installation to assure that accurate primary signals are obtained.

5. The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.

6. Stand-alone airflow measuring stations shall be Model HTA, as manufactured by EBTRON or pre-approved substitute. Refer to schedules and floor plans.

7. Each air monitor shall be tested by the Project TAB Contractor. Tests shall be conducted at full and part load fan capacity.

PART 3 INSTALLATION

3.1 CONTROL WIRING

A. Provide conduit and outlet boxes.

B. Install remote push-button stations and/or control devices interposed in the control wiring.

C. Provide over-current protection for all control and interlock wiring as specified in NFPA (70.1971) Art. 240-5 (a), Exception #4 and Art. 430-72, Exception.

D. Line voltage and exposed low voltage control wiring shall be run in conduit.

E. No splices will be allowed except at junction boxes and control centers.

F. No two wires of the same color shall be run in one conduit unless wires of the same color are properly tagged at both ends and any splice points. Do not change colors at splice points.

3.2 INSTALLATION

A. The control sequences indicated in the specifications herein show the intended sequences of operation of the various control systems and shall be followed completely, deviations are not acceptable.

B. Each control system shall be complete with all necessary thermostats, valves, relays, switches, accessories, etc., and all interconnections, and so arranged that they will provide the proper automatic sequence of operation between the various control devices as required to maintain the desired temperature, conditions and sequences.

C. All control equipment shall be fully modulating unless otherwise noted, and relays or accessories not specifically mentioned but required for proper operation shall be included.

D. The system shall be installed by competent mechanics and electricians regularly employed by the controls Contractor. Installation by mechanical Contractor is not acceptable.

E. Control and instrument wiring and capillaries are to be secured to building structure—not to ductwork.

F. The exact location of instruments, panelboards, accessories, etc., not definitely located shall be approved by the Architect/Engineer.

G. All automatic controls and accessories shall be located in accessible locations.

H. All non-panel, as well as panel mounted instruments, shall be clearly labeled as to use and system served by means of engraved laminated nameplates.

I. Where control instruments or accessories are to be installed on covered casings, ductwork, etc., they shall be mounted on the finished surface of the covering. Care shall be taken that there are no leaks around the stems where they pass through the metal work.

J. All modulating control valves, dampers, etc., shall operate in a slow, gradual manner without any jerking or slamming.

K. All controls shall operate satisfactorily without any cycling or hunting. The manufacturer shall furnish any necessary additional controls, relays or damping devices as required to correct cycling or hunt that occurs in any part of the control system after the system is in operation.

L. Automatic control manufacturer shall provide power to all electric actuators requiring external power source whether they are furnished by him or part of other equipment.

M. Electronic VAV controllers, motors, and sensors shall be provided under this scope of work. The control Contractor shall also include the cost of mounting controllers and motors by the VAV box manufacturer in his price.

N. The Automatic Control Contractor shall furnish all motorized valves and dampers to the Mechanical Contractor for installation.

3.3 CONTROL MANUFACTURER'S FIELD SERVICES AND INSTRUCTIONAL REQUIREMENTS

A. Start-up and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation. On-site training shall not begin until the system has been accepted by the Engineer and field verifications completed.

B. Local Training (Classroom Training): Local training shall be provided for up to 7 of the Owner’s representatives (6 staff members and the Engineer of Record). Local training may be held at the Owner’s site or at the local distributors offices at the sole discretion of the Engineer. This training shall be customized to address only specific hardware/software used at the site. A working understanding of documentation formats shall be a part of this training. Course outline and schedule shall be submitted to the Engineer no less than 30 days prior to commencement. Training shall consist of both lecture and hands-on format and must address troubleshooting as well as operation of the system and in accordance with the training syllabus described herein.

The training syllabus shall include as a minimum the following:

- ❑ System Architecture and Overview
  - ❍ Menus
  - ❍ Demo disk/workshop
  - ❍ Building control
  - ❍ Scheduling
  - ❍ Zone control
  - ❍ Trend logs
  - ❍ Program priorities
- ❑ Application Troubleshooting
  - ❍ System set-up
  - ❍ Times and dates
  - ❍ Input/output data
  - ❍ Configuration
  - ❍ ICS local programming
  - ❍ Building status/graphics
  - ❍ Maintenance procedures
  - ❍ Troubleshooting procedures

Schedule shall be for no less than four (4) hours of such instruction per individual. Local training shall be completed within 15 days prior to substantial completion, but after field verification. Cost of local training is a part of this contract.

C. On-site Training: On-site training shall be provided for up to 7 of the Owner's representatives (6 staff members and the Engineer of Record). This training shall be completed in groups of no more than 4 persons per group at one time in one 4-hour session for each group. The training shall focus on the specific installation and shall address both hardware and software. This training shall be completed after local training and after substantial completion. Specific as-built documentation for this project shall be used for reference as a part of this training. Pre-submit course outline to Engineer as stated above.

D. For all levels of training, a sign-off sheet shall be submitted to the Engineer certifying that each individual has completed such training to acceptance of individual. Hours of instruction received shall be a part of the sign- off sheet.

E. It shall be the Owner's responsibility to provide adequate time for attendance at all training sessions.

F. Training Aids: Provide an “Owner’s Copy” factory prepared DVD describing in layman’s terms the complete operation of the system. This DVD shall be professionally made by the manufacturer of the system. DVDs (home made) locally are not acceptable. Provide a copy of this DVD with the submittal package to the Engineer for approval prior to proceeding.

3.4 DEMONSTRATION

A. General: Provide field testing and adjustment of the complete EMCS and on-site, operational acceptance test of the complete operational EMCS. The Owner may witness all tests.

B. Field Test: When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on line. All testing, calibration, adjusting, and final field tests shall be completed by the Controls Manufacturer. Provide a cross check of each control point within the EMCS by making a comparison between the control demand at the Master and field controlled device. Verify that all systems are operable from local controls in the specified failure mode upon EMCS failure or loss of power. Verify that all systems return to EMCS control automatically upon resumption of EMCS operation or return of power. Submit the results of functional, cross and diagnostic tests.

C. The Controls Manufacturer shall, as a part of the base scope, provide two (2) days of operational verification, on-site, with the design Engineer present throughout. The verification shall be completed during two (2) continuous days during building non-occupancy, at the end of the final phase of project construction. This two (2) day period shall be over a weekend unless otherwise agreed upon in writing by the Controls Manufacturer and Engineer at the end of the two (2) day period.

The punchlist items shall be corrected by the Installer to the satisfaction of the Engineer within a two (2) week period directly following the verification period and shall be demonstrated to the Engineer on a weekend day in order to complete the verification process. This process shall continue until all items have been successfully demonstrated and acknowledged to the Engineer in writing. This must be completed prior to substantial completion.

3.5 ACCEPTANCE AND WARRANTY

A. An acceptance test of the completed system in the presence of the Owner's representative and the Engineer shall be performed. When the system performance is deemed satisfactory by these observers and all record (as-built) drawings have been received by the Owner, that part of the system shall be accepted for beneficial use and shall be considered complete.

B. All control hardware, software, and firmware delivered to the Installer by the Controls Manufacturer shall be warranted by the Controls Manufacturer for a period of two (2) years following the date of completion. Defects arising during this warranty period shall be corrected without cost to the Owner.

3.9 CONTRACTOR TRENDING REQUIREMENTS

A. Contractor shall configure the system to provide Excel Spreadsheets showing all points (I/O; virtual points; Setpoints; etc.) referenced in the documents at 5 minute intervals. Coordinate the number of spreadsheets and layout with the Engineer of Record. The spreadsheets shall be electronically submitted weekly to the Engineer throughout the

Warranty period. The first such spreadsheet shall be submitted and approved for content and format by the Engineer prior to Substantial Completion. Weekly submittal shall be consistent in layout week to week.

PART 4 SEQUENCE OF OPERATION

4.1 MULTIZONE AIR HANDLING UNIT

A. General:

1. Each AHU shall be controlled by its own dedicated DDC control panel. Each panel shall in-turn communicate with the Energy Management Control System (EMCS) over a twisted pair of wires. Provide mixed air low limit controllers to prevent the mixed air temperature from dropping below a preset level. The outside air damper shall close automatically if the mixed air drops below setpoint and send an alarm message to the printer. This damper shall require a reset through the computer terminal (manually) or automatically reset based on the outside air temperature (rise above 40°F). The system shall be capable of both reset methods.

2. Provide a high pressure sensor in the supply duct to shut-off the AHU fan if the duct static pressure exceeds the pressure setpoint (2-1/2" WG adjustable).

3. Interlock the exhaust fans per the schedule on the drawings.

4. Smoke detectors shall also be provided at the main supply air ducts of each air handling unit. The operation of the AHU is indexed by the DDC control panel from time scheduling command or from an operator command. The AHU is a multizone unit with a chilled water coil and electric heating coils in a blow thru configuration.

5. Monitor and Alarm Points:

   The following points will be monitored and alarmed at the EMCS: (also see point list)

   - ❑ Outside air temp
   - ❑ SA temp air temp (heating coil and cooling coil)
   - ❑ Low limit status
   - ❑ DDC loop parameters
   - ❑ Cool output %
   - ❑ Fan status
   - ❑ Sensors norm/fail status
   - ❑ Filter norm/dirty
   - ❑ Supply air static pressure
   - ❑ Outside air flowrate (CFM)

The following points will be operator adjustable and/or automatically reset by a EMCS program:

- ❑ Heating setpoint
- ❑ Cooling setpoint
- ❑ Unoccupied setpoints
- ❑ Supply air static pressure
- ❑ Reheat setpoint
- ❑ Outside air flowrate (CFM)
- ❑ Cold deck setpoint

Upon loss of communication with EMCS the standalone AHU DDC controller on each AHU shall operate in occupied mode.

B. Occupied Mode:

1. Cooling Mode Control

a. The 'Cooling-Off-Heating' mode selector switch is manually placed in the 'Cooling' mode which shall send a digital signal to the main EMCS panel. 'Cooling' mode is then broadcast to all local controllers. Control action shall be automatically adjusted at each controller. Changeover valves are in their 'Normal' position. At this point, no equipment is operating and the controllers are waiting and listening for further instructions.

b. Upon a timed local override signal or a scheduled start signal from the EMCS, the AHU or predetermined combination of AHUs (user definable) and required combination of secondary pumps (PCHP-1 and PCHP-2) shall start (each AHU H-O-A switch is required to be in the 'Auto' position). The outside air damper shall either open upon start of the AHU fan or open according to the morning warm-up sequence described later in this Section.

c. The AHU local control panels shall begin controlling the outside air cooling coils average discharge air temperature in the unit by manipulating the chilled water flowrate through the coil by modulating the chilled water control valve. The average discharge air temperature off of the cooling coil shall be maintained at +1/2°F to setpoint (52°F adjustable). The respective AHU local control panels shall also control the heating coil average discharge air temperature in the unit by cycling the reheat coil as required to maintain room temperature at setpoint if 100% of zone airflow is bypassed around cooling coil and zone temperature falls below setpoint. Reset the return air cooling coil leaving air temperature as required to maintain the critical zone bypass damper at 95% airflow through the cooling coil. Each zone’s multizone damper shall be modulated as required to maintain its respective space temperature sensor at setpoint (72°F adjustable).

d. The following points will be operator adjustable and/or automatically reset by the Main Controller program:

- ✦ Heating setpoints

- ✦ Cooling setpoints
- ✦ Unoccupied setpoints

e. Upon loss of communication with the Main Controller, the standalone AHU DDC controller on each AHU shall operate in occupied mode. Provide an H-O-A switch at the air handler to be normally in Auto position for control by the main controller. When the switch is in Hand mode, the air handler shall run continuously regardless of whether the PCM is operational or not. When the switch is in the Off position, the air handler shall shutdown. Exhaust fan interlocks shall operate through this H-O-A switch as well so that the exhaust fans interlock in the Hand mode.

2. Shutdown

a. Set the shutdown sequence schedule up to first stop flow of chilled water through the unit 15 minutes prior to stopping the air handler fan. This is to accommodate a dry down cycle.

4.2 VARIABLE VOLUME AIR HANDLING UNIT

A. General

1. Each AHU shall be controlled by its own dedicated DDC control panel. Each panel shall in-turn communicate with the Energy Management Control System (EMCS) over a twisted pair of wires. Provide mixed air low limit controllers to prevent the mixed air temperature from dropping below a preset level. The outside air damper shall close automatically if the mixed air drops below setpoint and send an alarm message to the printer. This damper shall require a reset through the computer terminal (manually) or automatically reset based on the outside air temperature (rise above 40°F). The system shall be capable of both reset methods.

2. A static pressure transmitter, located 2/3 downstream before the last takeoff, shall transmit a signal to the DDC control panel which shall, through its PID control loop, modulate the fan inlet guide vane actuator in order to maintain constant setpoint.

3. Provide a high pressure sensor in the supply duct to shut-off the AHU fan if the duct static pressure exceeds the pressure setpoint (2-1/2" WG adjustable).

4. Interlock the exhaust fans per the schedule on the drawings.

5. Differential pressure switches are required for fan flow status (digital type) and for filter status (analog type) indication. Smoke detectors shall also be provided at the return air and supply air ducts of each air handling unit. The operation of the AHU is indexed by the DDC control panel from time scheduling command or from an operator command. The AHU is a variable volume unit with a chilled water coil and a hot water coil in a draw thru configuration.

6. Monitor and Alarm Points

The following points will be monitored and alarmed at the EMCS: (also see point list)

- ❑ Outside air temp

- ❑ SA temp air temp (heating coil and cooling coil)
- ❑ Low limit status
- ❑ DDC loop parameters
- ❑ Cool output %
- ❑ Fan status
- ❑ Sensors norm/fail status
- ❑ Filter norm/dirty
- ❑ Supply air static pressure
- ❑ Outside air flowrate (CFM)

The following points will be operator adjustable and/or automatically reset by a EMCS program:

- ❑ Heating setpoint
- ❑ Cooling setpoint
- ❑ Unoccupied setpoints
- ❑ Supply air static pressure
- ❑ Reheat setpoint
- ❑ Outside air flowrate (CFM)
- ❑ Cold deck setpoint

Upon loss of communication with EMCS, the standalone AHU DDC controller on each AHU shall operate in occupied mode.

B. Occupied Mode:

1. Cooling Mode Control

a. The 'Cooling-Off-Heating' mode selector switch is manually placed in the 'Cooling' mode which shall send a digital signal to the main EMCS panel. 'Cooling' mode is then broadcast to all local controllers. Control action shall be automatically adjusted at each controller. Changeover valves are in their 'Normal' position. At this point, no equipment is operating and the controllers are waiting and listening for further instructions.

b. Upon a timed local override signal or a scheduled start signal from the EMCS, the AHU or predetermined combination of AHUs (user definable) and required combination of secondary pumps shall start (each AHU H-O-A switch is required to be in the 'Auto' position). The outside air damper shall either open upon start of the AHU fan or open according to the morning warm-up sequence described later in this Section.

c. The AHU local control panels shall begin controlling the cooling coils average discharge air temperature in the unit by manipulating the chilled water flowrate through the coil by modulating the chilled water control valve. The average discharge air temperature off of the cooling coil shall be maintained at +1/2°F to setpoint (52°F adjustable).

d. Constant Outside Air Control

1) The air monitor shall sense total air pressure and static pressure in the outside air duct. This signal shall be converted and transmitted by the differential pressure transmitter via a 4-20 mA signal to the PCM (analog input). The signal shall be linearized and converted to a flowrate (CFM). This flowrate shall be compared to setpoint, and through the PCMs PID control algorithm, the controller shall manipulate the position of the outside air and return air dampers to control the outside air CFM. The dampers shall be manipulated using split range control, first modulating the outside air damper to its full open position before modulating the return air damper closed. A separate analog output signal shall be provided for each damper.

