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SECTION 210500
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. In addition to Division 01 Specification Sections, related sections include the following:
   1. Division 01 Section "Cutting and Patching"
   2. Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
   3. Division 03 Sections "Cast-in-Place Concrete" and "Miscellaneous Cast-in-Place Concrete".
   4. Division 05 Section "Metal Fabrications" for structural steel.
   5. Division 09 Sections "Interior Painting" and "Exterior Painting".
   6. Division 08 Section "Access Doors and Frames" for access panels and doors.

1.2 RELATED REQUIREMENTS

A. All conditions imposed by these documents shall be applicable to all portions of the Work under this Division. These references are intended to point out specific items to the Contractor, but in no way relieve him of the responsibility of reading and complying with all relevant parts of the entire Specification.

B. The Contractor shall examine and coordinate with all Contract Drawings and Specifications, and all Addenda issued. Failure to comply shall not relieve them of responsibility. The omission of details of other portions of the Work from this Division shall not be used as a basis for a request for additional compensation.

C. The specific features and details for other portions of the Work related to the construction in progress or to the building(s) shall be determined by examination at the site.

1.3 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Mechanical sleeve seals.
   3. Sleeves.
   5. Fire-suppression equipment and piping demolition.
   6. Equipment installation requirements common to equipment sections.
   7. Painting and finishing.
   8. Concrete bases.
1.4 DEFINITIONS

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

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

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

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

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

1.5 SCOPE OF WORK

A. Inspection Of Site

1. The accompanying drawings do not indicate existing plumbing installations other than to identify modifications of and extensions thereof. The Contractor shall visit the site, inspect the installations and ascertain the conditions to be met and the work.

2. Failure to comply with an inspection of the site shall not constitute ground for any additional payments in connection with removing or modifying any part of the existing installations and/or installing any new work under this Division.

3. Review all construction details of the new portion of the building as illustrated on the architectural and structural drawings and be guided thereby.

B. The Work shall include modifications and extensions to existing systems, and the modification of the existing structure as required accommodating the installation of the Work.

C. Refer to other Divisions of the Specifications for related Work.

D. Contractor shall install, hang, support, etc. all Fire Protection systems and equipment to satisfy all requirements of the applicable seismic zone using performance requirements and design criteria for project site as indicated by architect.

E. It is the intent, unless otherwise indicated, that all products and materials described and specified under this Division, shall be provided for a complete working system irrespective of use of the phrases "install", "furnish", "furnish and install", or “provide” as described above has been actually included.

F. The Contractor shall be responsible for all Work of every description in connection with this Division of the Specifications.

G. The Contractor shall specifically and distinctly assume, and does so assume, all risk for damage or injury from whatever cause to property or person used or employed on or in connection with this Work and of all damages or injury to any person or property wherever located, resulting from an action or operation under the Contract in connection with the Work, and undertake the promise to defend the Owner against all claims on account of any such damage or injury.
H. The Contractor will be held responsible for the satisfactory execution and completion of the Work in accordance with the true intent of the Documents.

I. The Contractor shall provide without extra charge all incidental items required as part of the Work, even though it may not be specifically indicated. If the Contractor has reason for objecting to the use of any material, equipment, device or method of construction as indicated, he shall make report of such objections to the Owner's Representative, obtain proper approval and adjustment to the Contract, and shall proceed with the Work.

J. Electric wiring

1. All electric wiring shall be installed under Division 26, except for such equipment items as are prewired at their point of manufacture and so delivered to the project, and except for the following:

   a. Temperature Control Wiring and Power Wiring provided by controls contractor.

2. Prepare and submit for review wiring diagrams for all equipment furnished under this Division. Show on these diagrams all power, interlock, and control circuits. When the Architect takes no exception to these drawings, they shall become installation drawings for the Contractor.

1.6 ORDINANCES, PERMITS AND CODES

A. It shall be the Contractor's duty to perform the work and provide the materials covered by these specifications in conformance with all ordinances and regulations of all authorities having jurisdiction.

B. The work shall be in accordance with, but not limited to, the requirements of:

   1. National Fire Protection Association

C. Codes and standards referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes and regulations, the drawings, and specifications govern.

D. The Contractor shall obtain permits, plan checks, connection and specification fees, inspections, and approvals applicable to the Work as required by the regulatory authorities.

E. Fees and costs of any nature whatsoever incidental to permits, inspections, and approvals shall be assumed and paid by the Contractor.

F. The pro-rata costs, if any, for utilities serving this property will be paid for by the Owner and shall not be included as part of this Contract.

1.7 SUBMITTAL PROCEDURES

A. Common Requirements for Product Data: Where this Section and other Sections of this Division require Product Data to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:

   1. Submit hardcopy of Product Data in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of product data submittals shall be bound materials
as defined above. Separate products under distinct subheadings that correspond to paragraphs in specification text. Divide sections in binder with labeled divider tabs.

2. In addition to hardcopies required by Division 01, submit one copy of product data in electronic format. All files on disc shall be in Portable Document Format (.pdf).

3. Product Data shall not consist of manufacturer's catalogs or cut sheets that contain no indication of the exact item offered. The submission on individual items shall designate the exact item offered.

B. Product Data: For the following:

1. Dielectric fittings.
2. Mechanical sleeve seals.
3. Escutcheons.

C. Common Requirements for Shop Drawings: Where this Section and other Sections of this Division require Shop Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:

1. Prepare Shop Drawings using computerized drafting software compatible with AutoDesk’s AutoCAD®.
2. Submit hardcopy of Shop Drawings in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of Shop Drawings shall have each sheet clearly labeled with a unique sheet identification number.
3. In addition to hardcopies required by Division 01, submit one copy of Shop Drawings in electronic format. Files shall be include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).
4. Shop Drawings shall be of appropriate scale based on the following:
   
   a. Piping Systems, including all underfloor work: Minimum 1/8" = 1'-0".
   b. Mechanical rooms: 1/4" = 1' – 0".

5. Shop drawings shall include the following items:
   
   a. Concrete pads and foundations.
   b. Equipment room layouts with actual dimensions and offsets for all systems.
   c. Drain locations.

D. Common Requirements for Coordination Drawings: Where this Section and other Sections of this Division require Coordination Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures" and Division 01 Section "Project Management and Coordination". In addition to the requirements of Division 01 comply with the following:

1. Prepare Coordination Drawings using computerized drafting software compatible with AutoDesk's AutoCAD®. Drawings files must be composite with multiple distinctive layers for each of the various trades.
2. Submit hardcopy of Coordination Drawings in the quantity as required under Division 01. Hardcopies of Coordination Drawings shall have each sheet clearly labeled with a unique sheet identification number.
3. In addition to hardcopies required by Division 01, submit one copy of Shop Drawings in electronic format. Files shall be include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).
4. Coordination Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.
E. Coordination Drawings: Prepare drawings showing dimensioned layout for the following:

1. Penetration and Structural Opening: Floor plans showing sleeves and formed structural penetrations. Show sleeve and formed penetration layouts and relationships between structural components and other adjacent building elements, including but not limited to pre-tensioning and post-tensioning members where used.

2. Reflected Ceiling Plans: Ceiling plans, sections, and other necessary details showing dimensioned layouts for equipment located in or on the ceiling plane. Base dimensions on exact dimensioned data obtained from product submittals for products to be included in the Work. Differentiate between field measurements and assumed dimensions. Include the all items in the ceiling plane coordinated with each other, based on input from installers of the items involved.

3. Include the following items coordinated with each other, based on input from installers of the items involved:

   a. Suspended ceiling components.
   b. Structural members to which suspension systems for luminaires will be attached.
   c. Perimeter moldings, decorative ceiling elements, and Architectural features.
   d. Luminaires.
   e. HVAC Diffusers, Registers and Grilles.
   f. Speakers.
   g. Sprinklers.
   h. Fire Alarm initiating devices, including but not limited to the following:
      1) Smoke detectors.
      2) Heat detectors.
   i. Fire Alarm notification appliances.
   j. Occupancy sensors.
   k. Access panels.
   l. Security cameras and occupancy detectors.
   m. Wireless Access Points.
   n. Nurse Call Zone and Dome Lights.
   o. Patient Telemetry Receivers and Equipment.

4. Sprinkler Layouts:

   a. Single-line drawings of sprinkler and piping systems are satisfactory.
   b. Shop drawings shall be provided for the following:
      1) Fire protection Systems, including all underfloor work (prepared at a minimum scale of 1/8"=1'-0"")
      2) Equipment room layouts with actual equipment and piping at 1/4" = 1' – 0" scale. Show clearances, access spaces, relative heights of piping.
      3) Housekeeping and equipment concrete pads.
      4) Dimensioned floor drain locations and the equipment each serves.
   c. Equipment support locations, type of support, and weight on each support.
   d. Location of structural supports for structure-supported raceways.
   e. For floor mounted equipment: concrete base dimension, outline of equipment, and required clearances.
   f. Location of structural supports for seismic bracing.

F. Common Requirements for Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted,
meet the requirements defined in Division 01 Section "Submittal Procedures" for "Other Informational Submittals". In addition to the requirements of Division 01 comply with the following:

1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with “Compliance”. Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.

   a. “C” for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.

   b. “D” for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.

   c. “A” for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.

   d. “N/A” for Not Applicable: By noting the term “not applicable” or “N/A” in the margin, it shall be understood that the specified item is not applicable to the project.

G. Common Requirements For Qualification Data:

   1. Professional Engineer Qualifications: Where this Section and other Sections of this Division require a Professional Engineer to be responsible for Delegated Design requirements; Submit Qualification data for Professional Engineer including, but not limited to, proof of registration in the Project location.

   2. Independent Testing and Inspecting Agency Certification: Where this Section and other Sections of this Division require an Independent Testing and Inspecting agency to be responsible for Acceptance Testing and Field Quality Control requirements; Submit certification documentation for such agency that demonstrates compliance with the Quality Assurance paragraph of this Section.

H. Qualification Data: For Independent Testing and Inspecting Agency.

I. Welding certificates.

1.8 SUBSTITUTIONS

A. Where the product of a single manufacturer is mentioned by trade name or manufacturer's name in this Division, it is the only acceptable manufacturer.

B. Where two or more manufacturers are named, only those manufacturers will be considered or approved.

C. Manufacturers not listed will be considered for substitution prior to bid only. The substitute manufacturer shall submit a complete copy of the appropriate technical specification section minimum ten (10) business days prior to bid with each sub-paragraph noted with the comment, "compliance", "deviation", "alternate" or "not applicable". In the case of non-primary, vendor-supplied items, the name of the sub-vendor supplying said item, including model number, shall be indicated.
1. By noting the term "compliance" or "C", it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
2. By noting the term "deviation" or "D", it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.
3. By noting the term "alternate" or "A", it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. An alternate shall be fully described as to what the manufacturer proposes to provide.
4. By noting the term "not applicable" or "N/A", it shall be understood that the specified item is not applicable to the project.