The outside air damper and return air damper shall be controlled to maintain a constant amount of outside air throughout the AHU fan operating curve. This Contractor shall work with the T&B Contractor for calibration to these conditions and characteristics.

(2) Morning warm-up sequence shall be provided as an option for all units. During morning warm-up, the AHU supply fan is energized, the outside air dampers remain closed, interlocked relief and exhaust fans shall remain off, the VAV boxes shall be energized, and the AHU controls are energized. The outside air dampers shall remain closed for a period of 5 minutes (adjustable) or until space temperature setpoints have been met. During the period in which the outside air damper remains closed, the respective exhaust and relief fans for that system shall remain off so that system air balance is achieved and air infiltration does not occur. When the outside air dampers open and begin controlling outside air flowrate, then interlocked relief and exhaust fans shall start.

Limit switches shall be provided for both the outside air dampers and return air dampers to indicate when the damper is either in the full open position or full close position. All limit switches shall be a digital input to the Energy Management System. The AHU fan shall not start if both the outside air damper and return air damper are in the full close position.

e. Static Pressure

1) A static pressure transmitter, located 2/3 downstream before the last takeoff, shall transmit a signal to the DDC control panel which shall, through its PID control loop, modulate the fan volumetric flowrate through a variable inlet vane (4-20 mA) device (4-20 mA actuator is a part of this Base Bid).

f. The following points will be operator adjustable and/or automatically reset by the Main Controller program:

- ✦ Heating setpoints
- ✦ Cooling setpoints
- ✦ Unoccupied setpoints
- ✦ Outside air quantity setpoints

g. Upon loss of communication with the Main Controller, the standalone AHU DDC controller on each AHU shall operate in occupied mode. Provide an H-O-A switch at the air handler to be normally in Auto position for control by the main controller. When the switch is in Hand mode, the air handler shall run continuously regardless of whether the PCM is operational or not. When the switch is in the Off position, the air handler shall shutdown. Exhaust fan interlocks shall operate through this H-O-A switch as well so that the exhaust fans interlock in the Hand mode.

2. Heating Mode Control

a. The 'Cooling-Off-Heating' mode selector switch is manually placed in the 'Heating' mode which shall send a digital signal to the main EMCS panel. 'Heating' mode is then broadcast to all local controllers. Control action shall be automatically adjusted at each controller.

b. Upon a timed local override signal or a scheduled start signal from the EMCS, the AHU or predetermined combination of AHUs (user definable) (each AHU H-O-A switch is required to be in the 'Auto' position).

c. The AHU local control panels shall begin controlling the heating coils discharge air temperature in the unit by manipulating the electric heat strips The average discharge air temperature off of the heating coil shall be maintained to setpoint (85°F +1/2°F).

d. Constant outside air shall be controlled as described in the cooling mode.

3. Shutdown

a. Set the shutdown sequence schedule up to first stop flow of chilled water through the unit 15 minutes prior to stopping the air handler fan. This is to accommodate a dry down cycle.

4.3 CONSTANT VOLUME AIR HANDLING UNIT

A. General

1. Each AHU shall be controlled by its own dedicated DDC control panel. Each panel shall in-turn communicate with the Energy Management Control System (EMCS) over a twisted pair of wires. Provide mixed air low limit controllers to prevent the mixed air temperature from dropping below a preset level. The outside air damper shall close automatically if the mixed air temperature drops below setpoint.

2. Interlock the exhaust fans per the schedule on the drawings.

3. Differential pressure switches are required for fan flow status (digital type) and for filter status (analog type) indication. Smoke detectors shall also be provided at the return air and supply air ducts of each air handling unit. The operation of the AHU is indexed by the DDC control panel from time scheduling command or from an operator command. The AHU is a constant volume unit with a chilled water coil and a hot water coil in a draw thru configuration.

4. Monitor and Alarm Points

   The following points will be monitored and alarmed at the EMCS: (also see point list)

   - ❑ Outside air temperature
   - ❑ SA temp air temperature (heating and cooling)
   - ❑ Low limit status
   - ❑ DDC loop parameters
   - ❑ Cool output %
   - ❑ Fan status
   - ❑ Sensors norm/fail status
   - ❑ Filter norm/dirty

   The following points will be operator adjustable and/or automatically reset by a EMCS program:

   - ❑ Heating setpoint
   - ❑ Cooling setpoint
   - ❑ Unoccupied setpoints
   - ❑ Reheat setpoint

   Upon loss of communication with EMCS the standalone AHU DDC controller on each AHU shall operate in occupied mode.

B. Occupied Mode

1. Cooling Mode Control

   a. The 'Cooling-Off-Heating' mode selector switch is manually placed in the 'Cooling' mode which shall send a digital signal to the main EMCS panel. 'Cooling' mode is then broadcast to all local controllers. Control action shall be automatically adjusted at each controller. Changeover valves are in their 'Normal' position. At this point, no equipment is operating and the controllers are waiting and listening for further instructions.

b. Upon a timed local override signal or a scheduled start signal from the EMCS, the AHU or predetermined combination of AHUs (user definable) and required combination of secondary chilled pumps shall start (each AHU H-O-A switch is required to be in the 'Auto' position). The outside air damper shall open upon start of the AHU fan.

c. The AHU local control panels shall begin controlling the cooling coils average discharge air temperature in the unit by manipulating the chilled water flowrate through the coil by modulating chilled water control valve. The average discharge air temperature off of the cooling coil shall be maintained at +1/2°F to setpoint (52°F adjustable).

2. Heating Mode Control

a. The 'Cooling-Off-Heating' mode selector switch is manually placed in the 'Heating' mode which shall send a digital signal to the main EMCS panel. 'Heating' mode is then broadcast to all local controllers. Control action shall be automatically adjusted at each controller.

b. Upon a timed local override signal or a scheduled start signal from the EMCS, the AHU or predetermined combination of AHUs (user definable) (each AHU H-O-A switch is required to be in the 'Auto' position).

c. The AHU local control panels shall begin controlling the electric heating coil discharge air temperature. The average discharge air temperature off of the heating coil shall be maintained to setpoint (85°F +1/2°F).

3. Unoccupied Mode

a. The AHU is off, the OA damper is closed and the control valve is closed. The controls shall remain off until indexed by the EMCS to operate. If the space temperature rises above an unoccupied setpoint, the unit shall cycle but the OA damper shall remain closed.

4. Shutdown

a. Set the shutdown sequence schedule up to first stop flow of chilled water through the unit 15 minutes prior to stopping the air handler fan. This is to accommodate a dry down cycle.

4.4 CHILLER PLANT

A. Refer to controls drawings for written Sequence of Operations.

4.5 CHILLER (CH-1)

A. The standalone DDC microprocessor based chiller control panel shall monitor and control the chillers in a standalone mode or as directed by the EMCS. Perform the following chiller plant control strategies. See Section 15682 for complete coordination with chiller systems.

Chiller Sequencing—The EMCS shall start and stop system water pumps and chillers based upon the loading of the operating chillers. The points at which chillers are started and stopped shall be designated by chiller. The chiller sequencing routine shall allow automatic rotation of chiller operation in order to equalize chiller run time.

On an automatic command from the EMCS optimal/start program or from a manual command from the EMCS operator's terminal the chilled water system shall be enabled. First the chilled water pump for the lead chiller shall start and prove flow through the evaporator bundle. Only after the chilled water pumps are proven shall the chiller start.

The lag chiller shall start whenever the lead chiller current draw exceeds a user definable setting or when the common loop supply temperature exceeds setpoint. The lag chiller shall start in a similar manner to the lead chiller start sequence. The lead chiller will unload to match the lag chiller current draw. The two chillers shall then operate in unison as they load and unload to meet system demands. When the system current draw drops below a user definable setting, the lag chiller shall shut down.

Chilled Water Reset (Required for CH-1)—The EMCS shall allow reset of the chilled water supply temperature setpoint based on return chilled water, ambient temperature, or any other monitored point such as selected space temperature. The reset parameters shall be user selectable.

Chiller Demand Limiting (Required for CH-1)—As part of the demand limiting scheme on the building, the EMCS shall be able to monitor and reduce peak power demand through the limiting of chiller system capacity. The demand routine shall have automatic limit adjustment and shall allow automatic override based upon chilled water supply, chiller water return, and/or critical building zone temperature.

The DDC panel shall maintain a constant condenser supply water temperature by cycling the fans as required.

4.6 EMERGENCY EXHAUST CONTROL IN SCIENCE CLASSROOMS

A. The emergency exhaust fans are primarily to be operated when excessive fumes or odors are required to be evacuated from the room rapidly. The fan shall be started by the emergency push-button at the Teacher's desk. The motorized damper shall open, and after a 10 second delay, the exhaust fan shall run continuously for 20 minutes (adjustable between 0-60 minutes). Room air conditioning is not expected to be maintained during this purge condition. The doors should be opened while this fan is operating as indicated by signs mounted at the door and start button (refer to plans).

4.7 DX SPLIT SYSTEM

A. Provide a low voltage thermostat to enable the condensing unit on a rise in room temperature of 2°F above setpoint and stop the condensing unit on a fall in room temperature 2°F below setpoint. The thermostat shall allow the air handler fan to either run continuously or intermittently. Install the thermostat on the wall as shown or as directed by the Owner/Engineer during construction.

4.8 GENERAL

A. The Control Contractor is responsible to provide/add the required points to correctly perform the specified sequence of operation.

*** END OF SECTION 23 09 00 ***

SECTION 23 21 13

HYDRONIC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and hydronic specialties for the following:

1. Pre-insulated Underground pipe and fittings.
2. Hot-water heating piping.
3. Chilled-water piping.
4. Condenser-water piping.
5. Glycol cooling-water piping.
6. Makeup-water piping.
7. Condensate-drain piping.
8. Blowdown-drain piping.
9. Air-vents and Air-vent piping.
10. Safety-valve-inlet and -outlet piping.
11. Air Separators
12. Strainers.
13. P/T Plugs.
14. Calibrated Balancing Valves.
15. Relief Valves.
16. Suction Diffusers.
17. Thermometers.
18. Pressure Gauges.

B. Related Sections include the following:

1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

2. Division 23 Section "Hydronic Piping Specialties" equipment and accessories for hydronic piping systems.

3. Division 23 Section "HVAC Water Treatment" flushing, cleaning and chemical water treatment for hydronic piping systems.

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

B. RTRF: Reinforced thermosetting resin (fiberglass) fittings.

C. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.4 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Chilled-Water Piping: 150 psig at 200 deg F (93 deg C).

2. Hot-Water Heating Piping: 150 psig at 200 deg F (93 deg C).

3. Chilled-Water Piping: 150 psig at 200 deg F (93 deg C).

4. Condenser-Water Piping: 150 psig at 200 deg F (93 deg C).

5. Glycol Cooling-Water Piping: 150 psig at 200 deg F (93 deg C).

6. Makeup-Water Piping: 150 psig at 200 deg F (93 deg C).

7. Condensate-Drain Piping: 150 psig at 200 deg F (93 deg C).

8. Blowdown-Drain Piping: 200 deg F (93 deg C).

9. Air-Vent Piping: 200 deg F (93 deg C).

10. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Plastic pipe and fittings with solvent cement.

2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

3. Air control devices.

4. Flushing, cleaning and chemical treatment methodology, products, equipment and procedures including begin and end schedule.

5. Hydronic specialties.

6. Pipe, Fittings and Field Insulation Methodology

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

C. Shop Drawings: Detail, at 1:20 scale (or as appropriate for representation of details), the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

D. Welding certificates.

E. Qualification Data: For Installer.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

H. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.7 EXTRA MATERIALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 PRODUCTS

2.1 PRE-INSULATED UNDERGROUND PIPE AND FITTINGS

A. General

1. Factory fabricated, pre-insulated piping system shall be used underground for chiiled water service, using a welded jointing method.

2. Unless otherwise specified, all pipe, fittings, valves, and accessories shall conform to the requirements of ANSI B31.1, and shall be of the proper type for pressure and temperature of the water systems.

B. Carrier pipe

1. Carrier pipe shall be ASTM A-53 ERW, Grade B, butt weld, standard weight.

2. All pipe cut to length in the field and fittings shall be protected from water and dirt damage by installing rubber end seals or factory fabricated PVC caps over the casing and carrier pipe sealing the ends completely from exposure. In no case shall open ends of fittings or pipes be left exposed to the environment either in the field or en route.

C. HDPE Casing Pipe

1. Seamless High Density Polyethylene (HDPE) conforming to ASTM D1248. Piping wrap shall be heat shrunk at closures.

2. Minimum jacket thickness shall be in accordance with insulation thickness table.

D. Insulation

1. Insulation shall be Polyurethane foam and shall meet the following specifications:

a. Type: Two component urethane

b. Compressive Strength: 25 psi parallel min. at 5% comp.

c. Shrinkage: None at 70 F.

d. Free Rise Density: 2 to 3 lbs/cubic foot.

e. Aged "K" (70°F - 72 hrs): 0.14 @75 F BTU per inch per hour, per degree Fahrenheit, per square foot.

f. Closed Cell Content: 90-95% in conformance with ASTM 1784 completely filling the annular space between carrier pipe and jacketing.

g. Minimum thickness shall be per Insulation Thickness Table.

E. Casing Coupling

1. The casing coupling shall be HDPE meeting classification requirements of ASTM D1248. The coupling shall be SDR 51 or heavier in accordance with ASTM D2241. Insulate at each coupling with polyurethane foam to fill annular space between carrier pipe and casing.

2. Method of sealing the couplings shall be as follows:

a. Slip the casing coupling over the joined pipe sections. The casing coupling shall then be wrapped with heat shrink material in the field to provide a watertight seal (minimum thickness of exterior wrap shall be 60 mils).

F. Fittings

1. Fittings shall be pre-insulated by the piping system manufacturer using the same insulation thickness and casing as the pipe.

2. All fittings and expansion fittings shall be fabricated as detailed on drawings.

3. Field insulation of fittings utilizing factory approved insulation kits is also acceptable. PVC sleeve extenders and fitting covers shall be sealed with heat shrink tape after insulation of fitting is complete. Fitting cover shall be completely wrapped from one end to the other with heat shrink tape.

G. Penetration Sleeves

1. Provide where piping passes through masonry or concrete walls, floors, and roofs.

2. Sleeves in outside walls below and above grade, in floor, or in roof slabs, shall be schedule 40 or standard weight coated black steel pipe.

3. Space between piping or insulation casing, and the sleeve shall be sufficient to allow proper water tight sealing, but never less than 1/2".

4. Sleeves shall be held securely in proper position and location during construction.

5. Sleeves shall be of sufficient length to pass through entire thickness of walls or slabs. Sleeves in floor slabs shall extend 2 inch above the finished floor.

6. Refer to drawings for details.

H. Penetration Seals

1. All penetrations shall be sealed to prevent water from entering the building. (Refer to details on drawings.)

I. Insulation Thickness Table

1. Thickness of insulation for pre-fabricated insulated pipe and fittings shall be as follows:

NOMINAL PIPE SIZE IN INCHES	MINIMUM INSULATION THICKNESS IN INCHES	JACKET SIZE IN INCHES	JACKET THICKNESS IN MILS
1	1.91	5.4	125
1.5	1.62	5.4	125
2	1.38	5.4	125
2.5	1.77	6.7	125
3	1.46	6.7	125
4	1.96	8.7	125
6	1.98	10.85	125
8	1.95	12.85	150
10	1.52	14.12	150
12	1.53	16.14	150
14	1.88	18.22	150
16	1.92	20.3	175
18	1.90	22.3	175

J. Dimensions

1. The pre-fabricated insulated piping shall be furnished in 20' random lengths.

K. The pre-fabricated insulated piping system shall be as manufactured by Rovanco Corp., Thermal Pipe Systems, Inc., Ricwil, Thermacor Process, Energy Task Force, or Insultek.

L. Anchors: Anchors shall be 1/4" thick plate steel and extend 2-1/2" beyond the casing diameter. Anchors shall be pre-fabricated (attached to steel pipe) and sealed to pipe jacketing with pipe manufacturers standard anchor insulation kit. Location of anchors shall be a part of shop drawing submittal for approval by the Engineer. Anchor assembly shall be poured in concrete block by Contractor in field. Concrete blocks shall generally extend 12" in all directions from the anchor and rest on undisturbed earth.

M. Provide shop drawings of underground piping system, calculate, provide and show all expansion loops required for expansion and contraction of piping system. Shop drawings shall indicate depth of pipes required for system. Coordinate depth with all other trades and show on shop drawings all locations of underground utilities which may pose a conflict or require special care during installation. Expansion/contraction compensation will be accomplished utilizing factory pre-fabricated and pre-insulated expansion elbows, Z-bends, expansion loops, and anchors specifically designed for the intended application. External expansion compensation utilizing flexible expansion pads (minimum one inch thickness), extending on either side, both inside and outside the radius of the fittings are used with all fittings having expansion in excess of 1/2".

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings: ASME B16.22.

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

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

3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

a. Anvil International, Inc.

b. S. P. Fittings; a division of Star Pipe Products.

c. Victaulic Company of America.

C. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

C. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.

2. End Connections: Butt welding.

3. Facings: Raised face.

4. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

D. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

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

C. Dielectric Unions:

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

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. Hart Industries International, Inc.

d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.

2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:

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

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Factory-fabricated companion-flange assembly, for 150 minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:

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

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

3. Separate companion flanges and steel bolts and nuts shall have 150 psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings:

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

a. Calpico, Inc.

b. Lochinvar Corporation.

G. Dielectric Nipples:

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

a. Perfection Corporation; a subsidiary of American Meter Company.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Company, Inc.

d. Victaulic Company of America.

2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, and 300-psig minimum working pressure at 225 deg F.

2.6 VALVES

A. Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:

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

a. Armstrong Pumps, Inc.

b. Tour & Andersson; available through Victaulic Company of America.

c. Macon

d. Mepco.

2. CWP Rating: Minimum 125 psig.

3. Maximum Operating Temperature: 250 deg F.

4. Furnish and install, as shown on plans and with manufacturer’s recommendations, Model CBV-T threaded type circuit balancing valves.

5. Each valve shall have metering ports incorporating Nordel check valves on both sides of the seat.

6. All valves shall be “Y” pattern, equal percentage, globe style, designed either for presetting with a balance schedule or for proportional balancing. All metal parts are bronze copper alloy. Each valve shall provide four functions:

a. precise flow measurement;

b. precision flow balancing;

c. positive shutoff with a no-drip soft seat; and

d. diagnostic point for system analysis.

7. A ¼” NPT tapped drain port shall be provided on each side of valve seat.

8. Valves shall have four (4) full 360 degree adjustment turns of the handwheel (1,440 degrees) with a micrometer-type indicator and hidden memory feature to program the valve for a precise, tamper-proof, balanced setting. When installed, the handwheel and metering ports shall not be located on the bottom of the valve to prevent sediment deposits. Handwheel scale must be able to be positioned so that it may be clearly read without the use of mirrors or any special tools. Metering ports shall be interchangeable with drain ports to allow for read-out flexibility when installed in tight piping locations.

9. Each threaded CBV-T to be shipped with a pre-formed insulation to meet or exceed ASTM D1784/Class 14253-C, MEA #7-87, ASTM E84, and ASTM E136 with a flame spread rating of 25 or less and a smoke development rating of 50 or less.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

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

   a. Armstrong Pumps, Inc.

   b. Tour & Andersson; available through Victaulic Company of America.

   c. Macon

   d. Mepco.

2. CWP Rating: Minimum 125 psig.

3. Maximum Operating Temperature: 250 deg F.

4. CBV-G 2½" through 12" Flanged:

5. Furnish and install, as shown on plans and with manufacturer's recommendations, Circuit Balancing Valves.

6. The valve body shall be ductile iron with grooved ends or with Armgrip(tm) non-rotating ductile iron flange adapters. Valves shall be suitable for the working pressures and temperatures as shown on drawings.

7. Each valve shall have metering ports incorporating Nordel check valves, on both sides of the seat.

8. All valves shall be "Y" pattern, modified equal percentage, globe style, designed either for presetting with a balance schedule or for proportional balancing. Each valve shall perform four functions:

   a. precise flow measurement

   b. precision flow balancing

   c. positive shutoff with a no-drip soft seat; and

   d. diagnostic point for system analysis.

9. Valves shall have five, (2½" and 3") six, (4" through 6") twelve, (8") ten, (10") or fourteen (12") full 360 degree adjustment turns of the handwheel with a micrometer-type indicator and hidden memory feature to program the valve for a precise, tamper-proof balanced setting. When installed, the handwheel and metering ports shall not be located on the bottom of the valve to prevent sediment deposits. Handwheel scale must be able to be positioned so that it may clearly read without the use of mirrors or any special tools.

10. Circuit balancing valves shall be installed at least five pipe diameters downstream from any fitting and at least ten pipe diameters downstream from any pump. Two pipe diameters downstream of the CBV shall be free of any fitting.

11. The valve shall be furnished with pre-formed insulation to meet or exceed ASTM D1784/Class 14253-C, MEA #7-87, ASTM E84, and ASTM E136 with a flame spread rating of 25 or less and a smoke development rating of 50 or less.

E. Diaphragm-Operated, Pressure-Reducing Valves:

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

   a. Amtrol, Inc.

   b. Armstrong Pumps, Inc.

   c. Bell & Gossett Domestic Pump; a division of ITT Industries.

   d. Conbraco Industries, Inc.

   e. Spence Engineering Company, Inc.

   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.

3. Disc: Glass and carbon-filled PTFE.

4. Seat: Brass.

5. Stem Seals: EPDM O-rings.

6. Diaphragm: EPT.

7. Low inlet-pressure check valve.

8. Inlet Strainer: S.S. screen, removable without system shutdown.

9. Valve Seat and Stem: Noncorrosive.

10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

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

a. Amtrol, Inc.

b. Armstrong Pumps, Inc.

c. Bell & Gossett Domestic Pump; a division of ITT Industries.

d. Conbraco Industries, Inc.

e. Spence Engineering Company, Inc.

f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.

3. Disc: Glass and carbon-filled PTFE.

4. Seat: Brass.

5. Stem Seals: EPDM O-rings.

6. Diaphragm: EPT.

7. Wetted, Internal Work Parts: Brass and rubber.

8. Inlet Strainer: S.S. screen, removable without system shutdown.

9. Valve Seat and Stem: Noncorrosive.

10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.7 AIR CONTROL DEVICES

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

1. Amtrol, Inc.

2. Armstrong Pumps, Inc.

3. Bell & Gossett Domestic Pump; a division of ITT Industries.

4. Taco.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

D. Diaphragm-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. Tangential-Type Air Separators:

1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.

4. Blowdown Connection: Threaded.

5. Size: Match system flow capacity.

2.8 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig.

B. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.

2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.

3. Performance: Capable of misalignment.

4. CWP Rating: 150 psig.

5. Maximum Operating Temperature: 250 deg F.

C. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

2.9 THERMOMETERS

A. Provide thermometers where indicated, specified, and required. They shall be installed so that they can be clearly read from the floor.

B. Industrial stem thermometers shall have a scale not less than 9" long and shall be red-reading mercury type with white background and black etched graduations and numerals. Casing materials shall be aluminum on all products installed outdoors.

C. Thermometers shall be suitable for the service intended and the range shall be selected to span from approximately 10 degrees below through 10 degrees above the operating range of the fluid.

D. Thermometers shall have a guaranteed accuracy of within 1% of the range scale and shall be provided with 1 degree graduations. Thermometers shall be provided with brass separable socket wells.

E. Provide thermometer wells and necessary fittings where specified or indicated. Wells installed in insulated piping shall be provided with lagging extensions of appropriate length to accommodate insulation.

F. Thermometers shall be as manufactured by Marsh Instrument Co., Weksler Instrumentation, Trerice, Miljoco, or approved equal.

2.10 PRESSURE GAUGES

A. Pressure and compound pressure gauges shall be installed so that they can be clearly read from the floor and shall be Bronze Bourdon tube type with minimum 6" dials and snubbers. Dials shall be white with black numerals, graduations, and pointers, and shall be set in either iron, steel, or aluminum cases having a baked enamel finish. Cases shall have safety blowout plugs.

B. Pressure gauges shall have a range of approximately twice the operating pressure and all gauges shall have an accuracy of 1/2 of 1% of full scale reading. Gauges shall be provided with brass shutoff cocks.

C. Provide compound pressure gauges in pump suction pipe (30" Hg VAC. to 100 psi).

D. Provide gauges where indicated, specified, or required.

E. Gauges shall be manufactured by Marshalltown Instrument, Weksler Instrumentation, Trerice, Miljoco, or approved equal.

2.11 P/T PLUGS

A. Provide, in locations shown on drawings, a 1/2 inch MPT fitting for pipe line and 1/4 inch for valve body locations to receive either a temperature or pressure probe 1/8 inch OD. Fitting shall be solid brass with two valve cores of Neoprene capable of withstanding a maximum temperature of 200 deg. F at 500 psi, fitted with a color coded and marked cap with gasket, and shall be rated at 1000 psig at 140 deg. F.

B. Provide Owner with pressure gauge adapters with 1/8" O.D. probe and 5 inch testing thermometers for chilled water with a 25 - 125 F range.

C. Supply and present to the Owner upon completion of testing, two (2) pressure and temperature test kits. Each shall consist of one dual scale (0-100 psi, 0-230 feet of water) pressure gauge with a No. 500 gauge adapter attached, one 25-125 F pocket testing thermometer, one 0-220 F pocket testing thermometer, one 500 gauge adapter, and one protective carrying case.

D. Acceptable manufacturers shall be Peterson, Sisco, or approved equal.

2.12 SUCTION DIFFUSER

A. Provide a suction diffuser at inlet of each base mounted pump. Unit shall consist of angle type body with inlet vanes and combination Diffuser-Strainer-Orifice cylinder with 3/16" diameter openings for pump protection. Unit shall be equipped with disposable fine mesh start-up strainer which shall be removed after thirty (30) days of operation. Strainer free area shall be no less than five (5) times the section area of the pump connection. Unit shall be provided with adjustable support foot to carry weight of suction piping.

B. Suction diffusers shall be as manufactured by Bell and Gossett, TACO, Armstrong, Titan FCI, or Mueller.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping and chilled water piping, aboveground, NPS 2 and smaller shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered pressure-seal joints.

2. Schedule 40 steel pipe; Class 150 or Class 300 Malleable Iron fittings; and threaded joints.

B. Hot-water heating piping, and chilled water piping aboveground, NPS 2-1/2 and larger shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Condenser-water piping, aboveground, NPS 2 and smaller shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered pressure-seal joints.

2. Schedule 40 steel pipe; Class 150 or Class 300 Malleable Iron fittings; and threaded joints.

D. Condenser-water piping, aboveground, NPS 2-1/2 and larger shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Makeup-water piping installed aboveground shall be the following:

1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

F. Makeup-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

1. Condensate-Drain Piping: Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

G. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

H. Air-Vent Piping:

1. Inlet: Same materials and joining methods as for piping specified for the service in which air-vent is installed.

I. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves where indicated on the drawings.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple and 3/4 inch hose connection with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

R. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2. Provide strainer blowdown valve with 3/4 inch hose connection with cap.

S. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

T. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS ¾ to NPS 1-1/4: Maximum span, 6.5 feet; minimum rod size, 3/8 inch.

2. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inc).

3. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.

4. NPS 2-1/2: Maximum span, 10 feet; minimum rod size, 3/8 inch.

5. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

6. NPS 4: Maximum span, 10 feet; minimum rod size, 5/8 inch.

7. NPS 6: Maximum span, 10 feet; minimum rod size, 5/8 inch.

8. NPS 8: Maximum span, 14 feet; minimum rod size, 7/8 inch.

9. NPS 100: Maximum span, 14 feet; minimum rod size, 7/8 inch.

10. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.

11. NPS 14: Maximum span, 20 feet; minimum rod size, 1 inch.

12. NPS 16: Maximum span, 20 feet; minimum rod size, 1 inch.

13. NPS 18: Maximum span, 20 feet; minimum rod size, 1-1/4 inches.

14. NPS 20: Maximum span, 20 feet; minimum rod size, 1-1/4 inches.

C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.

2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.

3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

D. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger. Install automatic air vents at top of air separator. Refer to detail on drawings for further information..

D. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

E. Install bypass chemical feeders in each hydronic system where indicated, in upright position. Install feeder in minimum NPS 3/4insulated bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

F. Install expansion tanks on the minimum 4”pad housekeeping. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements. Refer to details.

G. Flow switches, temperature sensors, sensor sockets, wells gage taps, etc. shall be furnished under controls section of these specifications and installed under this Section. Locations of all sensor sockets, flow switches, and taps shall be coordinated with and supervised by the Controls Contractor.

H. Motorized control valves shall be furnished by the Controls Contractor, installed by the Mechanical Contractor.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Provide P/T ports at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping." Refer to details.

E. Install thermowells and ports for pressure gages and thermometers at equipment as indicated on details and according to Division 23 Section "Meters and Gages for HVAC Piping." Refer to details.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.

2. Inspect pumps for proper rotation.

3. Set makeup pressure-reducing valves for required system pressure.

4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

5. Set temperature controls so all coils are calling for full flow.

6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.

7. Verify lubrication of motors and bearings.

3.9 UNDERGROUND PIPE INSTALLATION

A. General

1. Installation of exterior buried factory-prefabricated preinsulated chilled water piping systems shall be in accordance with manufacturer's installation manual. Welding of steel piping including qualification of welders shall be in accordance with ASME B31.I, metallic arc process. Install piping straight and true to bear evenly on sand bedding material.

2. Installation Drawings: The system supplier shall provide engineered drawings of the piping layout indicating anchor locations and provisions for expansion and/or contraction. Computerized stress calculations including anchor forces shall be provided by the system manufacturer upon receipt from the installing contractor approved drawings complete with field measured dimensions. Drawing shall be signed and sealed by a P.E. employed by the piping manufacturer.

3. All units shall be part-numbered and dimensionalized for proper installation of the system.

4. Insulate and jacket field joints as indicated on the drawings.

5. Pipe handling: Pipe and accessories shall be handled in a manner to ensure delivery to the trench in an undamaged condition. Particular care shall be taken not to injure the pipe jacket and insulation. If any pipe or fitting is damaged, the repair shall be made by the Contractor at his expense in an approved manner. The interior of pipe and accessories shall be cleaned before being lowered into the trench for welding connection operations.

6. Cleaning of Piping: Keep interior and ends of new piping and existing piping affected by the Contractor's operations, cleaned of water and foreign matter during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.

7. Demolition: Remove materials so as not to damage materials which are to remain. Replace existing work damaged by the Contractor's operations with new work of the same construction.