D. It shall be understood that space allocations have been made on the basis of present and known future requirements and the dimensions of items of equipment or devices of a particular manufacturer whether indicated or not.

E. Any product or material offered in substitution which differs in dimension or configuration from the Documents, the Contractor shall provide as part of the submittal a drawing, minimum 1/4" = 1'-0" scale, showing that the substitution can be installed in the space available without interfering with other portions of the work or with access for operations and maintenance in the completed project.

F. Where substitute products or materials requiring different arrangement or connections from that indicated is accepted by the Owner's Representative, install the equipment or devices to operate properly and in harmony with the intent of the Documents, making all incidental changes in piping or wiring resulting from the substitution without any additional cost to the Owner.

G. The Contractor shall pay all additional costs incurred by other portions of the work in connection with all substitutions.

H. The Owner's Representative reserves the right to call for samples of any item of product or material offered in substitution, together with a sample of the specific item when, in their opinion, the quality of the item and/or the appearance is involved, and it is deemed that an evaluation of the item may be better made by visual inspection.

I. When any request for a substitution of a product or material is submitted and rejected, the item named in the Documents shall be furnished. Repetitive submittal of substitutions for the same item will not be considered.

1.9 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 Fire-Suppression 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.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver products and materials with factory-applied end caps or “heat shrink” wrappings to protect openings. Maintain opening protection through shipping, storage, and handling to prevent damage and the entrance of dirt, debris, and moisture.

B. Store light sensitive products and materials away from and protected against direct sunlight.

C. Support products and materials at all times to prevent sagging and bending.

D. The area provided for product and material storage at the jobsite shall be clean, dry and exposure to dust minimized.

E. Responsibility for the protection of products and materials shall extend to existing equipment, systems, and products and materials. Erect temporary sheltering structures, provide temporary bracing and supports, or cover existing equipment, systems, and products and materials to prevent damage and the entrance of dirt, debris, and moisture.

F. Failure on the part of the Contractor to comply with the above to the satisfaction of the Architect, Engineer, or either’s authorized representative shall be sufficient cause for the rejection of products and materials in question.

1.11 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression 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 fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

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 21 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.

C. All piping and tubing shall be American manufactured, unless otherwise indicated.

2.3 JOINING MATERIALS

A. Refer to individual Division 21 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. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Innerlinx by Mason Dallas.
      b. Metraflex Co.
      c. Linkseal by Thunderline.
   2. Sealing Elements: NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: 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.

2.5 SLEEVES

A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 10, galvanized, plain ends.
B. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. 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.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 FIRE-SUPPRESSION 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 fire-suppression systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   3. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

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 21 Sections specifying piping systems.

B. It is the intent of these Specifications to cover the design, hydraulic calculations, design and complete installation of the wet type automatic sprinkler, pre-action sprinkler or dry pipe sprinkler and standpipe system. The sprinkler contractor shall furnish and install the entire fire protection system, from the designated water supply connection to the final installation of each sprinkler head.

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 free of sags and bends.

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

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

J. Sleeves are not required for core-drilled holes.

K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
   1. Penetration assemblies shall comply with U.L. Fire Resistance Directory requirements for wall penetrations
   2. 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.

L. 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.

M. 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.

N. 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.

O. Verify final equipment locations for roughing-in.
P. 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 21 Sections specifying piping systems.

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

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

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

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

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

F. 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 PAINTING

A. Painting of fire-suppression 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.

3.5 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 not less than 4 inches larger in both directions than supported unit.
2. Concrete bases for all equipment shall be 4 inches (100 mm) tall above finished floor.

3.6 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 fire-suppression materials and equipment.
C. Field Welding: Comply with AWS D1.1.

3.7 GROUTING

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

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

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

G. Place grout around anchors.

H. Cure placed grout.

3.8 INSTALLATION, INSPECTIONS AND CERTIFICATIONS

A. The Contractor shall obtain timely inspections of the installation by the constituted authorities. Remedy any deficiencies to the satisfaction of the inspecting authority.

B. Upon final completion of the work, obtain certificates of acceptance from the constituted authorities. Deliver the certificates to the Architect for transmission to the Owner.

3.9 INSTRUCTION OF OWNER'S PERSONNEL

A. Provide the services of competent engineers and/or technicians acceptable to the Owner's Representative to instruct other representatives of the Owner in the complete and detailed operation of each item of equipment or device of all the various electrical systems. These instructions shall be provided for whatever periods may be necessary to accomplish the desired results.

B. Upon completion of these instructions, the Contractor shall obtain a letter of release, acknowledged by the Owner or his authorized representative, stating the dates on which the various kinds of instruction were given, and the personnel to whom the instructions were given.

C. The Contractor shall be fully responsible for proper maintenance of equipment and systems until the instructions have been given the Owner's personnel and the letter of release acknowledged.

D. In providing the instructions to the Owner's personnel, the written operating and maintenance manuals shall be followed in all instances, and the Owner's personnel shall be familiarized with such manuals.

E. Operating and maintenance manuals used for instructions shall include wiring diagrams, manufacturer's operating and maintenance instructions, parts lists (with sources identified), and other data as appropriate for each system.
END OF SECTION
SECTION 211000
WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. [Provide piping, valves, fittings and related products as listed on Drawings and described herein. All products to be purchased from Ferguson Enterprises.]

B. Section includes the following fire-suppression piping inside the building:
   1. Automatic wet-type, Class I standpipe systems.
   2. Automatic dry-type, Class I standpipe systems.
   4. Wet-pipe sprinkler systems.
   5. Dry-pipe sprinkler systems.
   6. Preaction sprinkler systems.

C. Related Sections include the following:
   1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
   2. Division 21 Section "Electric-Drive, Centrifugal Fire Pumps" for fire pumps, pressure-maintenance pumps, and pump controllers.
   3. [Division 21 Section "Clean-Agent Fire Extinguishing Systems" for extinguishing systems.]
   4. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.
   5. Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

1.2 DEFINITIONS
A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. [High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig.]

C. Underground Service-Entrance Piping: Underground service piping below the building.

1.3 SYSTEM DESCRIPTIONS
A. Combined Standpipe and Sprinkler System: Fire-suppression system with both standpipe and sprinkler systems. Sprinkler system is supplied from standpipe system.

B. Automatic Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.
C. Automatic Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.

D. Manual Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Does not have permanent water supply. Piping is dry. Water must be pumped into standpipes to satisfy demand.

E. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

F. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from opened sprinklers.

G. Preaction Sprinkler System: Automatic sprinklers are attached to piping containing air. Actuation of fire-detection system in same area as sprinklers opens deluge valve, permitting water to flow into piping and to discharge from sprinklers that have opened.

1.4 PERFORMANCE REQUIREMENTS


B. [High-Pressure Piping System Component Working Pressure: Listed for 250 psig minimum.]

C. Fire-suppression standpipe system design shall be approved by authorities having jurisdiction.

   1. Minimum residual pressure at each hose-connection outlet is the following:

      a. NPS 2-1/2 Hose Connections: 100 psig.

   2. Unless otherwise indicated, the following is maximum residual pressure at required flow at each hose-connection outlet:

      a. NPS 2-1/2 Hose Connections: 175 psig.

D. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.

   1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

   2. Sprinkler Occupancy Hazard Classifications shall be in accordance with the latest edition of NFPA 13.


   5. Maximum Protection Area per Sprinkler: Per NFPA 13

   6. Total Combined Hose-Stream Demand Requirement: Per NFPA 13

E. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13 and ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
1.5 SUBMITTALS

A. Product Data: For the following:
   1. Piping materials, including dielectric fittings, flexible connections, and sprinkler specialty fittings.
   2. Pipe hangers and supports, including seismic restraints.
   3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
   4. Air compressors, including electrical data.
   5. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
   6. Hose connections, including size, type, and finish.
   7. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
   8. Alarm devices, including electrical data.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Fire-hydrant flow test report.

D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.


F. Welding certificates.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.

I. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series number.

J. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."
   2. NFPA 14, "Installation of Standpipe, Private Hydrant, and Hose Systems."
   3. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

D. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

1.7 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.
   1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

B. Grooved-End, Ductile-Iron Pipe: AWWA C151, with factory- or field-formed, radius-cut-grooved ends according to AWWA C606.
   1. Grooved-Joint Piping Systems:
      a. Manufacturers:
         1) Victaulic Co. of America.
         2) Anvil International.
b. Grooved-End Fittings: ASTM A 536, ductile-iron casting with OD matching ductile-iron-pipe OD.

c. Grooved-End-Pipe Couplings: AWWA C606, gasketed fitting matching ductile-iron-pipe OD. Include ductile-iron housing with keys matching ductile-iron-pipe and fitting grooves, synthetic rubber gasket with center leg, and steel bolts and nuts.

d. Grooved-End-Pipe Transition Coupling: UL 213 and AWWA C606, gasketed fitting with end matching ductile-iron-pipe OD and end matching steel-pipe OD. Include ductile-iron housing with key matching ductile-iron-pipe groove and key matching steel-pipe groove, cast with offsetting, angle-pattern bolt pads, synthetic rubber gasket with center leg, listed for use with housing, and steel bolts and nuts.

e. Grooved-End Transition Flange: UL 213, gasketed fitting with key for ductile-iron-pipe dimensions. Include flange-type, ductile-iron housing with synthetic rubber gasket listed for use with housing and steel bolts and nuts.

2.2 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.

5. Steel Threaded Couplings: ASTM A 865.


2. Steel Flanges and Flanged Fittings: ASME B16.5.

C. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, roll-grooved ends.

1. Grooved-Joint Piping Systems:
   a. Manufacturers:
      1) Anvil International, Inc.
      2) TYCO
      3) Victaulic Co. of America.

   b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD or ASTM A 53 forged or fabricated from carbon steel pipe with factory grooved ends designed to accept grooved mechanical couplings from the same manufacturer.

   c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, synthetic rubber gasket listed for use with housing, and steel bolts and nuts.

      1) Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with
NFPA 13. Tongue and recess rigid type couplings shall only be used if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's latest recommendations.

a) 1-1/4" through 4": “Installation Ready” stab-on design, for direct ‘stab’ installation onto grooved end pipe without prior field disassembly and no loose parts.
b) 5" and larger: Standard rigid coupling.

2) Flexible Type: Use in seismic areas where required by NFPA 13.

a) 2" through 8": “Installation Ready” stab-on design, for direct ‘stab’ installation onto grooved end pipe without prior field disassembly and no loose parts.
b) 10" and larger: Standard flexible coupling.

d. Grooved-End-Pipe Flange Adapters: UL213 and AWWA C606, steel pipe OD dimensions, ASTM A536 ductile iron housing, flat faced, designed for incorporating flanged components with ANSI Class 125 bolt-hole patterns to a grooved piping system.

D. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13 specified wall thickness in NPS 6 to NPS 10.

2. Steel Flanges and Flanged Fittings: ASME B16.5.

E. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 4 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends.

1. Grooved-Joint Piping Systems:

a. Manufacturers:

1) Anvil International, Inc.
2) TYCO
3) Victaulic Co. of America.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD or ASTM A 53 forged or fabricated from carbon steel pipe with factory grooved ends designed to accept grooved mechanical couplings from the same manufacturer.

c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

1) Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be used if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer’s latest recommendations.
2.3 DIELECTRIC FITTINGS

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.

B. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.

C. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.

D. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig minimum working-pressure rating as required for piping system.

E. Dielectric Couplings: Galvanized steel with inert and noncorrosive thermoplastic lining and threaded ends and 300-psig working-pressure rating at 225 deg F.

F. Dielectric Nipples: Electroplated steel or ductile iron with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved ends and 300-psig working-pressure rating at 230 deg F.

2.4 FLEXIBLE CONNECTORS

A. Flexible connectors shall have materials suitable for system fluid. Include [175-psig minimum] [250-psig minimum] working-pressure rating and ends according to the following:

1. NPS 2 and Smaller: Threaded.
2. NPS 2-1/2 and Larger: Flanged.
3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.

B. Manufacturers:
1. Flexhead Industries, Inc.
2. Flexicraft Industries.
3. Flex-Pression, Ltd.
4. Proco Products, Inc.
5. Unaflex Inc.

C. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.

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

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

2.5 CORROSION-PROTECTIVE ENCASEMENT FOR PIPING

A. Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

2.6 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 300-psig working-pressure rating if fittings are components of high-pressure piping system.

B. Outlet Specialty Fittings:

1. Manufacturers:
   a. Anvil International, Inc.
   b. TYCO
   c. Victaulic Co. of America.

2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with locating collar to ensure proper installation, synthetic rubber gaskets, bolts and nuts, and threaded or grooved outlets.

3. Snap-On and Strapless Outlet Fittings: UL 213, ductile-iron housing or casting with gasket and threaded outlet.

C. Sprinkler Drain and Alarm Test Fittings: Bronze, Cast- or ductile-iron body; with threaded or grooved inlet and outlet, test valve, and orifice and sight glass.

1. Manufacturers:
   a. TYCO
   b. Fire-End and Croker Corp.
   c. Viking Corp.
   d. Victaulic Co. of America.
D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

1. Manufacturers:
   b. Fire-End and Croker Corp.
   c. Potter-Roemer; Fire-Protection Div.

E. Sprinkler Inspector’s Test Fitting: Bronze, Cast- or ductile-iron housing with threaded or grooved inlet and drain outlet and sight glass.

1. Manufacturers:
   a. AGF Manufacturing Co.
   b. TYCO
   c. G/J Innovations, Inc.
   d. Triple R Specialty of Ajax, Inc.
   e. Victaulic Company

F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

1. Manufacturers:
   a. CECA, LLC.
   b. Merit.

G. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

H. Flexible, Sprinkler Hose Fittings:

1. Manufacturers:
   a. Fivalco Inc.
   b. FlexHead Industries, Inc.
   c. Gateway Tubing, Inc.
   d. Victaulic AquaFlex

3. Type: Braided or unbraided, multiple-use stainless steel Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: [175 psig minimum] [300 psig].
5. Size: Same as connected piping, for sprinkler.

2.7 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 300-psig pressure rating if valves are components of high-pressure piping system.

B. Gate Valves with Wall Indicator Posts:

1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
2. Gate Valves: UL 262, ductile-iron body, bronze mounted, EPDM coated cast iron disc, brass stem, grooved ends, with horizontal-wall type, or upright post indicator.

3. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with operating wrench or hand wheel, extension rod, locking device, and cast-iron barrel.

4. Manufacturers:
   b. McWane, Inc.; Kennedy Valve Div.
   c. NIBCO.
   d. Stockham.
   e. Victaulic Company.

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.

1. NPS 1-1/2 and Smaller: Bronze body with threaded or grooved ends.
2. NPS 2 and NPS 2-1/2: Bronze body with threaded or grooved ends or ductile-iron body with grooved ends.
3. Manufacturers:
   a. NIBCO.
   b. Victaulic Co. of America.

D. Butterfly Valves: UL 1091.

1. NPS 3 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends. Weather-proof actuator with pre-wired supervisory switches monitoring the valve in the open or closed positions. Maximum 365 psig (2517 kPa) working pressure.

   a. Manufacturers:
      1) TYCO
      2) Global Safety Products, Inc.
      3) McWane, Inc.; Kennedy Valve Div.
      4) Mueller Company.
      5) NIBCO.
      6) Pratt, Henry Company.
      7) Victaulic Co. of America.

E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron or ductile-iron body with flanged or grooved ends. Up to 365 psig (2517 kPa) maximum working pressure.

1. Manufacturers:
   a. TYCO
   b. Crane Co.; Crane Valve Group; Crane Valves.
   d. Grinnell Fire Protection.
   e. Mueller Company.
   f. NIBCO.
   g. Potter-Roemer; Fire Protection Div.
   h. Reliable Automatic Sprinkler Co., Inc.
   i. Stockham.
   j. Victaulic Co. of America.
   k. Watts Industries, Inc.; Water Products Div.
F. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.
   a. Manufacturers:
      1) Crane Co.; Crane Valve Group; Crane Valves.
      2) NIBCO.

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
   a. Manufacturers:
      1) Crane Co.; Crane Valve Group; Crane Valves.
      2) Milwaukee Valve Company.
      3) Mueller Company.
      4) NIBCO.
      5) Victaulic Company.

G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

1. Indicator: [Electrical, 115-V ac, prewired, single-circuit, supervisory switch]
   [Electrical, 115-V ac, prewired, 2-circuit, supervisory switch] [Visual].
2. NPS 2-1/2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
   a. Manufacturers:
      1) Milwaukee Valve Company.
      2) NIBCO.
      3) Victaulic Co. of America.

3. NPS 3 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
   a. Manufacturers:
      1) TYCO
      2) Grinnell Fire Protection.
      3) Milwaukee Valve Company.
      4) NIBCO.
      5) Victaulic Co. of America.

2.8 BACKFLOW PREVENTERS

A. Double-Check Backflow-Prevention Assemblies:

1. Manufacturers:
   a. Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.
   d. Zurn Plumbing Products Group.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or steel with interior lining complying with AWWA C550 for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight through flow.
8. 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. Reduced-Pressure-Detector, Fire-Protection Backflow-Preventer Assemblies:

1. Manufacturers:
   a. Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.
   d. Zurn Plumbing Products Group.

2. Standard: ASSE 1047 and FMG approved or UL listed.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Cast iron with interior lining complying with AWWA C550 or Steel with interior lining complying with AWWA C550.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
   a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
   c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

C. Double-Check, Detector-Assembly Backflow Preventers:

1. Manufacturers:
   a. Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.
   d. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1048 and FMG approved or UL listed.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Body: Cast iron with interior lining complying with AWWA C550 or Steel with interior lining complying with AWWA C550.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
2.9 SPECIALTY VALVES

A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 300-psig pressure rating if valves are components of high-pressure piping system.

1. Manufacturers:
   a. TYCO
   c. Grinnell Fire Protection.
   d. Reliable Automatic Sprinkler Co., Inc.
   e. Victaulic Co. of America.
   f. Viking Corp.

2. Alarm Check Valves: UL 193, designed for vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer. Valve internal components shall be replaceable without removing the valve from the installed position.
   a. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.

3. Dry-Pipe Valves: UL 260, differential type; with bronze or brass seat with Nitrile O-ring seals, single-hinge pin, and latch design. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment. Minimum required air pressure is 13 psi with low pressure actuator and 300 psig maximum water pressure rating in all sizes. Valve internal components shall be replaceable without removing the valve from the installed position and shall be externally resettable. Valve shall be supplied completely assembled with shutoff valve, pre-set pressure switches and drain kit.
   a. Air Compressor: UL 753, fractional horsepower, 120-V ac, 60 Hz, single phase.
      1) Manufacturers:
         a) TYCO
         b) Gast Manufacturing, Inc.
         c) Grinnell Fire Protection.
         d) Reliable Automatic Sprinkler Co., Inc.
         e) Viking Corp.
         f) Victaulic Company

   b. Air Compressor/Air Maintenance Assembly: Consisting of a riser mounted compressor, air maintenance device, and flexible hoses for installation. Assemble shall be designed to ensure operational air pressure within 30 minutes of discharge.
4. Pre-Action Valves: UL 260, low differential, latched clapper design, with black enamel coated ductile iron body, tapped for main drain and all available trim configurations, aluminum bronze clapper with synthetic rubber seat, stainless steel spring and shaft, brass seat and Nitrile seat o-rings. Valve internal parts shall be replaceable without removing the valve from the installed position and shall be externally resettable. Maximum water pressure is 300 psig in all sizes and minimum required air pressure is 13 psig with low pressure actuator for pneumatic activation or solenoid valve for electrical activation. Valve shall have grooved ends for vertical installation. Separate check valve downstream is not required.

a. Air Compressor: UL 753, fractional horsepower, 120-V ac, 60 Hz, single phase.

   1) Manufacturers:

      a) TYCO
      b) Gast Manufacturing, Inc.
      c) Grinnell Fire Protection.
      d) Reliable Automatic Sprinkler Co., Inc.
      e) Viking Corp.
      f) Victaulic Company

B. Pressure-Regulating Valves: UL 1468, brass or bronze, NPS 1-1/2 and NPS 2-1/2, 400-psig minimum rating. Include female NPS inlet and outlet, adjustable setting feature, and straight or 90-degree-angle pattern design as indicated.

   1. Finish: Rough metal.
   2. Manufacturers:

      b. Fire-End and Croker Corp.
      c. GMR International Equipment Corporation.
      d. Grinnell Fire Protection.
      e. Potter-Roemer; Fire Protection Div.
      f. Zurn Industries, Inc.; Wilkins Div.

C. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.

   1. Manufacturers:

      a. AFAC Inc.
      b. Grinnell Fire Protection.

2.10 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have [300-psig] pressure rating if sprinklers are components of high-pressure piping system.

B. Manufacturers:

   1. TYCO
   2. Reliable Automatic Sprinkler Co., Inc.
   3. Victaulic Co. of America.
   4. Viking Corp.
C. Automatic Sprinklers: With heat-responsive element complying with the following:
   1. UL 199, for nonresidential applications.
   2. UL 1767, for early-suppression, fast-response applications.

D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
   1. All Sprinklers shall be Quick Response.