B. Field Joints

1. Carrier Piping Joints Without Concrete Anchor: Pressure test and approve piping joints. Provide joints with polyurethane insulation of same type and thickness as insulation on carrier piping. Provide waterproof shrink sleeves to cover insulation and overlap not less than 6 inches of each end of conduit section. Seal joint jacket watertight to adjacent jacketing to withstand 20 feet of hydrostatic water pressure.

2. Carrier Piping Joints With Concrete Anchor: Pressure test and approve piping joints. Provide each tee with concrete anchors (thrust blocks). Provide waterproof end seals between carrier piping and conduit. Encase carrier pipe fitting and conduit with a minimum of 6 inches of concrete or as otherwise shown in details or per manufacturer's calculations.

C. Assembly and Alignment: Assemble carrier pipe and fittings according to manufacturer's installation manual. Maintain proper alignment during assembly of welded joints and flanged joints.

D. Bedding: Accurately grade trench bedding with a minimum of 6 inches of manufactured or natural sand. Backfill sand to a minimum of 4 inches below conduit. Lay bedding to firmly support conduit along entire length.

E. Concrete: Thrust Blocks: Encase each tee of carrier pipe in thrust block against undisturbed soil. Disturbed soil under and around thrust blocks shall be compacted. Pour concrete anchor blocks where shown on installation drawings. After all anchor blocks are poured and cured, a hydrostatic test of shall be required as specified under Section 15990. No leakages shall be allowed.

F. Field Quality Control

1. Before final acceptance of work, test each system to demonstrate compliance with contract requirements. Thoroughly flush and clean piping before placing in operation. Flush piping at minimum velocity of 8 fps. Correct defects in the work and repeat tests until work is in compliance with contract requirements. Furnish potable water, electricity, instruments, connecting devices, and personnel for tests.

2. The services of a factory trained field service instructor directly employed by the system manufacturer (factory certified sales agent or representative) shall be required during the installation (once at the beginning for instructing the Contractor, once at the midpoint, and once at the end point of the project) and on-site to witness each hydronic test. The Instructor must obtain a daily written report from the Installation Contractor identifying progress and potential conflicts. The written report shall be presented to the Instructor on the same day it is prepared, one copy shall be forwarded to manufacturer's office, and one copy shall be forwarded to the Engineer’s office.

   The Instructor shall prepare site inspection reports which shall state whether or not the condition and quality of materials used and the installation of the system are in accordance with the manufacturer's approved drawing and published literature and is satisfactory in all respects, each time the instructor visits the site. A final report shall be signed by an officer of the manufacturer and duly notarized certifying the materials are installed in accordance with the manufacturers requirements and recommendations and will satisfactorily serve the intended use, including maintaining an insulation barrier between the pipe and surrounding soil, for the anticipated service life of the pipe.

3. Immediately after the system is installed in the ditch, a partial backfill shall be made in the middle of each unit leaving the joints exposed for inspection prior to the hydrostatic tests. The initial backfill is to be 12" of select materials, hand tamped in 6" layers above the jacket. Do not use frozen fill, sod, cinders or stones greater than 1/4" as backfill.

4. Field Tests of Carrier Piping: Do not cover carrier piping joints with insulation or concrete anchors (thrust blocks), until carrier piping joints pass field tests.

5. Hydrostatic Pressure Test: Test piping system in accordance with the requirements herein. Refer to the Field Quality Control Section below. During hydrostatic pressure test, examine piping system for leaks. Repair leaking joints, replace damaged and porous pipe and fittings with new materials, and repeat tests. The piping shall be tested in sections as required by the Contracting Officer to coordinate with disruption of utilities and traffic patterns. Contractor shall provide the necessary flanges, blank-off plates and valves for sectionalized testing.

6. After hydrostatic testing, backfill all remaining exposed pipe as instructed. Final backfill of selected earth shall be hand-placed and tamped in 12" layers over the top of the initial backfill. Remainder of the backfill shall be free of large boulders, rocks over 6" in diameter, frozen earth, or foreign matter. The backfill operation shall now be completed by any convenient means. Do not use wheeled or tracked vehicles for tamping.

7. Thrust Blocks: Place bedding and backfill around center portion of piping system, leaving thrust blocks and field joints clear for observation. After successful completion of hydrostatic pressure test, cast concrete thrust blocks.

8. Field Inspections: Prior to initial operation, inspect piping system for compliance with drawings, specifications, and manufacturer's submittals.

3.10 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.11 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure (125 psi) . Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.

2. Inspect pumps for proper rotation.

3. Set makeup pressure-reducing valves for required system pressure.

4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

5. Set temperature controls so all coils are calling for full flow.

6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.

7. Verify lubrication of motors and bearings.

3.12 CLEANING SEQUENCE

A. Hydronic Water Systems: Contractor shall rent a pump with strainer and pipe to new system. Contractor shall circulate for 48 hours, then drain systems as quickly as possible. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water and repeat until system cleaner is removed. After cleaning and flushing, the Contractor shall connect new piping to existing system as shown on drawings. Chemical Water treatment to be provided immediately upon acceptance of the cleaning.

B. The piping shall be thoroughly flushed with cleaned throughout with clean potable water at a rate of 6 to 8 feet per minute through the largest pipe on the circuit but not exceeding a pressure of 100 psi in the piping system. Provide a temporary bypass on the boiler piping to allow full circulation throughout the existing piping system including as much of the new piping system as possible minus the boilers and pumps. The temporary connection of the supply and return pipe at boiler bypass shall facilitate the flow of water through the piping system during flushing. Flush each heating branch and main system for a minimum of two hours and until the flushing water exiting the piping is clear and free of debris as determined by the owner's chemical treatment company. The source of the water supply to be used for flushing shall be as approved by the authority having jurisdiction. The contractor shall provide the temporary pumping system to be used for flushing the piping system. The new boiler pumps shall not be used as the flushing pumps. The flushing pumps shall be of the capacity (flow rate and dynamic head) as necessary to motivate the water through the largest pipe in the system at a minimum 6 fpm velocity. Provide temporary flexible piping and connections to the system as necessary to and from the flushing pumps.

C. Provide all necessary utility connections to the flushing pumps including power, make-up water, drain piping, etc. as necessary for safe operation. If diesel driven flushing pumps are used, these pumps shall be located outdoors in the appropriate open air environment far enough away from the building intake openings such that the diesel exhaust fumes do not pose any threats or perceived threats to the safety of the building environment and building occupants.

D. Prior the flushing and cleaning, this contractor shall remove, clean and reinstall all strainers on the heating system in the building. Upon completion of the flushing and cleaning process, this contractor shall again remove, clean and reinstall all strainers, and fill system with clean water. Adjust the expansion tank for pressure proper operation.

E. Once the system has been flushed, add cleaner to closed systems at concentration as recommended by manufacturer of water contained in the system; of one pound per 100 gallons of water for hot systems and one pound per 50 gallons of water for cold systems.

F. Each piping system shall be thoroughly cleaned by filling with a solution of commercial cleaning chemicals designed to remove deposits such as pipe dope, oils, loose mill scale, rust and other extraneous materials. The recommended dosages and characteristics of the cleaner shall be such that the water need only be at ambient temperature. After the recommended dosages are added, the water shall be circulated for 36-72 hours. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required. Systems shall then be drained, filled and flushed with clean water until no foreign matter is observed and total alkalinity of rinse water is equal to that of the make up water.

G. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.

H. Flush systems with clean water for one hour minimum. Drain completely and refill.

I. Remove, clean, and replace strainer screens.

J. Each system shall be properly treated to prevent scaling and corrosion.

K. The water treatment service company currently under contract with the owner shall provide the flushing, cleaning and chemical treatment process.

L. All cost associated with this service and certification shall be paid by the Contractor as a basic part of this project.

*** END OF SECTION 23 21 13 ***

SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following HVAC water-treatment systems:

1. Bypass chemical-feed equipment and controls.
2. Biocide chemical-feed equipment and controls.
3. Chemical treatment test equipment.
4. HVAC water-treatment chemicals.
5. Makeup water softeners.
6. Water filtration units for HVAC makeup water.

1.3 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

C. RO: Reverse osmosis.

D. TDS: Total dissolved solids.

E. UV: Ultraviolet.

1.4 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including [hot-water heating] [chilled water] [dual-temperature water] [and] [glycol cooling], shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.

2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.

3. Boron: Maintain a value within 100 to 200 ppm.

4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.

5. Soluble Copper: Maintain a maximum value of 0.20 ppm.

6. TDS: Maintain a maximum value of 10 ppm.

7. Ammonia: Maintain a maximum value of 20 ppm.

8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.

9. Microbiological Limits:

   a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.

   b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.

   c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.

   d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.

   e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

D. Open hydronic systems, including condenser water, shall have the following water qualities:

1. pH: Maintain a value within 8.0 to 9.1.

2. "P" Alkalinity: Maintain a maximum value of 100 ppm.

3. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.

4. Soluble Copper: Maintain a maximum value of 0.20 ppm.

5. TDS: Maintain a maximum value of 10 ppm.

6. Ammonia: Maintain a maximum value of 20 ppm.

7. Free "OH" Alkalinity: Maintain a maximum value of 0 ppm

8. Microbiological Limits:

   a. Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/ml.

b. Total Anaerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.

c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.

d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.

e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

9. Polymer Testable: Maintain a minimum value within 10 to 40.

1.5 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:

1. Bypass feeders.

2. Water meters.

3. Inhibitor injection timers.

4. pH controllers.

5. TDS controllers.

6. Biocide feeder timers.

7. Chemical solution tanks.

8. Injection pumps.

9. Ozone generators.

10. UV-irradiation units.

11. Chemical test equipment.

12. Chemical material safety data sheets.

13. Water softeners.

14. RO units.

15. Multimedia filters.

16. Self-cleaning strainers.

17. Bag- or cartridge-type filters.

18. Centrifugal separators.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: Power and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

E. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.

2. Water Analysis: Illustrate water quality available at Project site.

1.6 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping, heating, hot-water piping piping, condenser-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.

2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.

3. Periodic field service and consultation.

4. Customer report charts and log sheets.

5. Laboratory technical analysis.

6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

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:

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

1. Ampion Corp.

2. Anderson Chemical Co, Inc.

3. Aqua-Chem, Inc.; Cleaver-Brooks Div.

4. Barclay Chemical Co.; Water Management, Inc.

5. Boland Trane Services

6. GE Betz.

7. GE Osmonics.

8. H-O-H Chemicals, Inc.

9. Metro Group. Inc. (The); Metropolitan Refining Div.

10. ONDEO Nalco Company.

11. Watcon, Inc.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel. Provide feeders with side stream 5 micron bag filter with a minimum of 2 spare replacement bags. Rotate a clean bag into service each month. Clean and dry removed bag for use in rotation. Continue rotation for first 6 month or until owners water treatment contractor takes over maintenance. Insulate inlet and outlet piping from system piping to feeders. Provide inlet and outlet shut-off valves and calibrated balance valve. Refer to detail on drawings.

1. Capacity: 5 gal.

2. Minimum Working Pressure: 175 psig.

2.3 AUTOMATIC CHEMICAL FEED EQUIPMENT

A. Water Meter:

1. AWWA C701, turbine-type, totalization meter.

2. Body: Bronze.

3. Minimum Working-Pressure Rating: 100 psi.

4. Maximum Pressure Loss at Design Flow: 3 psig.

5. Registration: Gallons or cubic feet.

6. End Connections: Threaded.

7. Control: Low-voltage signal capable of transmitting 1,000 feet.

B. Inhibitor Injection Timers:

1. Microprocessor-based controller with LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation and Control for HVAC."

2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.

3. Test switch.

4. Hand-off-auto switch for chemical pump.

5. Illuminated legend to indicate feed when pump is activated.

6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.

7. LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

C. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation and Control for HVAC."

2. Digital display and touch pad for input.

3. Sensor probe adaptable to sample stream manifold.

4. High, low, and normal pH indication.

5. High or low pH alarm light, trip points field adjustable; with silence switch.

6. Hand-off-auto switch for acid pump.

7. Internal adjustable hysteresis or deadband.

D. TDS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door

2. Digital display and touch pad for input.

3. Sensor probe adaptable to sample stream manifold.

4. High, low, and normal conductance indication.

5. High or low conductance alarm light, trip points field adjustable; with silence switch.

6. Hand-off-auto switch for solenoid bleed-off valve.

7. Bleed-off valve activated indication.

8. Internal adjustable hysteresis or deadband.

9. Bleed Valves:

a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.

E. Biocide Feeder Timer:

1. Microprocessor-based controller with digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.

2. 24-hour timer with 14-day skip feature to permit activation any hour of day.

3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.

4. Solid-state alternator to enable use of two different formulations.

5. 24-hour display of time of day.

6. 14-day display of day of week.

7. Battery backup so clock is not disturbed by power outages.

8. Hand-off-auto switches for biocide pumps.

9. Biocide A and Biocide B pump running indication.

F. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.

2. Molded cover with recess for mounting pump.

3. Capacity: 30 gal.

G. Chemical Solution Injection Pumps:

1. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.

2. Adjustable flow rate.

3. Metal and thermoplastic construction.

4. Built-in relief valve.

5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

H. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

I. Injection Assembly:

1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.

2. Ball Valve: Three or two-piece, stainless steel as described in "Stainless-Steel Pipes and Fittings" Article below; and selected to fit quill.

3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.

4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

2.4 STAINLESS STEEL PIPES AND FITTINGS

A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.

B. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.

C. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig SWP and 600-psig CWP rating.

D. Controls: Interlock with pumps to operate when water is circulating.

2.5 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. Two-station rack for closed-loop systems.

2. Four-station rack for open systems.

2.6 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

B. Water Softener Chemicals:

1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.

2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

PART 3 EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install water testing equipment on wall near water chemical application equipment.

C. Install interconnecting control wiring for chemical treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Bypass Feeders: Install in closed hydronic systems, including hot-water heating and chilled water, and equipped with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

2. Install water meter in makeup water supply.

3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.

5. Install a swing check on inlet after the isolation valve.

F. Install automatic chemical-feed equipment for steam boiler and steam condensate systems and include the following:

1. Install makeup water softener.

2. Install water meter in makeup water supply.

3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

a. Pumps shall operate for timed interval when contacts close at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.

4. Install test equipment and furnish test-kit to Owner.

5. Install TDS controller with sensor and bleed valves.

a. Bleed valves shall cycle to maintain maximum TDS concentration.

G. Install automatic chemical-feed equipment for condenser water and include the following:

1. Install makeup water softener.

2. Install water meter in makeup water supply.

3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.

4. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

5. Install TDS controller with sensor and bleed valves.

a. Bleed valves shall cycle to maintain maximum TDS concentration.

6. Install pH sensor and controller with injection pumps and solution tanks.

a. Injector pumps shall operate to maintain required pH.

7. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.

a. Injection pumps shall operate to feed biocide on an alternating basis.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Common Work Results for HVAC."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."

E. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.

F. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.

G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.

2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.

3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.

4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

8. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Remove and replace malfunctioning units and retest as specified above.

D. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. For one year, sample boiler water at six week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

E. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.

2. Steam System: ASTM D 1066.

3. Acidity and Alkalinity: ASTM D 1067.

4. Iron: ASTM D 1068.

5. Water Hardness: ASTM D 1126.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 01 Section "Demonstration and Training."

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

*** END OF SECTION 23 25 00 ***

SECTION 23 52 16

CAST IRON CONDENSING BOILERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes gas-fired, condensing cast-iron boilers for heating hot water.