E. Sprinkler types, features, and options as follows:
   1. Concealed ceiling sprinklers, including cover plate.
   2. Extended-coverage sprinklers.
   3. Flush ceiling sprinklers, including escutcheon.
   4. High-pressure sprinklers.
   5. Institution sprinklers, made with a small, breakaway projection.
   6. Pendent sprinklers.
   7. Pendent, dry-type sprinklers.
   8. Quick-response sprinklers.
   9. Recessed sprinklers, including escutcheon.
   10. Sidewall sprinklers.
   11. Sidewall, dry-type sprinklers.
   12. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Special Coatings: Corrosion-resistant paint or Nickel-Teflon.

H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
   2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler. Sprinkler guards shall be listed, supplied, and approved for use with the sprinkler, by the sprinkler manufacturer.

2.11 FIRE HOSE VALVES

A. Manufacturers:
   2. Croker Corp.
   5. Mueller Company.
   6. Potter-Roemer; Fire-Protection Div.

B. Description: UL 668, brass or bronze, 300-psig minimum pressure rating, hose valve for connecting fire hose. Include angle pattern design; female NPS inlet and male hose outlet; and
2.12  FIRE VALVE CABINETS

A. Manufacturers:

2. Croker Corp.
5. McWane, Inc.; Kennedy Valve Div.
7. Potter-Roemer; Fire-Protection Div.

B. Description:  UL 668, brass or bronze, 300-psig minimum pressure rating, hose valve for connecting fire hose. Include angle pattern design; female NPS inlet and male hose outlet; and lugged cap, gasket, and chain. NPS 2-1/2 by NPS 1-1/2 reducer adapter and hose valve threads according to NFPA 1963 and matching local fire department threads.

1. Valve Operation: Nonadjustable type, unless pressure-regulating type is required.
2. Finish: Rough metal or chrome-plated.

C. Recessed mounted valve cabinet of 20 ga. Steel. Refer to architect for door and finish requirements. Cabinet must be large enough to accommodate hose valve indicated.

2.13  FIRE DEPARTMENT CONNECTIONS

A. Manufacturers:

1. TYCO
2. Elkhart Brass Mfg. Co., Inc.
3. Croker Corp.
5. Potter-Roemer; Fire-Protection Div.

B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."

1. Type: Flush, with [two] [three] [four] inlets and square or rectangular escutcheon plate.
2. Type: Exposed, projecting, with two inlets and round escutcheon plate.

C. Exposed, Freestanding-Type, Fire Department Connection: UL 405, [175-psig minimum] [300-psig] pressure rating; with corrosion-resistant-metal body, brass inlets with threads according to
NFPA 1963 and matching local fire department sizes and threads, and bottom outlet with pipe threads. Include brass lugged caps, gaskets, and brass chains; brass lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch-high, brass sleeve; and round, floor, brass escutcheon plate with marking "AUTO SPKR & STANDPIPE."


2.14 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch-diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 inlet and NPS 1 drain connections.

1. Manufacturers:
   a. TYCO
   c. Reliable Automatic Sprinkler Co., Inc.
   d. Victaulic Company.
   e. Viking Corp.

C. Electrically Operated Alarm: UL 464, with 8-inch-minimum-diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.

1. Manufacturers:
   b. System Sensor.

D. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

1. Manufacturers:
   a. ADT Security Services, Inc.
   b. Grinnell Fire Protection.
   c. ITT McDonnell & Miller.
   d. Potter Electric Signal Company.
   e. System Sensor.
   f. Viking Corp.
   g. Watts Industries, Inc.; Water Products Div.

E. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

1. Manufacturers:
b. Potter Electric Signal Company.
c. System Sensor.
d. Viking Corp.

F. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Manufacturers:
   a. McWane, Inc.; Kennedy Valve Div.
   b. Potter Electric Signal Company.
   c. System Sensor.

G. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

1. Manufacturers:
   b. System Sensor.

2.15 PRESSURE GAGES

A. Available Manufacturers:

1. AGF Manufacturing Co.
2. AMETEK, Inc.; U.S. Gauge.
5. Marsh Bellofram.
6. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2- to 4-1/2-inch-diameter, dial pressure gage with range of 0 to 300 psig.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.

B. Report test results promptly and in writing.
3.2 EXAMINATION

A. Examine roughing-in for hose valves and fire valve cabinets to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose valve cabinets are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PIPING APPLICATIONS, GENERAL

A. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

B. Underground Service Piping: Ductile-iron, grooved-end pipe and fittings; grooved-end-pipe couplings; and grooved joints. Include corrosion-protective encasement.

3.4 STANDPIPE SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Type or Dry-Type Standpipe System, 175-psig Maximum Working Pressure:

1. NPS 8 and smaller: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.

2. NPS 8 and smaller: Plain-end, black, standard-weight steel pipe; steel welding fittings; and welded joints.

3. NPS 8 and smaller: Grooved-end, black or galvanized, standard-weight steel pipe with roll-grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

4. NPS 8: Plain-end, Schedule 10 steel pipe; steel welding fittings; and welded joints.

5. NPS 8: Grooved-end, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. High-Pressure, Wet-Type or Dry-Type Standpipe System, 175- to 250-psig Working Pressure:

1. NPS 8 and Smaller: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.

2. NPS 8 and Smaller: Plain-end, black, standard-weight steel pipe; steel welding fittings; and welded joints.

3. NPS 8 and Smaller: Grooved-end, black or galvanized, standard-weight steel pipe with roll-grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Pipe or Dry-pipe Sprinkler System, 175-psig Maximum Working Pressure:

1. Sprinkler-Piping Fitting Option: Specialty sprinkler fittings, [NPS 2] [NPS 2-1/2] [NPS 3] and smaller, including mechanical-T and -cross fittings, may be used downstream from sprinkler zone valves.
2. NPS 2: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
3. NPS 2-1/2 to NPS 6: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
4. NPS 2-1/2 to NPS 6: Plain-end, black, standard-weight steel pipe; steel welding fittings; and welded joints.
5. NPS 2-1/2 to NPS 6: Grooved-end, black or galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. High-Pressure, Wet-Pipe and Dry-pipe Sprinkler System, 175- to 250-psig Working Pressure:
1. NPS 2: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
2. NPS 2-1/2 to NPS 6: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
3. NPS 2-1/2 to NPS 6: Plain-end, black, standard-weight steel pipe; steel welding fittings; and welded joints.
4. NPS 2-1/2 to NPS 6: Grooved-end, black or galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.6 VALVE APPLICATIONS
A. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 14.
  1. Shutoff Duty: Use ball, butterfly, or gate valves.

3.7 JOINT CONSTRUCTION
A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.
B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 (DN 200) with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.
C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
  2. Steel Pipe: Roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
  3. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.
  4. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer.
  5. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing.
D. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.
1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
2. NPS 2-1/2 to NPS 4: Use dielectric flanges.
3. NPS 5 and Larger: Use dielectric flange insulation kits.

3.8 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 22 Section "Facility Water Distribution Piping" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Refer to Division 22 Section "Facility Water Distribution Piping" for backflow preventers.

3.9 WATER-SUPPLY CONNECTION

A. Connect fire-suppression piping to building's interior water distribution piping. Refer to Division 22 Section "Domestic Water Piping" for interior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water distribution piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.

3.10 PIPING INSTALLATION

A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints. Encase piping in corrosion-protective encasement.

D. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

F. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.
I. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install drain valves on standpipes.

K. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

L. Install alarm devices in piping systems.

M. Hangers and Supports: Comply with NFPA 13 for hanger materials.
   1. Install standpipe system piping according to NFPA 14.
   2. Install sprinkler system piping according to NFPA 13.

N. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
   1. In grooved piping systems, seismic motion shall be accommodated by installing swing joints consisting of flexible couplings, pipe nipples and elbows that provide simultaneous movement in all directions, or other seismic movement compensation devices such as loops, offsets, or expansion joints when an in-line device is required, to provide flexibility to the system and help reduce pipe stresses.

O. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

P. Drain dry-type standpipe piping.

Q. Drain dry-pipe sprinkler piping.

R. Pressurize and check dry-pipe sprinkler system piping and air compressors.

S. Fill wet-standpipe system piping with water.

T. Fill wet-pipe sprinkler system piping with water.

U. Install flexible connectors on fire-pump and jockey pump supply and discharge connections.

V. Grooved-end-pipe flexible couplings may be used in lieu of flexible connectors for vibration isolation at equipment connections. A minimum of three (3) couplings, for each connector, shall be placed in close proximity to the source of vibration.

3.11 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

D. Specialty Valves:
   1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.
   2. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
      a. Install air compressor and compressed-air supply piping.

3.12 SPRINKLER APPLICATIONS

A. Where specific types are not indicated, use the following sprinkler types:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Public areas with Suspended Ceilings: Concealed sprinklers.
   5. Spaces Subject to Freezing: [Upright sprinklers] [Pendent, dry sprinklers] [Sidewall, dry sprinklers].
   6. Special Applications: All Sprinkler heads to be Quick Response type.
   7. Sprinkler Finishes:
      a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
      b. Concealed Sprinklers: Rough brass, with factory-painted bright white cover plate.
      c. Flush Sprinklers: Bright chrome, with painted bright white escutcheon.
      d. Semi-Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

3.13 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.

B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

D. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.

E. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

3.14 FIRE HOSE VALVE INSTALLATION

A. Install hose connections adjacent to standpipes, unless otherwise indicated.
B. Install freestanding hose connections for access and minimum passage restriction.

C. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device, unless otherwise indicated.

3.15 FIRE VALVE CABINET INSTALLATION

A. Install recessed hose stations for access and minimum passage restriction.

B. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device, unless otherwise indicated.

C. Install wall-mounting, recessed type fire hose valves in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Cabinets are specified in Division 10 Section "Fire Extinguisher Cabinets."

3.16 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire department connections in vertical wall.

B. Install freestanding-type, fire department connections in level surface.

   1. Install protective pipe bollards as required. Refer to Division 05 Section "Metal Fabrications" for pipe bollards.

C. Install ball drip valve at each check valve for fire department connection.

D. Install ball drip valve and check valve for free standing fire department connections in accessible pit.

3.17 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.

D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

F. Connect compressed-air supply to dry-pipe sprinkler piping.

G. Connect air compressor to the following piping and wiring:

   1. Pressure gages and controls.
2. Electrical power system.
3. Fire alarm devices, including low-pressure alarm.

H. Electrical Connections: Power wiring is specified in Division 26.

I. Connect alarm devices to fire alarm.

J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

L. 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.

3.18 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14.