B. Related Sections include the following:

1. Division 15 Section “Breechings, Chimneys, and Stacks” for connections to breechings, chimneys, and stacks.

2. Division 15 Sections for control wiring for automatic temperature control.

1.3 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, and method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Source Quality Control Tests and Inspection Reports: Indicate and interpret test results for compliance with performance requirements before shipping.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Maintenance Data: Include in the maintenance manuals specified in Division 1. Include parts list, maintenance guide, and wiring diagrams for each boiler.

1.4 QUALITY ASSURANCE

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

1. The Terms “Listed” and “Labeled”: As defined in NFPA 70, Article 100.

2. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” as defined in OSHA Regulation 1910.7.

B. ASME Compliance: Boilers shall bear ASME “H” stamp and be National-Board listed.

C. FM Compliance: Control devices and control sequences according to requirements of FM.

D. Comply with NFPA 70 for electrical components and installation.

E. IRI Compliance: Control devices and control sequences according to requirements of IRI (GE GAP).

F. CSD-1

G. SCAQMD Rule 1146.2 for low NOx equipment

H. ARRA Compliance: Total overall percentage of US origin materials used in the manufacturing of the boilers shall be 100% and 100% assembly of these products shall be completed in the US – Buy American compliant.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section “Cast-in-Place Concrete.”

1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents. Installing contractor shall provide one year of warranty parts and labor.

B. Special Warranty: Submit a written warranty, executed by the contractor for the heat exchanger.

1. Warranty Period: Manufacturer’s standard, but not less than 10 years from date of Substantial Completion on the heat exchanger. Additional 21-year thermal shock warranty on heat exchanger.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Manufacturer shall be a company specializing in manufacturing the products specified in this section with minimum five (5) years experience. Subject to compliance with requirements, manufacturers offering boilers that may be incorporated into the Work include, but are not limited to, the following:

B. Design: Boilers shall be CSA design certified as a condensing boiler. Boilers shall be designed for minimum of 5:1 continuous turn down with constant CO2 over the turndown range. The boiler shall operate with natural gas or propane and have a CSA International certified input rating as noted on the drawings, and a thermal efficiency rating up to 99% at minimum input. The boiler shall be symmetrically air-fuel coupled such that changes in combustion air flow or flue flows affect the BTUH input without affecting combustion quality. The boiler will automatically adjust input for altitude and temperature induced changes in air density. The boiler will use a proven pilot interrupted spark ignition system. The boiler shall use a UL approved flame safeguard ignition control system using UV detection flame sensing. The UV detector shall be air cooled to prevent condensate formation and so designed as to prevent misalignment. The design shall provide for silent burner ignition and operation. The boiler shall be down fired counter flow such that formed condensate always moves toward a cooler zone to prevent re-evaporation. An aluminum corrosion resistant condensate drain designed to prevent pooling and accessible condensate trap shall be provided. In some jurisdictions, a means of neutralizing the condensate pH levels may be required. Boiler shall be able to vent a horizontal distance of 80 (120 for KN-16/26/30) equivalent feet with a vent diameter equivalent to the combustion chamber outlet diameter.

C. Service Access: The boilers shall be provided with access covers for easily accessing all serviceable components. The boilers shall not be manufactured with large enclosures, which are difficult to remove and reinstall. All accesses must seal completely as not to disrupt the sealed combustion process. All components must be accessible and able to adjust with the removal of a single cover or cabinet component.

D. Indicating lights: Each boiler shall include a diagnostic control panel with a full text display indicating the condition of all interlocks and the BTUH input percentage. Access to the controls shall be through a completely removable cover leaving diagnostic panel intact and not disrupted.

E. Manufacturers: Advanced Thermal Hydronics Model KN (a Mestek Company) is the basis of design. Listed acceptable manufacturers shall be subject to compliance with requirements. The following manufacturers will be considered and **shall provide a Pre-Submittal prior to bid:**

1. Viessmann Vertomat.
2. Cleaver Brooks – Clear Fire.
3. Patterson Kelley – Mach.
4. LAARS
5. Raypack.

2.2 COMPONENTS

A. Combustion Chamber: The combustion chamber shall be constructed of cast-iron. It shall be a down-fired design utilizing lightweight refractory around the burner housing.

B. Heat Exchanger: Boilers shall be a cast iron sectional unit designed for pressure firing and shall be constructed and tested for 100 P.S.I water working pressure, in accordance with the A.S.M.E. Section IV Rules for the Construction of Heating Boilers. Individual sections will have been subjected to a hydrostatic pressure test of 250 PSIG at the factory before shipment and they shall be marked, stamped or cast with the A.S.M.E. Code symbol. Boilers with less than 250-psi pressure test will not be acceptable for this project. The sections shall be of a down fired counter flow single-pass design. Water ports will be sealed with steel push nipple connectors. The sections will be fully machined for metal to metal sealing of the gas side surfaces. The design will provide for equal temperature rise through all sections. The iron shall have a minimum thickness of ¼". The heat exchanger design should have no limitations on temperature rise or restrictions to inlet water temperature and a Cv of 60 (KN-6), 100 (KN-10), 160 (KN-16), 190 (KN-20), 240 (KN-26) and 278 (KN-30).

C. **The heat exchanger must be completable with a water loop pH level of 9.5-10.5. Aluminum heat exchangers are not acceptable.**

D. Jackets: Stainless Steel.

E. Gas Burner: The burner shall be metal fiber mesh construction, allowing high turndown of the fuel-air mixture. The burner flame shall burn horizontally and be of the pre-mix type with a forced draft fan. Burner shall fire to provide equal distribution of heat throughout the entire heat exchanger. The burner shall be easily removed for maintenance without the disruption of any other major component of the boiler. A window view port shall be provided for visual inspection of the boiler during firing. The gas distribution components and burner shall be enclosed with a cast aluminum housing.

F. Ignition components: The ignition hardware shall consist of Alumina ceramic insulated ignition electrodes and UV sensing tube permanently arranged to ensure proper ignition electrode and UV alignment.

G. Rated Capacity: The boiler shall be capable of operating at rated capacity with pressures as low as 2" (3" for KN-26/30) W.C. at the inlet to the burner gas valve.

H. The burner shall be capable of 99% efficiency without exceeding a NOx reading above 11ppm.

I. The burner and gas train shall be provided with the following trim and features:

1. Burner Firing: Full modulation with 5:1 turndown @ Continuous CO2

2. Burner Ignition: Intermittent spark

3. Safety Controls: Energize ignition, limit time for establishing flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, and allow gas valve to open.

4. Flue-Gas Collector: Enclosed combustion chamber with integral combustion-air blower and single venting connection.

5. Gas Train: Manual ball type gas valves (2), main gas valve, manual test and check valves, pilot gas pressure regulator, and automatic pilot gas valve. All components to be factory mounted and CSD-1 compliant.

6. Safety Devices: Low gas pressure switch, air-flow switch, and blocked flue detection switch, low water cutoff (manual reset), high temperature manual reset. All safeties to be factory mounted.

2.3 BOILER TRIM

A. Controls: The boiler control package shall be a MTI Heat-Net or equivalent, integrated boiler management system. The control system must be integral to each boiler, creating a control network that eliminates the need for a “wall mount” stand-alone boiler system control. Additional stand-alone control panels, independent of a Building Management System (BMS), shall not be allowed to operate the boiler network.

The Heat-Net control shall be capable of operating in the following ways:

1. As a stand-alone boiler control system using the Heat-Net protocol, with one “Master” and multiple “Member” units.

2. As a boiler network, enabled by a Building Management System (BMS), using the Heat-Net protocol, with one “Master” and multiple “Member” units.

3. As “Member” boilers to a Building Management System (BMS) with multiple input control methods.

4. Failsafe mode – When a Building Automation System is controlling set point, if communications are lost, the boiler/system will run off the Local set point.

5. Adaptive Modulation – Lowers the modulation rate of all currently operating boilers before a newly added boiler enters operation.

6. Priority Firing – Allows mixing of condensing, non-condensing base-load and/or other combination of (2) functional boiler types utilizing (2) priority levels.

7. Available priority start/stop qualifiers shall be done using any combination of: A) Modulation Percentage B) Outdoor Air Temperature or C) Return Water Temperature.

8. Base Loading – Provides the ability to control (1) base load boiler with enable/disable and 4-20mA modulating signal (if required).

MASTER:

A boiler becomes a Master when a resistance type 10K sensor is connected to the J10 “SYS/ DHW HEADER” terminals. **The sensor shall be auto detected.** The Master senses and controls the header/loop temperature utilizing a system setpoint. It uses any boilers it finds “Heat-Net Members” or those defined in the control setup menus to accomplish this. The “Master” shall also have the option of monitoring Outside Air Temperature “OA” to provide full outdoor air reset functionality. **Only one master shall be allowed in the boiler network.**

When operating as a “Master”, the Heat-Net control provides a stand-alone method using a PID algorithm to regulate water temperature. The algorithm allows a single boiler “Master” or multiple “Master + Member” boilers in a network of up to 16 total boilers.

The control algorithm is based upon a control band, at the center of which is the setpoint. While below the control band, boilers are staged on and modulated up until the control band is entered. Once in the control band, modulation is used to maintain setpoint. Optimized system efficiency is always accomplished by setting the Modulation Maximum "Mod-Max" setting to exploit each boiler in the network's inverse efficiency curve. The control shall operate so that the maximum number of boilers required, operate at their lowest inputs until all boilers are firing. Once all boilers are firing, the modulation clamp is removed and all boilers are allowed to fire above this clamped percentage up to 100%. This "boiler efficiency" clamp is defaulted to 80% and thus limits all the boilers individual outputs to 80% until the last boiler fires. **The 80% default must be field adjustable for varying operating conditions.** All boilers modulate up and down together always at the same modulation rate. Boilers are shut down only when the top of the band is breached, or before the top of the band, if the control anticipates that there is a light load. Timers shall also be included in each control in the network to prevent any boiler from short cycling.

MEMBER:

Additional boilers in the network always default to the role of member. The lack of sensors connected to the J10 terminals "SYS/DHW Header" on each additional boiler shall ensure this.

Each "Member" shall sense its supply outlet water temperature and modulate based on signals from a Building Management System (BMS) or "Master" boiler. When operating as a member, starting, stopping, and firing rate shall also be controlled by the "BMS" or "Master" boiler.

When using the Heat-Net protocol, the system setpoint shall be sent from the "Master", along with the modulation value to control firing rate. It also receives its command to start or stop over the Heat-Net cable. Each "Member" will continuously monitor its supply outlet temperature against its operating limit. If the supply temperature approaches the operating limit temperature (adjustable), the boilers input control rate is limited and its modulation value decreases to minimize short cycling. If the operating limit is exceeded, the boiler shall shut off.

Each Heat-Net control in the boiler network shall have the following standard features:

1. Digital Communications Control.
    a. Boiler to Boiler: Heat-Net
    b. Building Management System (BMS): MODBUS standard protocol. (BACnet and LONWORKS optional protocols)
2. Analog 4:20 and 0-10vdc also supported.
3. Distributed control using Heat-Net protocol for up to 16 total boilers.
4. System/Boiler operating status in English text display.
5. Interlock, Event, and System logging with a time stamp.
6. Advanced PID algorithm optimized for specific boilers.
7. Four dedicated temperature sensor inputs for: Outside Air Temperature, Supply (Outlet Temperature, Return Temperature (Inlet), and Header Temperature.

8. Automatically detects the optional temperature sensors on start up.

9. Menu driven calibration and setup menus with a bright 4-line Vacuum Fluorescent Display.

10. (8) Dedicated 24vac interlock monitors and 8 dedicated 120vac system monitors used for diagnostics and providing feedback of faults and system status.

11. Multiple boiler pump or motorized boiler valve control modes.

12. Combustion Air Damper control with proof time.

13. Optional USB/RS485 network plug-in to allow firmware updates or custom configurations.

14. Optional BACnet and LONWORKS interface.

15. Alarm contacts.

16. Runtime hours.

17. Outdoor Air Reset with programmable ratio.

18. Time of Day clock to provide up to four (4) night setback temperatures.

19. Failsafe mode when a Building Management System (BMS) is controlling setpoint. If communications is lost, the boiler/system shall run off the Local Setpoint.

20. Support for domestic hot water (DHW) using a 10k sensor or a dry contact input from a tank thermostat and a domestic hot water relay (pump/valve)

21. Continuous Daily Runtime Restart feature that monitors the runtime of each boiler and if any in the network have exceeded 24 hours of continuous runtime, the boiler is restarted to protect the UV flame scanner.

22. Allows for selection of any boiler in the network to act as Lead Boiler.

23. Adaptive Modulation feature in which the Master boiler adjusts the system modulation rate to a lower value when a new boiler in the network is started to compensate for the added BTU's to the system. Once the newly added boiler fires and the adjustable timer expire, the Master resumes control of the system modulation to maintain setpoint temperature.

24. Priority firing – Allows mixing of condensing and non-condensing, base load and/or other combination of (2) functional boiler types utilizing (2) priority levels.

25. Available priority start/stop qualifiers shall be done using any combination of: A) modulation percentage B) outdoor air temperature (or) C) return water temperature.

26. Base Loading – Provides the ability to control (1) base load boiler with enable/disable and 4-20mA modulating signal (if required).

B. Safety-Relief Valve: ASME rated, factory set to protect boiler and piping as per schedule/drawings. 100 psi maximum allowable working pressure

C. Gauge: Combination water pressure and temperature shipped factory installed. LCD outlet temperature readout to be an integral part of the front boiler control panel display to allow for consistent easy monitoring of temperatures factory mounted and wired.

D. Burner Controls: Boiler shall be provided with a Honeywell RM7800 series digital flame safe guard with UV rectification. The flame safe guard shall be capable of both pre and post purge cycles.

E. High Limit: Temperature control with manual-reset limits boiler water temperature in series with the operating control. High Limit shall be factory mounted and sense the outlet temperature of the boiler through a dry well.

F. PROVIDE THE FOLLOWING STANDARD TRIM:

1. Stainless Steel Condensate Receiver Pan
2. Low Air Pressure Switch
3. Blocked Flue Detection Switch
4. Modulation Control
5. Temperature/Pressure Gauge
6. Manual Reset High Limit (CSD-1 Factory Mounted and Wired)
7. Low Gas Pressure Safety Switch
8. Low Water Cutoff with Manual Reset (CSD-1 Factory mounted and wired)
9. Supply Outlet Temperature Display
10. Full Digital Text Display for all Boiler Series of Operation and Failures
11. Air Inlet Filter
12. Variable Frequency Drive (not required on KN-16/26/30) and Combustion Air Fan with Safety Interlock
13. Condensate Trap
14. High Gas Pressure Switch (KN-26/30)
15. Flow Switch Mounted and Wired (KN-16/26/30)
16. Relief Valve (Shipped Loose)

G. PROVIDE THE FOLLOWING JOB SPECIFIC TRIM AND FEATURES:

1. High Gas Pressure Switch and Valve Proving Switch for IRI Compliant Gas Train
2. Flow switch mounted and wired

2.4 MOTORS

A. Refer to Division 15 Section "Motors" for factory-installed motors.

B. Boiler Blower Motor: Blower motor shall be externally mounted for ease of service. There shall be no requirement to remove covers or gas train components to remove the blower motor. The KN-6 Blower shall be .5 HP and FLA not to exceed 5 Amps. The KN-10 Blower shall be .5 HP and FLA not to exceed 8 Amps. The KN-16 Blower shall be .75 HP and FLA not to exceed 10 Amps. The KN-20 Blower shall be 1 HP and FLA not to exceed 11 Amps. The KN-26 Blower shall be 3 HP and FLA not to exceed 14 Amps. The KN-30 Blower shall be 3 HP and FLA not to exceed 14 Amps.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect boilers according to the ASME Boiler and Pressure Vessel Code, Section IV. Boilers shall be test fired in the factory with a report attached permanently to the exterior cabinet of the boiler for field reference.

PART 3 EXECUTION

3.0 STATE REQUIRED INSPECTION

A. The Contractor shall comply with the requirements of the 2017 Florida Statutes, Chapter 554. The installer must, before installing the boiler, apply on a form adopted by rule of the department for a permit to install the boiler from the chief boiler inspector. The application must include the boiler's A.S.M.E. manufacturer's data report and other documents required by the State Boiler Code before the boiler is placed in service. The installer must contact the chief boiler inspector to schedule an inspection for each boiler no later than 7 days before the boiler is placed in service.

3.1 EXAMINATION

A. Examine area to receive boiler for compliance with requirements for installation tolerances and other conditions affecting boiler performance. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install boilers level and plumb, according to manufacturer's written instructions and referenced standards.

B. Install gas-fired boilers according to NFPA 54.

C. Support boilers on a minimum 4-inch- (100-mm-) thick concrete base, 4 inches (100 mm) larger on each side than base of unit.

D. Install electrical devices furnished with boiler, but not specified to be factory mounted.

3.3 CONNECTIONS

A. Connect gas piping full size, to boiler gas-train inlet with union.

B. Connect hot water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

C. Install piping from safety-relief valves to nearest floor drain.

D. Connect breeching to boiler outlet, full size of outlet. The boiler shall operate under positive (Category IV) or negative (Category II) stack pressure. Vent material must be listed AL29-4C Stainless Double Wall Stack for condensing appliances.

E. Electrical: Comply with applicable requirements in Division 16 Sections.

F. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to supervise the field assembly of components and installation of boilers, including piping and electrical connections. Report results in writing.

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Boiler shall be commissioned by factory-authorized technician. Contact local representative for factory authorized technician information.

B. Manufacturer’s representative shall supply a factory authorized service technician to start up the boilers.

3.5 CLEANING

A. Flush and clean boilers on completion of installation, according to manufacturer’s written instructions.

B. After completing boiler installation, including outlet fi ttings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes including chips, scratches, and abrasions with manufacturer's stainless steel polish.

3.6 COMMISSIONING

A. Engage a factory-authorized service representative to provide startup service. Start up to be performed only after complete boiler room operation is field verified to offer a substantial load, and complete system circulation. One-year warranty shall be handled by factory authorized tech.

B. Verify that installation is as indicated and specified.

1. Verify that electrical wiring installation complies with manufacturer’s submittal and installation requirements in Division 16 Sections. Do not proceed with boiler startup until wiring installation is acceptable to equipment Installer.

C. Complete manufacturer’s installation and startup checklist and verify the following:

1. Boiler is level on concrete base.
2. Flue and chimney are installed without visible damage.
3. No damage is visible to boiler jacket, refractory, or combustion chamber.
4. Pressure-reducing valves are checked for correct operation and specified relief pressure. Adjust as required.
5. Clearances have been provided and piping is flanged for easy removal and servicing.
6. Heating circuit pipes have been connected to correct ports.
7. Labels are clearly visible.
8. Boiler, burner, and flue are clean and free of construction debris.
9. Pressure and temperature gages are installed.
10. Control installations are completed.

D. Ensure pumps operate properly.

E. Check operation of gas pressure regulator device on gas train, including venting.

F. Check that fluid-level, flow-switch (optional), and high-temperature interlocks are in place.

G. Start pumps and boilers, and adjust burners to maximum operating efficiency.

1. Fill out startup checklist and attach copy with Contractor Startup Report.
2. Check and record performance of factory-provided boiler protection devices and firing sequences.
3. Check and record performance of boiler fluid-level, flow-switch (optional), and high-temperature interlocks.
4. Operate boilers as recommended or required by manufacturer.

H. Perform the following tests for maximum and minimum firing rates for modulating burner. Adjust boiler combustion efficiency at maximum and minimum modulation rates. Perform combustion flue gas test at minimum and maximum modulation rate. Measure and record the following:

1. Differential pressure across air / gas orifice.
2. Combustion-air temperature at inlet to burner.
3. Flue-gas temperature at boiler discharge.
4. Flue-gas carbon dioxide, oxygen, and carbon monoxide concentration.
5. Flue gas NOx emissions where applicable.

6. Natural flue draft.

I. Measure and record temperature rise through each boiler.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Operate boiler, including accessories and controls, to demonstrate compliance with requirements.

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 maintenance manuals. Refer to Division 1 Section "Contract Closeout."

4. Review data in the maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

5. Schedule training with Owner with at least 7 days' advance notice.

*** END OF SECTION 23 52 16 ***

DIVISION 26—ELECTRICAL

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SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. Basic electrical requirements specifically applicable to Division 26 Electrical.

1.2 SECTION INCLUDES

A. Basic Electrical Requirements specifically applicable to Division 26 Sections, in addition to Division 01 General Requirements.

1.3 INTENT

A. It is the intention of these specifications and drawings to call for finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

1.4 SURVEYS AND MEASUREMENTS

A. Base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work. All material take-offs for the site shall be field measured prior to bids.

1.5 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the contract. Drawings are not to be scaled. The architectural drawings and details shall be examined for exact location of fixtures and equipment. Where they are not definitely located, this information shall be obtained from the Architect.

B. If directed by the Architect or Engineer, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

C. At the time of each shop drawing submission, the Contractor shall call the Engineer's attention (in writing) to, and plainly mark on shop drawings, any deviations from the Contract Documents.

D. Samples, drawings, specifications, catalogs, submitted for approval, shall be properly labeled indicating specific service for which material or equipment is to be used, location, section and article number of specifications governing, Contractor's name, and name of job. All equipment shall be labeled to match labeling on contract documents.

E. Catalogs, pamphlets, or other documents submitted to describe items on which approval is being requested, shall be specific and identification in catalog, pamphlet, etc. of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.

F. Approval rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are approved, said approval does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract drawings and specifications.

G. All shop drawings shall be submitted to the A/E by Contractor no later than 30 days from the day of contract award.

H. Failure of the Contractor to submit shop drawings in ample time for checking shall not entitle him to an extension of contract time, and no claim for extension by reason of such default will be allowed.

I. Submit all Division 16 submittals at one (1) time in one (1) integral group. Piece-by-piece submission of individual items will not be acceptable. Engineer may check contents of each submittal set upon initial delivery; if not complete as set forth herein, submittal sets may be returned to Contractor without review and approval and will not be accepted until made complete.

J. At the close of the job, prior to final review, five (5) bound copies of the following shall be submitted by transmittal letter to the Engineer for review and acceptance.

1. Equipment warranties

2. Contractor's warranty

3. Parts list and manuals for all equipment

4. Operating Instructions (in writing)

5. Written instructions on maintenance and care of the system

1.6 REFERENCES

A. ANSI/NFPA 70—National Electrical Code.

B. State Requirements for Educational Facilities (SREF) and Schools, Colleges and Universities, Chapter 4, Section 453 and 468, respectively, of the Florida Building Code.

C. NFPA 101—Life Safety Code.

D. Florida Department of Education Accessibility Guidelines and Requirements.

1.7 SUBMITTALS

A. Submit under provisions of Division 1.

B. Proposed Products List: Include Products specified in the following Sections, but not limited to:

1. Section 26 05 19 .....Low-Voltage Electrical Power Conductors and Cables.

2. Section 26 05 26 .....Grounding and Bonding for Electrical Systems.

3. Section 26 05 29 .....Hangers and Supports for Electrical Systems.

4. Section 26 05 33 .....Raceway and Boxes for Electrical Systems.

5. Section 26 05 53 .....Identification for Electrical Systems.

6. Section 26 27 26 .....Wiring Devices.

7. Section 26 28 16 .....Enclosed Switches and Circuit Breakers.

C. It shall be understood that review of shop drawings by the Engineer does not supersede the requirement to provide a complete and functioning system in compliance with the Contract Documents.

1.8 SUBSTITUTIONS

A. Materials and equipment are specified herein by a single or by multiple Manufacturers to indicate quality and performance required. The drawings are based upon equipment scheduled on drawings and specified. If another Manufacturer is considered for substitution during the bidding process, the Electrical Contractor shall be responsible for coordinating all electrical, mechanical, structural, or architectural changes. Comparable equipment Manufacturers which are listed as equals shall be considered as substitutes. Manufacturers other than the basis of design shall submit a catalog information and 1/4" scale plan and section drawings showing proper fit and all clearances for maintenance items.

B. Substitutions of other Manufacturer's will be considered for use if, in the Engineers opinion, the item requested for substitution is equal to that specified. The Contractor shall provide to the Engineer a typed comparative list of the basis of design and the proposed substitute.

Request for approval of substitutions or equals prior to bid must be made in writing. The approval of any substitutions or equals prior to bid shall not be construed as a shop drawing approval. The substitute or equal must be submitted as described in the specifications and meet all the requirements of the specifications and drawings.

C. All requests for substitutions shall be submitted as described in paragraph 1.07, B., and specifically indicate any and all differences or omissions between the product specified as basis of design and the product proposed for substitution.

D. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawing, which requires any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical or electrical, all such redesign, and all new drawings and detailing required therefore, shall be prepared by the Subcontractor at his own expense and submitted to the Architect/Engineer for approval.

E. Where such approved deviation requires quantity and arrangement of equipment from that specified or indicated on the drawings, any other additional equipment required by the system, at no additional cost to the Owner.

1.9 COOPERATION WITH OTHER TRADES

A. Give full cooperation to other trades and furnish in writing to the General Contractor, with copies to the Architect, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.

B. When work installed under this Division will be in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer/Architect, prepare composite working drawings and sections at a suitable scale not less than 1/4" = 1'0", clearly showing how work is to be installed in relation to the work of other trades. If the work is installed before coordinating with other trades, or so as to cause any interference with work of other trades, make all the necessary changes in work to correct the condition without extra charge.

C. Furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.10 ELECTRICAL UTILITY COORDINATION

A. The contractor shall arrange with Utility Company for permanent electric service including payment of Utility Company charges for service.

B. Service shall be underground Service Entrance. System Voltage: 277/480 volts, three phase, four-wire, 60 Hertz.

C. Utility Company: Florida Power and Light Corp.

D. Install service entrance in accordance with Utility Company's rules and regulations.

E. The utility company shall provide the primary utility conduits and the Electrical Contractor shall install the conduits as directed by the utility company. The utility company shall provide and install the primary conductors.

1.11 PROTECTION

A. Protect all work and material provided under this Division from damage. All damaged equipment work or material provided under this Division shall be replaced with new. Rebuilts are not acceptable.

B. Protect all work and equipment until inspected, tested, and accepted. Protect work against theft, injury, or damage; and carefully store material and equipment received on site which are not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

1.12 SCAFFOLDING, RIGGING, AND HOISTING

A. Provide all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

1.13 REMOVAL OF RUBBISH

A. This Contractor shall at all times keep premises free from accumulations of waste materials or rubbish caused by his employees or work. At completion of work he shall remove all his tools, scaffolding, materials, and rubbish from the building and site. He shall leave the premises and his work in a clean, orderly, and acceptable condition.

1.14 SAFETY

A. This Contractor shall comply with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.333), Title 29—Labor, Chapter XIII, Bureau of Standards, Department of Labor, Part 1518—Safety and Health Regulations for Construction; and that his housekeeping and equipment be maintained in such a manner that they comply with the Florida Industrial Commission Safety Code and Regulations of the Federal Williams—Steiger Occupational Safety and Health Act of 1970 (OSHA), wherein it states that the Contractor shall not require any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health and safety.

1.15 SUPERVISION

A. This Contractor shall provide a competent, experienced, full time superintendent who is acceptable to the Architect/Engineer and Owner, and who is authorized to make decisions on behalf of the Contractor.

1.16 MATERIAL AND WORKMANSHIP

A. All materials and apparatus required for the work, except as specifically specified otherwise, shall be new, of first-class quality, and shall be furnished, delivered, erected, connected and finished in every detail, and shall be so selected and arranged as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article as approved by the Engineer shall be furnished. Refer to substitutions in this Section.

B. Unless otherwise specifically indicated on the plans or specifications, all equipment and materials shall be installed with the approval of the Architect and Engineer in accordance with the recommendations of the Manufacturer. This includes the performance of such tests as the Manufacturer recommends.

1.17 QUIET OPERATION AND VIBRATION

A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer and the Owner. In case of moving machinery, sound, or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer and the Owner shall be corrected in an approved manner at no additional expense to the Owner.

1.18 FOUNDATIONS, SUPPORTS, PIERS, ATTACHMENTS

A. This Contractor shall furnish and install all necessary foundations, supports, pads, bases and piers required for all equipment furnished under this Division, and shall submit drawings to the Architect and Engineer for approval before purchase, fabrication or construction of same.

B. For all floor mounted equipment, provide concrete pads which extend six inches (6") beyond equipment base in all directions with top edge chamfered. Inset six inches (6") steel dowel rods into floors to anchor pads. Shop drawings of all foundations and pads shall be submitted to the Architect and Engineer for approval before same are constructed.

C. Construction of foundations, supports, pads, bases, and piers where mounted on the floor, shall be the same materials and same quality of finish as the adjacent and surrounding flooring material.

D. All equipment, unless shown otherwise, shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Architect and the Engineer, not strong enough shall be replaced as directed.

1.19 ACCESS DOORS FOR WALLS AND CEILINGS

A. Provide flush panel access doors with a 16 gauge steel frame and a 14 gauge steel door panel.

B. Finish is to be primed painted steel.

C. Provide concealed hinges which allow the door to open 175 degrees and have a removable pin.

D. Provide access doors with a locked flush mounted vandal proof spanner head operated steel cams.

E. Provide 1-1/2 hour "B" label door for rated chase walls.

F. Furnish masonry anchors for installation in masonry walls and metal lath wings with casing bead for plaster installation.

G. Provide a minimum 2'-0" by 2'-0" access doors unless shown or noted otherwise on the drawings.

H. Access doors for chase walls shall be mounted 16" off the finish floor.

I. Access doors for electrical equipment shall be a minimum of 12" larger than equipment all around.

1.20 REGULATORY REQUIREMENTS

A. Conform to applicable Codes and Standards as follows:

1. Standard:

a. Certain standard materials and installation requirements are described by reference to standard specifications. These standards are as follows:

NEMA..... National Electrical Manufacturers Association.

UL ..... Underwriters Laboratories.

ANSI..... American National Standards Institute.

For additional standards and requirements see other sections of the specifications.

Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition at the time project is bid unless otherwise specified herein.

2. Codes and Rules:

   a. All material furnished and all work installed shall comply with the following codes as they apply to this project:

      - NFPA 70 and NFPA 101.
      - Regulations of the Florida Industrial Commission Concerning Safety.
      - Applicable County, State, and Local Building Codes.
      - Local and State Fire Marshal Rules and Regulations.
      - Chapter 4A-47, Florida Administrative Code - Uniform Fire Safety Standards for Elevators.
      - Occupational Safety and Health Agency Standards (OSHA).
      - Florida State Board of Health Rules and Regulations.
      - Florida Building Code.
      - State Requirements for Educational Facilities (SREF) and Schools, Colleges and Universities, Chapter 4, Section 453 and 468, respectively, of the Florida Building Code.

      Applicable codes shall be those adopted by the authority having jurisdiction at the time project is bid.