3.19 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

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. Energize circuits to electrical equipment and devices.
4. Start and run air compressors.
5. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
6. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
7. Coordinate with fire alarm tests. Operate as required.
8. Coordinate with fire-pump tests. Operate as required.
9. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.20 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

C. Protect sprinklers from damage until Substantial Completion.
3.21 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

B. Grooved coupling manufacturer's factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

END OF SECTION
SECTION 213113

ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Split-case fire pumps.
   2. Fire-pump accessories and specialties.
   3. Flowmeter systems.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
D. Product Certificates: For each fire pump, from manufacturer.
E. Source quality-control reports.
F. Field quality-control reports.
G. Operation and Maintenance Data: For fire pumps to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS
A. Description: Factory-assembled and -tested fire-pump and driver unit.
B. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

2.2 HORIZONTALLY MOUNTED, SINGLE-STAGE, SPLIT-CASE FIRE PUMPS
A. Manufacturers:
3. PACO Pumps; Grundfos Pumps Corporation, U.S.A.
4. Peerless Pump, Inc.
5. Aurora Pump.
B. Pump:
1. Standard: UL 448, for split-case pumps for fire service.
3. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
5. Shaft and Sleeve: Steel shaft with bronze sleeve.
a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

6. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.

C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

D. Driver:

1. Standard: UL 1004A.
2. Type: Electric motor; NEMA MG 1, polyphase Design B.

E. Capacities and Characteristics: Refer to schedule on drawings.

2.3 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.

C. Relief Valves:

1. Manufacturers:
   a. CLA-VAL Automatic Control Valves.
   b. Kunkle Valve; a part of Tyco International Ltd.
   c. Watts Regulator Company; a division of Watts Water Technologies, Inc.
   d. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

F. Discharge Cone: Closed or open type.

G. Fire Pump Test Header:

5. Manifold:
   a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
   b. Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
e. Escutcheon Plate: Brass or bronze; rectangular.
f. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
g. Exposed Parts Finish: [Rough] [brass], [chrome plated].
h. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.4 FLOWMETER SYSTEMS

A. Manufacturers:
1. Gerand Engineering Co.
2. Hydro Flow Products, Inc.
3. Hyspan Precision Products, Inc.
5. Victaulic Company.

B. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.

C. Pressure Rating: 175 psig minimum.

D. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.

E. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches in diameter. Include bracket or device for wall mounting.

1. Tubing Package: NPS 1/8 or NPS 1/4 soft copper tubing with copper or brass fittings and valves.

2.5 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

1. Verification of Performance: Rate fire pumps according to UL 448.

B. Fire pumps will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.
B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.

B. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete."

C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

D. Support piping and pumps separately so weight of piping does not rest on pumps.

E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Division 21 Section "Water Based Fire-Suppression Systems."

F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in Division 21 Section "Water Based Fire-Suppression Systems."

G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.

H. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer’s written instructions.

I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers’ wiring diagram submittals to electrical Installer.

J. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.3 ALIGNMENT

A. Align split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.
3.4 CONNECTIONS

A. Comply with requirements for piping and valves specified in Division 21 Section "Water Based Fire-Suppression Systems." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect relief-valve discharge to drainage piping or point of discharge.

D. Connect flowmeter-system meters, sensors, and valves to tubing.

E. Connect fire pumps to their controllers.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.6 FIELD QUALITY CONTROL

A. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Division 21 Section "Controllers for Fire-Pump Drivers."

B. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:
   1. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
   2. Test according to NFPA 20 for acceptance and performance testing.
   3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION
SECTION 213400

JOCKEY PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Regenerative-turbine, jockey pumps.

1.2 PERFORMANCE REQUIREMENTS

A. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For pumps, accessories, and specialties. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Field quality-control reports.

D. Operation and Maintenance Data: For pumps to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.
PART 2 - PRODUCTS

2.1   REGENERATIVE-TURBINE, JOCKEY PUMPS

A.   Manufacturers:

2.   PACO Pumps; Grundfos Pumps Corporation U.S.A.
3.   Aurora Pump.
4.   S.A. Armstrong Limited.

B.   Description: Factory-assembled and -tested, close-coupled, single-stage, regenerative-turbine centrifugal pump as defined in ANSI HI 1.1-1.2 and HI 1.3; with pump and motor mounted horizontally.

C.   Pump Construction:

1.   Casing: Radially split, cast iron, with threaded inlet and outlet.
2.   Impeller: Bronze, balanced, and keyed to shaft.
5.   Seal: Mechanical type with spring-loaded rotating head.

D.   Motor: Single speed with permanently lubricated ball bearings. Comply with requirements in Division 21 Section "Common Motor Requirements for Fire Suppression Equipment."

E.   Nameplate: Permanently attached to pump and indicating capacity and characteristics.

F.   Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.2   MOTORS

A.   Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 21 Section "Common Motor Requirements for Fire Suppression Equipment."

1.   Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2.   Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

PART 3 - EXECUTION

3.1   EQUIPMENT INSTALLATION

A.   NFPA Standard: Comply with NFPA 20 for installation of jockey pumps.

B.   Base-Mounted Pump Mounting: Install pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete."

C.   Install regenerative-turbine, jockey pumps according to ANSI HI 1.4.
D. Provide minimum 18” clear on all sides for maintenance.

3.2 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Jockey pumps will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 ADJUSTING

A. Lubricate pumps as recommended by manufacturer.

B. Set field-adjustable pressure-switch ranges as indicated.

END OF SECTION
SECTION 213900
CONTROLLERS FOR FIRE-PUMP DRIVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Full-service, full-voltage controllers rated 600 V and less.
   2. Remote alarm panels.
   3. [Low-suction-shutdown panels.]

B. Related Sections:
   1. Division 21 Section "Jockey Pump" for jockey-pump controllers.

1.2 DEFINITIONS

A. ATS: Automatic transfer switch(es).
B. ECM: Electronic control module.
C. MCCB: Molded-case circuit breaker.
D. N.O.: Normally open.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-pump controllers and alarm panels shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type of product indicated. Include dimensioned plans, elevations, sections, details, and attachments to other work, including required clearances and service spaces around controller enclosures.

1. Show tabulations of the following:
   a. Each installed unit's type and details.
b. Enclosure types and details for types other than NEMA 250, Type 2.
c. Factory-installed devices.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of integrated unit.
f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
g. Specified modifications.

2. Detail equipment assemblies and indicate dimensions, weights, loads, method of field assembly, components, and location and size of each field connection.

3. Schematic and Connection Diagrams: For power, signal, alarm, and control wiring and for pressure-sensing tubing.

C. Qualification Data: For qualified testing agency.

D. Seismic Qualification Certificates: For each type of product indicated, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Certificates: For each type of product indicated, from manufacturer.

F. Manufacturer’s factory test reports of fully assembled and tested equipment.

G. Source quality-control reports.

H. Operation and Maintenance Data: For each type of product indicated 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 setting field-adjustable timers, controls, and status and alarm points.

2. Manufacturer’s written instructions for testing, adjusting, and reprogramming microprocessor-based logic controls.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.

B. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.

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.

D. Comply with standards of authorities having jurisdiction pertaining to materials and installation.

E. Comply with NFPA 20 and NFPA 70.
F. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section “Vibration and Seismic Controls for Electrical Systems.”

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Ambient Temperature Rating: Not less than 40 deg F and not exceeding 122 deg F unless otherwise indicated.
2. Altitude Rating: Not exceeding 6600 feet unless otherwise indicated.

B. Interruption of Existing Electric Service: Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electric service, and comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required NEC clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.

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

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Indicating Lights: Two of each type and color of lens installed; two of each type and size of lamp installed.
2. Auxiliary Contacts: One for each size and type of magnetic contactor installed.
3. Power Contacts: Three for each size and type of magnetic contactor installed.
4. Contactor Coils: One for each size and type of magnetic controller installed.
5. Relay Boards: One for each size and type of relay board installed.
6. Operator Interface: One microprocessor board(s), complete with display and membrane keypad.

PART 2 - PRODUCTS

2.1 FULL-SERVICE CONTROLLERS

A. Manufacturers:
1. ASCO Power Technologies, LP; Firetrol Products.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Master Control Systems, Inc.
4. Metron, Inc.

B. General Requirements for Full-Service Controllers:

1. Comply with NFPA 20 and UL 218.
2. Listed by an NRTL for electric-motor driver for fire-pump service.
3. Combined automatic and nonautomatic operation.
4. Factory assembled, wired, and tested; continuous-duty rated.
5. Service Equipment Label: NRTL labeled for use as service equipment.

C. Method of Starting:

1. Pressure-switch actuated.
   a. Water-pressure-actuated switch and pressure transducer with independent high-
      and low-calibrated adjustments responsive to water pressure in fire-suppression
      piping.
   b. System pressure recorder, electric ac driven, with spring backup.
   c. Programmable minimum-run-time relay to prevent short cycling.
   d. Programmable timer for weekly tests.
3. Solid-State Controller: Reduced-voltage type.
4. Emergency Start: Mechanically operated start handle that closes and retains the motor
   RUN contactor independent of all electric or pressure actuators.

D. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting.

E. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and nonthermal
   MCCB; with a common, externally mounted operating handle, and providing locked-rotor
   protection.

F. Door-Mounted Operator Interface and Controls:

1. Monitor, display, and control the devices, alarms, functions, and operations listed in
   NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:
   a. Microprocessor-based logic controller, with multiline digital readout.
   b. Membrane keypad.
   c. LED alarm and status indicating lights.
3. Local and Remote Alarm and Status Indications:
   a. Controller power on.
   b. Motor running condition.
   c. Loss-of-line power.
   d. Line-power phase reversal.
   e. Line-power single-phase condition.
4. Audible alarm, with silence push button.
5. Nonautomatic START and STOP push buttons or switches.
G. Optional Features:

1. Extra Output Contacts:
   a. One N.O. contact(s) for motor running condition.
   b. One set(s) of contacts for loss-of-line power.
   c. One each, Form C contacts for high and low reservoir level.
2. Local alarm bell.
3. Door-mounted thermal or impact printer for alarm and status logs.

H. Automatic Transfer Switch (ATS):

1. Complies with NFPA 20, UL 218, and UL 1008.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
6. Local and Remote Alarm and Status Indications:
   a. Normal source available.
   b. Alternate source available.
   c. In normal position.
   d. In alternate position.
   e. Isolating means open.
7. Audible alarm, with silence push button.
9. Engine test push button.
10. Start generator output contacts.
11. Timer for weekly generator tests.

2.2 REMOTE ALARM PANELS

A. General Requirements for Remote Alarm Panels: Comply with NFPA 20 and UL 218; listed by an NRTL for fire-pump service.

B. Manufacturers:

1. ASCO Power Technologies, LP; Firetrol Products.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Master Control Systems, Inc.
4. Metron, Inc.