3. Permits, Fees and Inspections

   a. The Contractor shall give all necessary notices, obtain all permits and pay all government fees, sales taxes and other costs, including utility connections or extensions, in connection with this work; file all necessary approvals of all governmental departments having jurisdiction.

   b. Obtain all required certificates of inspection for his work and deliver to the Owner/Engineer the same certificates before request for acceptance and final payment for the work.

   c. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations.

d. The Contractor shall inform the Engineer of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

B. Conform to Florida Department of Education Accessibility Guidelines and Requirements.

1.21 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Architect/Engineer before proceeding.

C. The Contractor shall inform the Engineer of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

D. The scope of the work included under this Division of the Specifications shall include complete electrical systems as shown on the plans and as specified herein. The General Conditions and Special Conditions of these specifications shall form a part and be included under this Section of the Specifications. Provide all supervision, labor, material, equipment, machinery, factory trained personnel, and any and all other items necessary to complete the electrical systems. All items of equipment are specified in the singular; however, provide and install the number of items of equipment as indicated on the drawings, and as required for complete systems.

1.22 SEQUENCING AND SCHEDULING

A. Construct Work in sequence under provisions of Division 1.

1.23 LICENSE

A. The Subcontracting Firm for the electrical and systems installation shall be licensed by the State of Florida and the local authorities, regularly engaged in the installation of electrical systems and other related equipment. The Subcontracting Firm shall be familiar with all local conditions including interpretations, codes and shall have at least 5 years of successful installation experience on similar projects of the same magnitude and scope.

The Subcontracting Firm shall list at least three projects it has successfully completed over the last five years for proof of experience of this caliber. This list shall be included with submittals for review by Architect/Engineer. The Subcontracting Firm shall hold a Florida State Certified Electrical Contractor license for this project. The Subcontracting firm for the fire alarm system shall be a certified "EF" installer.

1.24 AS-BUILT DRAWINGS

A. This Contractor shall provide AutoCad as-built drawings and copies of each AutoCad file on CD before final payment will be issued.

*** END OF SECTION 26 05 00 ***

SECTION 26 05 10

ELECTRICAL DEMOLITION FOR REMODELING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical Demolition.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify field measurements and circuiting arrangements are as shown on drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents. Report discrepancies to the Architect/Engineer before disturbing existing installation.

D. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with utility company and school facility.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service and Distribution System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the Owner at least one week before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Notify the Owner at least one week before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Relocate system to temporary office location. Extend all existing and temporary fire alarm circuit and control wiring to this location.

F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Notify the Owner and telephone utility company at least one week before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

G. Existing Intercom System: Maintain existing system in service. Relocate system to temporary office location. Extend all existing and new intercom circuits to this location. Disable system only to make switchovers and connections. Notify the Owner at least one week before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Furnish and install temporary wiring and intercom circuits as required.

H. Furnish, install, and maintain temporary power and lighting for all areas and for trades. Lighting levels shall equal the existing condition prior to demolition work.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of Division 1 and this Section.

B. Prior to any demolition, this Contractor shall survey the building and paint a large red ‘R’ on the equipment to be removed as coordinated with the architectural and HVAC plans and roofer. If any item(s) is incorrectly tagged, then this Contractor shall clean off the paint so there is no confusion.

C. If any conflicts arise in the field as to which equipment, ductwork, etc., is to be removed, then this Contractor shall notify the Owner/Engineer in writing and shall include a sketch and description of the field conflict for further direction.

D. In areas where demolition is required of this Contractor, then this Contractor shall be responsible for all phases of demolition, including, but not limited to, removal, storage, and reinstallation of items to remain.

E. Remove, relocate, and extend existing installations to accommodate new construction.

F. Remove abandoned wiring to source of supply.

G. Remove exposed, abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors and patch surfaces.

H. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed or remove boxes for wall to be patched.

I. Disconnect and remove abandoned panelboards and distribution equipment.

J. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

K. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

L. Repair adjacent construction and finishes damaged during demolition and extension work.

M. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

N. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

O. Coordinate with roofer and assist in removal of all roof mounted electrical conduit devices, equipment, etc., to be removed as indicated on the roofing drawings and HVAC drawings.

3.4 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

3.5 INSTALLATION

A. Install relocated materials and equipment under the provisions of Division 1.

*** END OF SECTION 26 05 10 ***

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.

2. Connectors, splices, and terminations rated 600 V and less.

3. Sleeves and sleeve seals for cables.

4. Conductor sizes are based on copper.

B. Related Sections include the following:

1. Section 26 05 33 .....Raceway And Boxes For Electrical Systems.

2. Section 26 05 53 .....Identification For Electrical Systems.

1.3 REFERENCES

A. ANSI/NFPA 70—National Electrical Code.

B. NEMA WC5—Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.4 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

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

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70 where wire and cable is not shown.

1.7 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

B. Determine required separation between cable and other work.

PART 2 PRODUCTS

2.1 CONDUCTORS AND CABLES

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:

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

1. Alcan Products Corporation; Alcan Cable Division.

2. American Insulated Wire Corp.; a Leviton Company.

3. General Cable Corporation.

4. Senator Wire & Cable Company.

5. Southwire Company.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.

E. Multiconductor Cable: Comply with NEMA WC 70 for Type SO with ground wire.

2.2 CONNECTORS AND SPLICES

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:

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

1. AFC Cable Systems, Inc.

2. Hubbell Power Systems, Inc.

3. O-Z/Gedney; EGS Electrical Group LLC.

4. 3M; Electrical Products Division.

5. Tyco Electronics Corp.

C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

D. No splices shall be permitted in underground locations.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

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:

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

1. Advance Products & Systems, Inc.

2. Calpico, Inc.

3. Metraflex Co.

4. Pipeline Seal and Insulator, Inc.

C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

2. Pressure Plates: Carbon steel. Include two for each sealing element.

3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN-XHHW, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

F. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway.

G. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

J. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

K. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

L. Class 1 Control Circuits: Type THHN-THWN, in raceway.

M. Class 2 Control Circuits: Type THHN-THWN-TFFN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Concealed Dry Interior Locations: Use only building wire and cable (all types) in raceway.

E. Exposed Dry Interior Locations: For feeders, branch circuits, and class 1 remote control circuits, use only building wire in raceway. For class 2 or 3 control cable and power limited fire protective signaling cables run in raceway.

F. Above Accessible Ceilings: For feeders, branch circuits and class 1 remote control cables use only building wire in raceway. For class 2 or 3 remote control cables run exposed. For power limited fire protective signaling cables run in raceway.

G. Wet or Damp Interior Locations: For feeders, branch circuits and class 1 remote control cables use only building wire in raceway. For class 2 or 3 remote control cable and power limited fire protective signaling cables run in raceway.

H. Exterior Locations: For feeders, branch circuits and class 1 remote control cables use only building wire run in raceway. For class 2 or 3 remote control cables and fire protective signaling cables run in raceway.

I. Underground Installations: For feeders, branch circuits and class 1 remote control cables use only building wire run in raceway. For class 2 or 3 remote control cables and for power limited fire protective signaling cables run in raceway.

J. Use wiring methods indicated on Drawings.

K. Each branch circuit shall have a dedicated neutral conductor. Shared neutrals on multiwire branch circuits are not acceptable.

L. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.

M. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

N. All conductors size #6 and smaller shall be color coded insulation. Equipment grounding conductors #6 and smaller to have green or bare exterior finish per NEC 250-119(A). Grounded conductors (neutral) #6 and smaller to have a white or grey exterior finish per NEC 200-6. Conductors size #4 and larger shall be color code by use of colored plastic tape applied within 6" of each conductor end. All color coding shall be with the same color being used with its respective phase or bus through the entire job as follows:

208/120 VOLTS	277/480 VOLTS
Phase A.....Black	Phase A.....Brown
Phase B.....Red	Phase B.....Orange
Phase C.....Blue	Phase C .....Yellow
Neutral.....White	Neutral.....Gray
Ground .....Green	Ground .....Green

O. Grounding conductors shall be identified with a continuous outer finish that is either green, or green with one or more yellow stripe.

P. Protect exposed cable from damage.

Q. Support cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

R. Neatly train and lace wiring inside boxes, equipment, and panelboards.

S. Clean conductor surfaces before installing lugs and connectors.

T. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

U. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

V. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

W. Terminate spare conductors with electrical tape.

X. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

Y. Splice only in accessible junction boxes. No splices shall be permitted in underground locations.

Z. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both wall surfaces.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

J. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

*** END OF SECTION 26 05 19 ***

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1. Underground distribution grounding.

2. Common ground bonding with lightning protection system.

1.3 SYSTEM DESCRIPTION

A. Ground the electrical service system neutral at service entrance equipment to metallic water service, concrete encased rebar, building steel, and to supplementary grounding electrodes.

B. Ground each separately-derived system neutral to nearest effectively grounded metallic water pipe, concrete encased rebar, nearest effectively grounded building structural steel member, and separate grounding electrode.

C. Provide communications system grounding conductor at point of service entrance and connect to separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

E. Install lightning surge protection on all service entrances as shown on drawings. Lightning surge protector shall have a minimum withstand rating of a Class "C" test.

F. Bond metallic gas piping with #4 AWG copper conductor.

1.4 SUBMITTALS

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

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Test wells.

2. Ground rods.

3. Ground rings.

4. Grounding arrangements and connections for separately derived systems.

5. Grounding for sensitive electronic equipment.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NETA MTS.

a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.

b. Include recommended testing intervals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with UL 467 for grounding and bonding materials and equipment.

D. Grounding system resistance shall not exceed 10 ohms.

E. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method. Submit test results to Engineer for review and approval immediately upon completing the test and prior to energizing new utility service. The testing shall include sufficient ground resistant data readings from distances up 100 feet away from the ground triad in order to plot a distinct plateau between two distinctive slopes.

PART 2 PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.

2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 4 inches in cross section, unless otherwise indicated; with insulators, length as required for number of terminations plus 25 percent future capacity.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; sectional type, 3/4 inch by 10 feet in diameter, two (2) rods coupled together for overall length of 20 feet.

PART 3 EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

B. Underground Grounding Ring Conductors: Install bare-copper conductor, No. 4/0 AWG minimum when indicated on the drawings to provide.

1. Bury at least 24 inches below grade.

2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch, minimum, from wall, 6 inches above finished floor, unless otherwise indicated.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Clamp connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.

2. Lighting circuits.

3. Receptacle circuits.

4. Single-phase motor and appliance branch circuits.

5. Three-phase motor and appliance branch circuits.

6. Flexible raceway runs.

7. Armored and metal-clad cable runs.

8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

D. Metal and Concrete Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors. Provide ground rod at each location.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Ground Ring (when identified and called for on the drawings): Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of item indicated.

1. Install copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.

2. Bury ground ring not less than 24 inches from building foundation.

H. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.

2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

D. Report measured ground resistances that exceed the following values:

1. Main service equipment and distribution gear.

2. Separately derived system (i.e., transformers, uninterruptible power supply, engine generators).

3. Grounding system resistance shall not exceed 10 ohms.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

F. Supplement by adding additional ground rods to achieve 10 ohms.

*** END OF SECTION 26 05 26 ***

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

2. Construction requirements for concrete bases.

3. Supports/safety wire and chains for light fixtures and equipment.

B. Related Sections include the following:

1. Division 26 Section "Interior Lighting and Theatrical Lighting."

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.

2. Steel slotted channel systems. Include Product Data for components.

3. Nonmetallic slotted channel systems. Include Product Data for components.

4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. 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:

a. Allied Tube & Conduit.

b. Cooper B-Line, Inc.; a division of Cooper Industries.

c. ERICO International Corporation.

d. GS Metals Corp.

e. Thomas & Betts Corporation.

f. Unistrut; Tyco International, Ltd.

g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. Channel Dimensions: Selected for applicable load criteria.

B. Located In or Around Cooling Tower Yards: Pipe hangers, equipment supports, miscellaneous structure components, hardware, bolts, washers, nuts, screws, etc., shall be non-metallic polyester resin, vinyl ester resin, fiberglass, glass reinforced polyurethane, or 316 stainless steel.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Shall not be used.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. 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:

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

1) Cooper B-Line, Inc.; a division of Cooper Industries.

2) Empire Tool and Manufacturing Co., Inc.

3) Hilti Inc.

4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment. After fabrication shall be coated with hot-dipped galvanized with a minimum of 1.50 oz/ft on all sides.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

C. Field cuts shall be zinc coated.

2.3 SAFETY WIRE, CABLES, AND CHAIN

A. Chain, General Specifications: Equivalent to Campbell Chain Company's specified system of steel, electrically welded standard finish (do not galvanize or electroplate), in continuous lengths. Comply with Manufacturer's recommendations.

B. Drop Forged Chain Fittings (eye bolts, pad eyes, inks, chain shackles, snaps, anchor shackles, swivels, turn buckles): Of the same materials and finish as the chain and of the same or greater working load limits, of the same manufacturer or as may be specifically recommended by the chain manufacturer.

C. General Specifications for Wire: 8-gauge galvanized annealed steel wire (multiple strands of lesser gauge will not be considered acceptable). Each wire shall, itself, be looped through the building structural framing above and not to other wiring systems. The angle of the wires shall be kept as vertical as possible and not over 45 degrees from the vertical.

D. Cable for Exposed-to-Public-View-Applications: Where suspended chandeliers, light fixtures, or special equipment occurs, stainless steel flexible aircraft cable or stainless steel flexible marine cable, 302/304, as manufactured by Paulsen, or equal, or Sailbryte as manufactured by Macwhyte corrosion resistant stainless steel or better, right regular lay, in continuous lengths, shall be used. Comply with manufacturer's recommendations.

E. Forged and other stainless steel fittings for stainless steel aircraft or marine cable (turnbuckles, swagings, Nicro-Press sleeves, wire rope clips, use only in concealed positions), connecting links shoulder rivets, jaw fittings, eye fittings, lifting eyes, thimbles, swivels, eye nuts, heavy thimbles, clevis nuts, eye pads, shoulder pins); of same material, of same or greater working loads limits as the cable, of the same manufacturer or as recommended by the cable manufacturer, of type 304/316 electro-polished finish, drop forged, non-magnetic (when available for particular fitting). Manufactured by Merrill or equal. See Workmanship paragraph below.

F. Stainless steel cable for loads (per cable) not exceeding 100 lbs.: 3/32" 7x19 with tensile load limit of 920 lbs. minimum.

G. Stainless steel cable for loads (per cable) not exceeding 500 lbs.: 3/16" 7x19 with tensile load limit of 3,700 lbs. minimum.

H. Workmanship: Stainless steel cable is required to be used only in areas where such is exposed to "public view" therefore only fittings designed for cold swaging or Nicro-Press fittings or swagless terminals such as Macwhyte Norseman Terminals are to be used whereby no wire ends, nuts, pins, or cotter keys, or clips are visible. Swaging shall be done only with a rotary swager (not a roll swager.) Manufacturer's recommendations and specifications shall be adhered to. Pertinent portions of the booklet Wire Rope Facts published by Banks Wire Rope and Sling, Inc. (available in Tampa) and Construction Care and Maintenance of Marine Rigging by Macwhyte Wire Rope Company (available at the Lazzerette Company) which may pertain also to stainless steel cable, shall be adhered to.

PART 3 EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with conduit clamps.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

3. To Existing Concrete: Expansion anchor fasteners.

4. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

5. To Light Steel: Sheet metal screws.

6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate[by means that meet seismic-restraint strength and anchorage requirements].

7. Do not drill structural steel members.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

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

B. Touchup: Comply with requirements in Division 09 Painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

*** END OF SECTION 26 05 29 ***

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SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Section 26 05 26 .....Grounding and Bonding for Electrical Systems.
2. Section 26 05 29 .....Hangers and Supports for Electrical Systems.
3. Section 26 05 53 .....Identification for Electrical Systems.
4. Section 26 27 26 .....Wiring Devices.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: All raceway types, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.