C. General Requirements for Remote Alarm Panels: Factory assembled, wired, and tested.

D. Supervisory and Normal Control Voltage: 120-V ac; single source.

E. Audible and Visual Alarm and Status Indications:
1. Driver running.
2. Loss of phase.
3. Phase reversal.
4. Supervised power on.
5. Common trouble on the controller.
6. Controller connected to alternate power source.

F. Audible alarm, with silence push button.
G. Pump REMOTE START push button.

2.3 [LOW-SUCTION-SHUTDOWN PANELS]

A. Manufacturers:
   1. ASCO Power Technologies, LP; Firetrol Products.
   2. Master Control Systems, Inc.
   3. Metron, Inc.

B. General Requirements for Low-Suction-Shutdown Panels:
   1. Listed by an NRTL for fire-pump service.
   2. Factory assembled, wired, and tested.
   3. Prevents automatic start of fire pump, and shuts down automatically started fire pump, on low-suction pressure.

C. Operation: Integral pressure switch.

D. Supervisory and Normal Control Voltage: 120-V ac; single source.

E. Include audible and visual alarms and status indications, with silence push button, for the following conditions:
   1. Control power available.
   2. Low-suction pressure.
   3. Normal-suction pressure.

2.4 ENCLOSURES

A. Fire-Pump Controllers, ATS, Remote Alarm Panels, and Low-Suction-Shutdown Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.
   1. Indoor, Dry and Clean Locations: Type 1 (IEC IP10).
   2. Indoor Locations Subject to Dripping Noncorrosive Liquids: Type 2 (IEC IP11).

B. Enclosure Color: Manufacturer's standard "fire-pump-controller red".

C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.

D. Optional Features:
1. Floor stands, 12 inches high, for floor-mounted controllers.

2.5 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and UL 218.

1. Verification of Performance: Rate controllers according to operation of functions and features specified.

B. Fire-pump controllers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive equipment, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROLLER INSTALLATION

A. Install controllers within sight of their respective drivers.

B. Connect controllers to their dedicated pressure-sensing lines.

C. Floor-Mounting Controllers: Install controllers on 4-inch nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches above finished floor. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete."

D. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Comply with NEMA ICS 15.

3.3 REMOTE ALARM [AND LOW-SUCTION-SHUTDOWN] PANEL INSTALLATION

A. Install panels on walls with tops not higher than 72 inches above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For
ATS not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

3.4 POWER WIRING INSTALLATION

A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 CONTROL AND ALARM WIRING INSTALLATION

A. Install wiring between controllers and remote devices and facility's central monitoring system. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Control-Voltage Electrical Power Cables."

B. Install wiring between remote alarm and low-suction-shutdown panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Control-Voltage Electrical Power Cables."

C. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Division 28 Section "Digital, Addressable Fire-Alarm System."

D. Bundle, train, and support wiring in enclosures.

E. Connect remote manual and automatic activation devices where applicable.

3.6 IDENTIFICATION

A. Comply with requirements in NFPA 20 for marking fire-pump controllers.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Division 26 Section "Identification for Electrical Systems."

3.7 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. Acceptance Testing Preparation:

1. Inspect and Test Each Component:
   a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
   b. Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
   c. Test continuity of each circuit.
2. Verify and Test Each Electric-Driver Controller:
   a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify Architect and Construction Manager before starting the motor(s).
   b. Test each motor for proper phase rotation.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Field Acceptance Tests:
   1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to Architect, Construction Manager, Owner and authorities having jurisdiction.
   2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
   3. Engage manufacturer's factory-authorized service representative to be present during the testing.
   4. Perform field acceptance tests as outlined in NFPA 20.

E. Controllers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.9 ADJUSTING

A. Adjust controllers to function smoothly and as recommended by manufacturer.
   B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.
   C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
   D. Set field-adjustable pressure switches.

3.10 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
   B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.
3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controllers, remote alarm panels, low-suction-shutdown panels, and to use and reprogram microprocessor-based controls within this equipment.

END OF SECTION
SECTION 220500
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. In addition to Division 01 Specification Sections, related sections include the following:

1. Division 01 Section “Cutting and Patching”
2. Division 02 Section “Selective Structure Demolition” for general demolition requirements and procedures.
3. Division 03 Sections “Cast-in-Place Concrete” and “Miscellaneous Cast-in-Place Concrete”.
4. Division 05 Section “Metal Fabrications” for structural steel.
5. Division 09 Sections “Interior Painting” and “Exterior Painting”.
6. Division 08 Section “Access Doors and Frames” for access panels and doors.

1.2 RELATED REQUIREMENTS

A. All conditions imposed by these documents shall be applicable to all portions of the Work under this Division. These references are intended to point out specific items to the Contractor, but in no way relieve him of the responsibility of reading and complying with all relevant parts of the entire Specification.

B. The Contractor shall examine and coordinate with all Contract Drawings and Specifications, and all Addenda issued. Failure to comply shall not relieve them of responsibility. The omission of details of other portions of the Work from this Division shall not be used as a basis for a request for additional compensation.

C. The specific features and details for other portions of the Work related to the construction in progress or to the building(s) shall be determined by examination at the site.

1.3 SUMMARY

A. This Section includes the following:

1. Scope of work.
2. Piping materials and installation instructions common to most piping systems.
3. Transition fittings.
4. Dielectric fittings.
5. Mechanical sleeve seals.
7. Escutcheons.
8. Grout.
10. Equipment installation requirements common to equipment sections.
11. Painting and finishing.
12. Concrete bases.

1.4 DEFINITIONS

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

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

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

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

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

F. Products and Materials: Components and assemblies for the construction of the systems as indicated in the Documents including, but not limited to pipes, tubes, valves, and equipment.

G. Products or Materials: See "Products and Materials".

H. Provide: The materials and equipment described shall be furnished, installed and connected under this Division, complete for operation, unless specifically noted to the contrary. Identical to the phrase "furnish and install".

I. Furnish: The material, equipment, etc. to be supplied, but not installed by the supplier.

J. The following are industry abbreviations for materials:

   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PE: Polyethylene plastic.
   3. PVC: Polyvinyl chloride plastic.
   4. EPDM: Ethylene-propylene-diene terpolymer rubber.
   5. NBR: Acrylonitrile-butadiene rubber.

K. VFD: Variable frequency drive. This may be used interchangeably with VSD (variable speed drive), VSC (variable speed controller), and VFMC (variable frequency motor controller). This technology varies the frequency of the incoming electrical signal to change the speed of driven equipment.

1.5 SCOPE OF WORK

A. Inspection Of Site

   1. The accompanying drawings do not indicate existing plumbing installations other than to identify modifications of and extensions thereof. The Contractor shall visit the site, inspect the installations and ascertain the conditions to be met and the work.
2. Failure to comply with an inspection of the site shall not constitute ground for any additional payments in connection with removing or modifying any part of the existing installations and/or installing any new work under this Division.

3. Review all construction details of the new portion of the building as illustrated on the architectural and structural drawings and be guided thereby.

B. Products and Materials Description

1. Where two or more units of the same kind or class of a specific item are required, these shall be the products of a single manufacturer; however, the component parts of the item need not be the products of one manufacturer.

2. In describing the various products and materials, in general each item will be described singularly, even though there may be a multiplicity of identical items. Also, where the description is only general in nature, exact sizes, duties, space arrangements, horsepower requirements and other data shall be determined by reference to the Documents.

C. The Work shall include modifications and extensions to existing systems, and the modification of the existing structure as required accommodating the installation of the Work.

D. Refer to other Divisions of the Specifications for related Work.

E. Contractor shall install, hang, support, etc. all MEP systems and equipment to satisfy all requirements of the applicable seismic zone using performance requirements and design criteria for project site as indicated by architect.

F. It is the intent, unless otherwise indicated, that all products and materials described and specified under this Division, shall be provided for a complete working system irrespective of use of the phrases “install”, “furnish”, “furnish and install”, or “provide” as described above has been actually included.

G. The Contractor shall be responsible for all Work of every description in connection with this Division of the Specifications.

H. The Contractor shall specifically and distinctly assume, and does so assume, all risk for damage or injury from whatever cause to property or person used or employed on or in connection with this Work and of all damages or injury to any person or property wherever located, resulting from an action or operation under the Contract in connection with the Work, and undertake the promise to defend the Owner against all claims on account of any such damage or injury.

I. The Contractor will be held responsible for the satisfactory execution and completion of the Work in accordance with the true intent of the Documents.

J. The Contractor shall provide without extra charge all incidental items required as part of the Work, even though it may not be specifically indicated. If the Contractor has reason for objecting to the use of any material, equipment, device or method of construction as indicated, he shall make report of such objections to the Owner’s Representative, obtain proper approval and adjustment to the Contract, and shall proceed with the Work.

K. Electric wiring

1. All electric wiring shall be installed under Division 26, except for such equipment items as are prewired at their point of manufacture and so delivered to the project, and except for the following:
a. Temperature Control Wiring and Power Wiring provided by controls contractor.

2. Prepare and submit for review wiring diagrams for all equipment furnished under this Division. Show on these diagrams all power, interlock, and control circuits. When the Architect takes no exception to these drawings, they shall become installation drawings for the Contractor.

3. All domestic cold and hot water piping shall be heat traced when routed external to the building or in areas susceptible to freezing conditions.

1.6 ORDINANCES, PERMITS AND CODES

A. It shall be the Contractor's duty to perform the work and provide the materials covered by these specifications in conformance with all ordinances and regulations of all authorities having jurisdiction.

B. All work herein shall conform to all applicable laws, ordinances, and regulations of the local utility companies.

C. The work shall be in accordance with, but not limited to, the requirements of:

1. National Fire Protection Association
3. Wichita Falls Building Codes
4. Texas Safety Code
5. Texas Boiler Code
6. Texas Department Of State Health Services

D. Codes and standards referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes and regulations, the drawings, and specifications govern.

E. The Contractor shall obtain permits, plan checks, connection and specification fees, inspections, and approvals applicable to the Work as required by the regulatory authorities.

F. Fees and costs of any nature whatsoever incidental to permits, inspections, and approvals shall be assumed and paid by the Contractor.

G. The pro-rata costs, if any, for utilities serving this property will be paid for by the Owner and shall not be included as part of this Contract.

1.7 REFERENCE STANDARDS

A. Where differences between building codes, state laws, local ordinances, industry standards, utility company regulations and the Contract Documents occur, the most stringent shall govern. The Contractor shall promptly notify the Owner's Representative in writing of any such difference.

B. Should the Contractor perform any Work that does not comply with local codes, laws and ordinances, industry standards or other governing regulations, the Work shall be corrected on noncompliance deficiencies with the Contractor bearing all costs.

C. In addition to the aforementioned ordinances, industry standards published by the following organizations shall apply:
1. AIA AMERICAN INSTITUTE OF ARCHITECTS
2. AASHO AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS
3. ACI AMERICAN CONCRETE INSTITUTE
4. AGA AMERICAN GAS ASSOCIATION
5. AISC AMERICAN INSTITUTE OF STEEL CONSTRUCTION
6. ANSI AMERICAN NATIONAL STANDARDS INSTITUTE
7. API AMERICAN PETROLEUM INSTITUTE
8. ARI AIR CONDITIONING & REFRIGERATION INSTITUTE
9. ASHRAE AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR CONDITIONS ENGINEERS, INC.
10. ASME AMERICAN SOCIETY OF MECHANICAL ENGINEERS
11. ASTM AMERICAN SOCIETY FOR TESTING AND MATERIALS
12. AWSC AMERICAN WELDING SOCIETY CODE
13. AWWA AMERICAN WATER WORKS ASSOCIATION
14. CISPI CAST IRON SOIL PIPE INSTITUTE
15. ASPE AMERICAN SOCIETY OF PLUMBING ENGINEERS
16. FM FACTORY MUTUAL
17. IRI INDUSTRIAL RISK INSURERS
18. NBS NATIONAL BUREAU OF STANDARDS
19. NFPA NATIONAL FIRE PROTECTION ASSOCIATION
20. PDI PLUMBING AND DRAINAGE INSTITUTE
21. UL UNDERWRITER'S LABORATORIES

D. Where the Contract Documents exceed the above requirements, the Contract Documents shall govern. In no case shall Work be installed contrary to or below the minimum legal standards.

1.8 DRAWINGS AND SPECIFICATIONS

A. The inter-relation of the specifications, the drawings, and the schedules are as follows:

1. The specifications provide the written requirements for the quality, standard, nature of the materials, equipment and construction systems.
2. The drawings establish the quantities, approximate dimensions, details and location of equipment.
3. The schedules give the capacities, characteristics and components.

B. For any individual project, if there is conflict between the drawings and or specifications, they are equivalent in authority and priority. Should they disagree in themselves, or with each other, prices shall be based on the most expensive combination of quality and quantity of work indicated. In the event of the above mentioned disagreements the resolution shall be determined by the Architect.

C. Contractor is responsible to bring any conflicts in drawings and/or specifications to the attention of the Architect, immediately, prior to any work being done.

D. Where the specifications do not fully agree with the schedules, the schedules shall govern. Figures given on drawings govern scale measurements and large scale details govern small scale drawings.

E. Review all construction details illustrated on the architectural and structural drawings and be guided thereby.
1.9 SUBMITTAL PROCEDURES

A. Common Requirements for Product Data: Where this Section and other Sections of this Division require Product Data to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:

1. Submit hardcopy of Product Data in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of product data submittals shall be bound materials as defined above. Separate products under distinct subheadings that correspond to paragraphs in specification text. Divide sections in binder with labeled divider tabs.
2. In addition to hardcopies required by Division 01, submit one copy of product data in electronic format. All files on disc shall be in Portable Document Format (.pdf).
3. Product Data shall not consist of manufacturer's catalogs or cut sheets that contain no indication of the exact item offered. The submission on individual items shall designate the exact item offered.

B. Product Data: For the following:

1. Dielectric fittings.
2. Mechanical sleeve seals.
3. Escutcheons.

C. Common Requirements for Shop Drawings: Where this Section and other Sections of this Division require Shop Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:

1. Prepare Shop Drawings using computerized drafting software compatible with AutoDesk’s AutoCAD®.
2. Submit hardcopy of Shop Drawings in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of Shop Drawings shall have each sheet clearly labeled with a unique sheet identification number.
3. In addition to hardcopies required by Division 01, submit one copy of Shop Drawings in electronic format. Files shall be include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).
4. Shop Drawings shall be of appropriate scale based on the following:
   a. Piping Systems, including all underfloor work: Minimum 1/8" = 1'-0".
   b. Mechanical rooms: 1/4" = 1’ – 0”.
5. Shop drawings shall include the following items:
   a. Concrete pads and foundations.
   b. Equipment room layouts with actual dimensions and offsets for all systems.
   c. Roof layouts.
   d. Trench locations and sizes.
   e. Dimensioned floor drain locations.

D. Common Requirements for Coordination Drawings: Where this Section and other Sections of this Division require Coordination Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures" and Division 01 Section "Project Management and Coordination". In addition to the requirements of Division 01 comply with the following:
1. Prepare Coordination Drawings using computerized drafting software compatible with AutoDesk’s AutoCAD®. Drawings files must be composite with multiple distinctive layers for each of the various trades.

2. Submit hardcopy of Coordination Drawings in the quantity as required under Division 01. Hardcopies of Coordination Drawings shall have each sheet clearly labeled with a unique sheet identification number.

3. In addition to hardcopies required by Division 01, submit one copy of Shop Drawings in electronic format. Files shall include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).

4. Coordination Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.

E. Coordination Drawings: Prepare drawings showing dimensioned layout for the following:

1. Penetration and Structural Opening: Floor plans showing sleeves and formed structural penetrations. Show sleeve and formed penetration layouts and relationships between structural components and other adjacent building elements, including but not limited to pre-tensioning and post-tensioning members where used.

2. Shop drawings shall be provided for the following:
   
   1) Sheet Metal and Duct Systems, including all underfloor work (prepared at a minimum scale of 1/8” = 1’-0”)
   
   2) Piping and equipment systems for storm, domestic water, waste and vent and other plumbing piping systems. (Preferably at 1/4” = 1’-0” and not less than 1/8” = 1’-0”).
   
   3) Equipment room layouts with actual equipment, piping, and duct at 1/4” = 1’-0” scale. Show clearances, access spaces, relative heights of piping.
   
   4) Housekeeping and equipment concrete pads.
   
   5) Dimensioned floor drain locations and the equipment each serves.
   
   6) Roof layouts.
   
   7) Trench locations and sizes.

   b. Equipment support locations, type of support, and weight on each support.
   
   c. Location of structural supports for structure-supported raceways.
   
   d. For floor mounted equipment: concrete base dimension, outline of equipment, and required clearances.
   
   e. Location of structural supports for seismic bracing.

F. Common Requirements for Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures" for “Other Informational Submittals”. In addition to the requirements of Division 01 comply with the following:

1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with “Compliance”. Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.

   a. “C” for Compliance: By noting the term “compliance” or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
b. “D” for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.

c. “A” for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.

d. “N/A” for Not Applicable: By noting the term “not applicable” or “N/A” in the margin, it shall be understood that the specified item is not applicable to the project.

G. Common Requirements For Qualification Data:

1. Professional Engineer Qualifications: Where this Section and other Sections of this Division require a Professional Engineer to be responsible for Delegated Design requirements; Submit Qualification data for Professional Engineer including, but not limited to, proof of registration in the Project location.

2. Independent Testing and Inspecting Agency Certification: Where this Section and other Sections of this Division require an Independent Testing and Inspecting agency to be responsible for Acceptance Testing and Field Quality Control requirements; Submit certification documentation for such agency that demonstrates compliance with the Quality Assurance paragraph of this Section.

H. Qualification Data: For Independent Testing and Inspecting Agency.

I. Welding certificates.

1.10 SUBSTITUTIONS

A. Where the product of a single manufacturer is mentioned by trade name or manufacturer's name in this Division, it is the only acceptable manufacturer.

B. Where two or more manufacturers are named, only those manufacturers will be considered or approved.

C. Manufacturers not listed will be considered for substitution prior to bid only. The substitute manufacturer shall submit a complete copy of the appropriate technical specification section minimum ten (10) business days prior to bid with each sub-paragraph noted with the comment, "compliance", "deviation", "alternate" or "not applicable". In the case of non-primary, vendor-supplied items, the name of the sub-vendor supplying said item, including model number, shall be indicated.

1. By noting the term "compliance" or "C", it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.

2. By noting the term "deviation" or "D", it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.

3. By noting the term "alternate" or "A", it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. An alternate shall be fully described as to what the manufacturer proposes to provide.

4. By noting the term "not applicable" or "N/A", it shall be understood that the specified item is not applicable to the project.
D. It shall be understood that space allocations have been made on the basis of present and known future requirements and the dimensions of items of equipment or devices of a particular manufacturer whether indicated or not.

E. Any product or material offered in substitution which differs in dimension or configuration from the Documents, the Contractor shall provide as part of the submittal a drawing, minimum 1/4" = 1'-0" scale, showing that the substitution can be installed in the space available without interfering with other portions of the work or with access for operations and maintenance in the completed project.

F. Where substitute products or materials requiring different arrangement or connections from that indicated is accepted by the Owner's Representative, install the equipment or devices to operate properly and in harmony with the intent of the Documents, making all incidental changes in piping or wiring resulting from the substitution without any additional cost to the Owner.

G. The Contractor shall pay all additional costs incurred by other portions of the work in connection with all substitutions.

H. The Owner's Representative reserves the right to call for samples of any item of product or material offered in substitution, together with a sample of the specific item when, in their opinion, the quality of the item and/or the appearance is involved, and it is deemed that an evaluation of the item may be better made by visual inspection.

I. When any request for a substitution of a product or material is submitted and rejected, the item named in the Documents shall be furnished. Repetitive submittal of substitutions for the same item will not be considered.

1.11 QUALITY ASSURANCE

A. All Work shall be performed by properly licensed technicians skilled in their respective trades. All materials, equipment and devices shall be installed in accordance with the recommendations of the manufacturer and in the best standard practice to bring about results of a first class condition.

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

C. 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.

D. Electrical Characteristics for Plumbing Equipment:
   1. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
   2. Where variable frequency drives are provided for equipment, whether installed separately or integral to the equipment, the VFDs shall conform to Division 26 section, "Variable Frequency Motor Controllers".
E. Wherever a UL standard has been established for a particular type of material, equipment or
device, each item of such material, equipment or device provided on this project shall meet the
requirements of the UL standard in every way, and shall be UL listed and labeled.

F. Products and materials shall be of the best quality customarily applied in quality commercial
practice, and shall be by reputable manufacturers.

G. Each major component shall bear a nameplate giving the name and address of the
manufacturer, and the catalog number or designation of the component.

H. Products and materials provided under this Division of the Specifications shall be essentially the
standard item, unless otherwise noted, of the specified manufacturer, or where allowed, an
alternate manufacturer.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Deliver products and materials with factory-applied end caps or “heat shrink” wrappings to
protect openings. Maintain opening protection through shipping, storage, and handling to
prevent damage and the entrance of dirt, debris, and moisture.

B. Store light sensitive products and materials away from and protected against direct sunlight.

C. Support products and materials at all times to prevent sagging and bending.

D. The area provided for product and material storage at the jobsite shall be clean, dry and
exposure to dust minimized.

E. Responsibility for the protection of products and materials shall extend to existing equipment,
systems, and products and materials. Erect temporary sheltering structures, provide temporary
bracing and supports, or cover existing equipment, systems, and products and materials to
prevent damage and the entrance of dirt, debris, and moisture.