2. For handholes and boxes for underground wiring, including the following:

a. Duct entry provisions, including locations and duct sizes.

b. Frame and cover design.

c. Grounding details.

d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

e. Joint details.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.

2. Alflex Inc.

3. Allied Tube & Conduit; a Tyco International Ltd. Co.

4. Anamet Electrical, Inc.; Anaconda Metal Hose.

5. Electri-Flex Co.

6. Manhattan/CDT/Cole-Flex.

7. Maverick Tube Corporation.

8. O-Z Gedney; a unit of General Signal.

9. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1. Zinc coated ¾" minimum.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. EMT: ANSI C80.3. ¾" minimum.

F. LFMC: Flexible steel conduit with PVC jacket.

G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Steel set screw or steel compression. One inch (1") and smaller shall be insulated throats.

2. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

3. Fittings for EMT: Steel, set-screw or compression type.

4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

H. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.

2. Anamet Electrical, Inc.; Anaconda Metal Hose.

3. Arnco Corporation.

4. CANTEX Inc.

5. CertainTeed Corp.; Pipe & Plastics Group.

6. Condux International, Inc.

7. ElecSYS, Inc.

8. Electri-Flex Co.

9. Lamson & Sessions; Carlon Electrical Products.

10. Manhattan/CDT/Cole-Flex.

11. RACO; a Hubbell Company.

12. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Type EPC-40-PVC and EPC-80-PVC. ¾" minimum.

D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

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. Arnco Corporation.

2. Endot Industries Inc.

3. IPEX Inc.

4. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for plenum installation.

2.4 METAL WIREWAYS

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

1. Cooper B-Line, Inc.

2. Hoffman.

3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways, as required for complete system.

D. Wireway Covers: Hinged type or screw-cover type, as indicated.

E. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS

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

1. Hoffman.

2. Lamson & Sessions; Carlon Electrical Products.

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.6 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect/Engineer.

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

a. Thomas & Betts Corporation.

b. Walker Systems, Inc.; Wiremold Company (The).

c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

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

a. Butler Manufacturing Company; Walker Division.

b. Enduro Systems, Inc.; Composite Products Division.

c. Hubbell Incorporated; Wiring Device-Kellems Division.

d. Lamson & Sessions; Carlon Electrical Products.

e. Panduit Corp.

f. Walker Systems, Inc.; Wiremold Company (The).

g. Wiremold Company (The); Electrical Sales Division.

2.7 BOXES, ENCLOSURES, AND CABINETS

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

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.

2. EGS/Appleton Electric.

3. Erickson Electrical Equipment Company.

4. Hoffman.

5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.

6. O-Z/Gedney; a unit of General Signal.

7. RACO; a Hubbell Company.

8. Robroy Industries, Inc.; Enclosure Division.

9. Scott Fetzer Co.; Adalet Division.

10. Spring City Electrical Manufacturing Company.

11. Thomas & Betts Corporation.

12. Walker Systems, Inc.; Wiremold Company (The).

13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Metal Floor Boxes: Cast metal, fully adjustable, rectangular. Hubbell B-4236 Series, Walker 880CS Series.

E. Floor Box Covers: Polished solid brass.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

I. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

6. Plywood backboard, marine-grade, ¾" thick.

7. Copper Ground Bar with #6 Copper Grounding: Electrode conductor to building steel.

8. Terminal Blocks: ANSI/NEMA ICS 4: UL listed. Channel mounted tubular pressure screw connectors, rated 300 volts.

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.

1. Color of Frame and Cover: Gray.

2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.

3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

5. Cover Legend: Molded lettering, "ELECTRIC" or "COMMUNICATION."

6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

8. All in-ground boxes shall be traffic bearing type.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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

2. Basis-of-Design Product: Subject to compliance with requirements, provide Quazite PG Series or a comparable product by one of the following:

a. Armorcast Products Company.

b. Carson Industries LLC.

c. CDR Systems Corporation.

d. NewBasis.

2.9 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.10 SLEEVE SEALS

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. Advance Products & Systems, Inc.

2. Calpico, Inc.

3. Metraflex Co.

4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

2. Pressure Plates: Carbon steel. Include two for each sealing element.

3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.

2. Concealed Conduit, Aboveground: Rigid steel conduit or EMT.

3. Underground Conduit: RNC, Type EPC-40 PVC, direct buried.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

6. Application of Handholes and Boxes for Underground Wiring:

a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete. SCTE 77, Tier 15 structural load rating.

b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.

c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

d. No splices shall be permitted in underground locations.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:

a. Loading dock.

b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

c. Mechanical rooms.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations (including all mechanical equipment rooms).

5. Damp or Wet Locations: Rigid steel conduit.

6. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable in raceway or EMT.

7. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.

8. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: General-use, optical fiber/communications cable in raceway; Riser-type, optical fiber/communications cable in raceway. Outside Plant, Plenum-type, optical fiber/communications cable in RGC or IMC.

9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs: Metallic raceways shall be coated with Bitumastic.

1. Run conduit parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Change from Type EPC-40-PVC to rigid steel conduit or IMC before rising above the floor.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use #12 insulated conductor or polypropylene line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.

2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.

3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where otherwise required by NFPA 70.

N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet.

1. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.

2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

O. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

Q. Set metal floor boxes level and flush with finished floor surface.

R. Install insulated bushing on all conduits. Install grounded metal bushing with lug on all mains, sub-feeders, switchboards, panelboards, transformers, chillers, disconnects, starters, and equipment rated at 100 amps and above.

S. Do not install flush mounting boxes back to back in walls. Provide minimum 12 inch separation. Provide 24 inch minimum separation in acoustic rated walls.

T. Install boxes to preserve fire resistance rating of partitions and other elements using materials and methods that are UL listed and tested.

U. Use stamped steel bridges to fasten flush mounted outlet box between studs.

V. Existing Walls, Public Areas, Classrooms, Offices, Restrooms, Hallways, etc.: Conduit and boxes shall be concealed. Saw cut walls and floor slab. Make arrangements with General Contractor to patch all areas.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.

2. Install backfill as specified in Division 31 Section "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

7. Transition from PVC (EPC-40 and EPC-80) to rigid galvanized conduit 5'-0" out from building foundation walls.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.8 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

*** END OF SECTION 26 05 33 ***

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways, Junction Boxes, and Pullboxes Carrying Circuits at 600 V or Less:

1. Emergency Distribution System: Red.

2. 480 Volt, Single and Three Phase System: Blue.

3. 208 Volt, Single and Three Phase System: Black.

4. Fire Alarm System: Red.

5. Motor and Other Control Systems: Purple.

6. Telephone System: Yellow.

7. Television System: Brown.

8. Security System: White.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.

2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high letters on 20-inch centers.

D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

G. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.

H. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.4 FLOOR MARKING TAPE

A. 2-inch wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.

2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.

3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.

2. 1/4-inch grommets in corners for mounting.

3. Nominal size, 7 by 10 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.7 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.

2. Punched or drilled for mechanical fasteners.

3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.9 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.

3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.

3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.

3. UL 94 Flame Rating: 94V-0.

4. Temperature Range: Minus 50 to plus 284 deg F.

5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 10-foot maximum intervals in straight runs, and at 5-foot maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits: Identify with self-adhesive vinyl label, self-adhesive vinyl tape applied in bands, or painted bands. Install labels at 10-foot maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.

2. Power.

3. UPS.

4. Lighting.

5. Fire Alarm.

6. Controls.

C. Power-Circuit Conductor Identification, 600 V or Less: For all conductors.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

b. Colors for 208/120-V Circuits:

1) Phase A: Black.

2) Phase B: Red.

3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.

2) Phase B: Orange.

3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.

2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.

3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.

b. Controls with external control power connections.

J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.

b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits, specific to the load served and distinguishable from all other in the panel. The directory shall be placed in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.

b. Enclosures and electrical cabinets.

c. Access doors and panels for concealed electrical items.

d. Switchgear.

e. Switchboards.

f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

g. Substations.

h. Emergency system boxes and enclosures.

i. Motor-control centers.

j. Enclosed switches.

k. Enclosed circuit breakers.

l. Enclosed controllers.

m. Variable-speed controllers.

n. Push-button stations.

o. Power transfer equipment.

p. Contactors.

q. Remote-controlled switches, dimmer modules, and control devices.

r. Battery-inverter units.

s. Battery racks.

t. Power-generating units.

u. Monitoring and control equipment.

v. UPS equipment.

*** END OF SECTION 26 05 53 ***

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge suppression units.
4. Wall-box motion sensors.
5. Isolated-ground receptacles.
6. Hospital-grade receptacles.
7. Snap switches and wall-box dimmers.
8. Solid-state fan speed controls.
9. Wall-switch and exterior occupancy sensors.
10. Pendant cord-connector devices.
11. Cord and plug sets.
12. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

B. Related Sections include the following:

1. Division 26 Section "Raceways and Boxes for Electrical Systems."
2. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).

2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Leviton Mfg. Company Inc. (Leviton).

4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 8300 (duplex).

b. Hubbell; HBL8310 (single), HBL8300H (duplex).

c. Leviton; 8310 (single), 8300 (duplex).

d. Pass & Seymour; 9301-HG (single), 9300-HG (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; CR 5253IG.

b. Leviton; 5362-IG.

c. Pass & Seymour; IG6300.

3. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; TR8300.

b. Hubbell; HBL8300SG.

c. Leviton; 8300-SGG.

d. Pass & Seymour; 63H.

3. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with UL 498 Supplement SD.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; HGF20.

b. Hubbell; HGF8300.

c. Leviton; 6898-HG.

d. Pass & Seymour; 2091-SHG.

2.4 TVSS RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.

1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.

2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex TVSS Convenience Receptacles:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5362BLS.

b. Hubbell; HBL5362SA.

c. Leviton; 5380.

3. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.

2.5 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.

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

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

a. Cooper Crouse-Hinds.

b. EGS/Appleton Electric.

c. Killark; a division of Hubbell Inc.

2.6 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; L520R.

b. Hubbell; HBL2310.

c. Leviton; 2310.

d. Pass & Seymour; L520-R.

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.

2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).

b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).

c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).

d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 2221PL for 120 V and 277 V.

b. Hubbell; HPL1221PL for 120 V and 277 V.

c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.

d. Pass & Seymour; PS20AC1-PLR for 120 V.

3. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 2221L.

b. Hubbell; HBL1221L.

c. Leviton; 1221-2L.

d. Pass & Seymour; PS20AC1-L.

3. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 1995.

b. Hubbell; HBL1557.

c. Leviton; 1257.

d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 1995L.

b. Hubbell; HBL1557L.

c. Leviton; 1257L.

d. Pass & Seymour; 1251L.

2.10 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 1000 W; dimmers shall require no derating when ganged with other devices. Match load shown on drawings.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.11 FAN SPEED CONTROLS

A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.

1. Three-speed adjustable rotary knob, 1.5 A.

2.12 OCCUPANCY SENSORS

A. Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 6111 for 120 V, 6117 for 277 V.

b. Hubbell; WS1277.

c. Leviton; ODS 10-ID.

d. Pass & Seymour; WS3000.

e. Watt Stopper (The); WS-200.

3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.

B. Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; AT120 for 120 V, AT277 for 277 V.

b. Leviton; ODS 15-ID.

3. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.

C. Exterior Occupancy Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Leviton; PS200-10.

b. Watt Stopper (The); EW-100-120.

3. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.

2.13 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: Smooth stainless steel.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.14 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type or flap-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular or round, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray for data/communications outlets, ivory for convenience outlets, unless otherwise indicated.

E. Voice and Data Communication Outlet: Blank cover with bushed cable opening for four CAT 5 jacks.

2.15 POKE-THROUGH ASSEMBLIES

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:

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

1. Hubbell Incorporated; Wiring Device-Kellems.

2. Pass & Seymour/Legrand; Wiring Devices & Accessories.

3. Square D/ Schneider Electric.

4. Thomas & Betts Corporation.

5. Wiremold Company (The).

6. Evolution.

C. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.

1. Service Outlet Assembly: Flush type with two (2) duplex receptacles and space for four (4) RJ-45 jacks.

2. Size: Selected to fit nominal 6-inch cored holes in floor and matched to floor thickness.

3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.

4. Closure Plug: Arranged to close unused 6-inch cored openings and reestablish fire rating of floor.

5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 5e voice and data communication cables.

2.16 MULTIOUTLET ASSEMBLIES

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:

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

1. Hubbell Incorporated; Wiring Device-Kellems.

2. Wiremold Company (The).

C. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

D. Raceway Material: Metal, with manufacturer's standard finish.

E. Wire: No. 12 AWG.

2.17 SERVICE POLES

A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.

1. Poles: Nominal 2.5-inch-square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.

2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.

3. Finishes: Manufacturer's standard painted finish and trim combination.

4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.

5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.

6. Voice and Data Communication Outlets: Four RJ-45 Category 5e jacks.

2.18 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Toggle Switches: Ivory.

2. Convenience Receptacles: Ivory.

3. Data/Communication Receptacles: Gray.

4. GFCI Receptacles: Ivory.

5. Wiring Devices Connected to Emergency Power System: Red.

6. TVSS Devices: Blue.

7. Isolated-Ground Receptacles: Orange.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.

b. Straighten conductors that remain and remove corrosion and foreign matter.

c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.

2. Verify that dimmers used for fan speed control are listed for that application.

3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.

2. Test Instruments: Use instruments that comply with UL 1436.

3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.

2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.

4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.

6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight blade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

*** END OF SECTION 26 27 26 ***

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 22 deg F and not exceeding 104 deg F.

2. Altitude: Not exceeding 1000 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than fourteen (14) days in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Owner's written permission.

4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Fuse Pullers: One for each size and type.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac for voltage applied, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V ac for voltage applied, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 240 or 600-V ac for voltage applied, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open when specified with VFD mounted separately.

6. Hookstick Handle: Allows use of a hookstick to operate the handle.

7. Lugs: Mechanical type, suitable for number, size, and conductor material.

8. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac for voltage applied, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V ac for voltage applied, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 240 or 600-V ac for voltage applied, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open when specified with VFD mounted separately.

5. Hookstick Handle: Allows use of a hookstick to operate the handle.

6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 RECEPTACLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 240 or 600-V ac for voltage applied, 30 A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

C. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: 240 or 600-V ac for voltage applied, 30 A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

E. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

1. Receptacle Manufacturer and Catalog Number: NEMA type configuration as shown on drawings.

2.4 SHUNT TRIP SWITCHES

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

1. Cooper Bussmann, Inc.

2. Ferraz Shawmut, Inc.

3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power of enough capacity to operate shunt trip, connected pilot, and indicating and control devices. Refer to drawings to ensure separate 120 V source not provided by other means.

E. Accessories:

1. Oiltight key switch for key-to-test function.

2. Oiltight green ON pilot light.

3. Isolated neutral lug; 100 percent rating.

4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.

5. Form C alarm contacts that change state when switch is tripped.

6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.5 MOLDED-CASE CIRCUIT BREAKERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Long- and short-time pickup levels.

2. Long- and short-time time adjustments.

3. Ground-fault pickup level, time delay, and I2t response.

E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

F. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

G. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

H. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

I. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self- powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact when indicated on drawings.

2.6 MOLDED-CASE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:

1. Standard frame sizes and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.7 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.

3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.

4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

6. Mechanical Cooling Tower Areas: NEMA 250, Type 4X, stainless steel.

7. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

*** END OF SECTION 26 28 16 ***