F. Failure on the part of the Contractor to comply with the above to the satisfaction of the Architect,
Engineer, or either’s authorized representative shall be sufficient cause for the rejection of
products and materials in question.

1.13 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.

D. Installation Drawings

1. Prepare special drawings as called for elsewhere herein or directed by the Architect to
coordinate this work with the work of other Divisions, to illustrate changes in this work to
facilitate its concealment in finished spaces, to avoid obstructions, or to illustrate the
installation of a substitute equipment item.
2. Use these drawings in the field for the installation of the work. Unless otherwise directed, do not submit these drawings for review, but provide 3 copies to the Architect for information.

E. Schedule And Sequence Of Work

1. The Contractor shall meet and cooperate with the Owner and Owner's Representative to schedule and sequence Work so as to ensure meeting scheduled completion dates and avoid delaying other portions of the Work. Work requiring special sequencing shall be at no additional cost to the Owner and shall have no impact on the schedule.

2. Work schedules and completion dates as established shall be rigidly adhered to. Cooperate in establishing these schedules and perform the work under this Division at such times as directed so as to ensure meeting scheduled dates and avoid delaying any other Contractor.

3. Any work involving a service suspension shall be scheduled in advance with the Owner.

4. Should it be necessary to perform certain operations on an "overtime" basis in order not to interrupt the normal usage of the facility, include the costs of such overtime without change in the Contract amount.

5. The Contractor shall be responsible for coordinating the demolition and tie-in of the central plant system with the Owner and construction manager.

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.

C. All piping and tubing shall be American manufactured, unless otherwise indicated.

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

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

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

G. 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.

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

2.4 TRANSITION FITTINGS

A. 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.

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.

C. 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.

D. 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.

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

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. 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.

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.

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. Innerlinx by Mason Dallas.
   b. Metraflex Co.
   c. Linkseal by Thunderline.

2. Sealing Elements: EPDM for high temperature applications and NBR for all others unless otherwise indicated, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: 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. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 10, galvanized, plain ends.

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, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated and rough brass, pending approval by Architect.

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

1. Finish: Polished chrome-plated and rough brass, pending approval by Architect.
2.9 GROUT

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

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

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

A. 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.

B. 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 SALVAGED MATERIALS

A. Reuse no salvaged material except as noted on the Drawings, specified herein, or directed by the Architect. Remove from the premises all present materials falling under this Division, which are removed from the existing building. Upon completion, leave no "dead" line or equipment installed in any portion of the area being remodeled.

3.3 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 Shop 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, after Architect’s final approval of finish, for penetrations of walls, ceilings,
and floors according to the following:

1. New piping penetrations shall be one-piece escutcheons.
2. Existing piping penetrations shall be two-piece escutcheons.
3. All sleeved penetrations shall be deep-drawn to allow flush installation between
escutcheon and finished surface.

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 to prevent water entrance to the
      sleeved hole. Vertical pipe supports must be extended to and supported by the
      floor and not the sleeve.
   b. Strike above subparagraph and retain subparagraph below when a pipe curb is
      required at all floor penetrations in lieu of extended sleeves.
   c. Provide concrete pipe curb in floors of mechanical equipment areas or other wet
      areas 4 inches above finished floor level.

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.

N. 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 for above ground locations.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter for above ground and all underground locations.
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.

3.4 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.


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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   3. 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.
   4. PVC Nonpressure Piping: Join according to ASTM D 2855.

J. 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.

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

3.5 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.
3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Equipment called for on the plans and not listed herein shall be provided as though it were fully described herein.

B. Equipment called for herein shall be completely provided, whether fully detailed or not on the plans, and/or scheduled.

C. All equipment as indicated on the plans and as described herein shall be installed per manufacturer’s recommendations to allow for proper operation and maintenance of the equipment.

D. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

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

F. 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.

G. Where any piece of equipment is too large for ingress through normal building openings, it shall be placed in its containing space before the enclosing structure is completed.

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

3.7 PAINTING

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

3.8 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 not less than 4 inches larger in both directions than supported unit.
2. Concrete bases for all equipment shall be 4 inches (100 mm) tall above finished floor.

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

B. Field Welding: Comply with AWS D1.1.
3.10 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.

3.11 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.

3.12 INSTALLATION, INSPECTIONS AND CERTIFICATIONS

A. The Contractor shall obtain timely inspections of the installation by the constituted authorities. Remedy any deficiencies to the satisfaction of the inspecting authority.

B. Upon final completion of the work, obtain certificates of acceptance from the constituted authorities. Deliver the certificates to the Architect for transmission to the Owner.

3.13 OPERATION PRIOR TO COMPLETION

A. When any piece of mechanical or electrical equipment is operable and it is to the advantage of the contractor to operate the equipment, he may do so with permission of Owner, providing that he properly supervises the operation, retains full responsibility for the equipment operated, and protects against dirt accumulations during operation. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner or until final acceptance by the Owner.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, and properly adjust the operation of the equipment before final acceptance by the Owner.
3.14 INSTRUCTION OF OWNER'S PERSONNEL

A. Provide the services of competent engineers and/or technicians acceptable to the Owner's Representative to instruct other representatives of the Owner in the complete and detailed operation of each item of equipment or device of all the various electrical systems. These instructions shall be provided for whatever periods may be necessary to accomplish the desired results.

B. Upon completion of these instructions, the Contractor shall obtain a letter of release, acknowledged by the Owner or his authorized representative, stating the dates on which the various kinds of instruction were given, and the personnel to whom the instructions were given.

C. The Contractor shall be fully responsible for proper maintenance of equipment and systems until the instructions have been given the Owner's personnel and the letter of release acknowledged.

D. In providing the instructions to the Owner's personnel, the written operating and maintenance manuals shall be followed in all instances, and the Owner's personnel shall be familiarized with such manuals.

E. Operating and maintenance manuals used for instructions shall include wiring diagrams, manufacturer's operating and maintenance instructions, parts lists (with sources identified), and other data as appropriate for each system.

3.15 SEALANT

A. Apply sealant to penetrations of all floor and wall assemblies to maintain pressure differentials required by AIA for all pressure sensitive rooms. Sealant materials and installation requirements are specified in Division 07 Section “Joint Sealants” and Division 09 Section “Gypsum Board Assemblies.

END OF SECTION
SECTION 220519

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Thermometers.
   2. Gages.
   3. Test plugs.

B. Related Sections:
   1. Division 22 Section "Facility Water Distribution Piping" for domestic and fire-protection water service meters outside the building.
   2. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.
   3. Division 23 Section "Facility Natural-Gas Piping" for gas meters.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

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

1.3 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer and gage, signed by product manufacturer.

PART 2 - PRODUCTS

2.1 THERMOMETERS

A. Digital Vari-angle Thermometer, self-powered and within 1% accuracy, Similar to Weiss Model DVU35.

   1. Case: Hi-impact ABS
   2. Range: -40/300 °F (-40/150 °C)
   3. Display: 3/8” LCD digits, wide ambient formula
   4. Accuracy: 1% of reading or 1° whichever is greater
5. Resolution: 1/10° between -19.9/199.9 °F (-28/93 °C)
6. Recalibration: Internal potentiometer
7. Lux Rating: 10 Lux (one foot-candle)
8. Update Rate: 10 seconds
9. Ambient Operating Range: -30/140 °F (-35/60 °C)
10. Ambient Temp. Error: Zero
11. Humidity: 100%
12. Sensor: Glass passivated thermistor
13. Connector: adjustable angle

2.2 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.

B. Description: Pressure-tight, socket-type 304 stainless steel fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAGES

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

1. Ernst Gage Co.
2. Miljoco Corp.
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.
5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
6. Dwyer Instruments, Inc.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Liquid-filled type, cast aluminum, 4 1/2-inch (114-mm) diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Pointer: Red or Black metal.
7. Window: Glass.
9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 50 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel ball type.
2. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.
2.4 TEST PLUGS

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

1. Flow Design, Inc.
2. MG Piping Products Co.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

   1. Insert material for water service at 20 to 200 deg F shall be CR.
   2. Insert material for water service at minus 30 to plus 275 deg F shall be EPDM.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install digital thermometers in the following locations:

   1. Inlet and outlet of each domestic water heater.
   2. Inlet and outlet of each thermostatic mixing valve.

B. Install thermometers in separable sockets at each additional location indicated on the Drawings or specified elsewhere herein.

C. Provide the following temperature ranges for thermometers:

   1. Domestic Hot Water: 30 to 200 deg F, with 2-degree scale divisions.
   2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.

3.2 GAGE COCK APPLICATIONS

A. Install test plugs adjacent to all control sensors (except Insertion Type Flow Meters) installed in piping systems.

B. Valved pressure gage connections shall be installed in each location indicated on the Drawings and/or specified elsewhere herein.

C. Install each gage cock on a nipple of sufficient length so that the cock handle will be free of the pipe insulation. Position each cock so that a 41/2" diameter dial gage may be easily read and screwed into and out of the cock.
D. On pumps use a single pressure gage connected by ball valves and metal tubing to the inlet and discharge flanges as well as the suction diffuser inlet flange, if applicable.

E. Install gage cocks at each pump as close to pump suction and discharge connections as practicable. Use any gage connections provided in the pump casing.

3.3 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

C. Furnish and install calibrated pressure gauges at each location indicated on the Drawings, specified elsewhere herein, and/or as a standard.

3.4 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.

C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

D. Install ball-valve and snubber or syphon fitting in piping for each pressure gage.

E. Install test plugs in tees in piping.

F. Install connection fittings for attachment to portable indicators in accessible locations.

G. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.

H. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. [Provide piping, valves, fittings and related products as listed on Drawings and described herein. All products to be purchased from Ferguson Enterprises.]

B. This Section includes the following general-duty valves:
   1. Copper-alloy ball valves.
   2. Ferrous-alloy ball valves.
   3. Ductile-iron butterfly valves.
   4. High-pressure butterfly valves.
   5. Bronze check valves.
   6. Cast-iron swing check valves.
   7. Spring-loaded, lift-disc check valves.
   8. Chainwheel actuators.

C. Related Sections include the following:
   1. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
   2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and charts.
   3. Division 22 piping Sections for specialty valves applicable to those Sections only.
   4. Division 23 "Facility Natural Gas Piping" for natural gas valves.

1.2 DEFINITIONS

A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. NBR: Acrylonitrile-butadiene rubber.
   4. PTFE: Polytetrafluoroethylene plastic.
   5. TFE: Tetrafluoroethylene plastic.
   6. NRS: Nonrising stem.
   7. OS&Y: Outside screw and yoke.

1.3 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; furnished specialties; and accessories.
1.4 QUALITY ASSURANCE

A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

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

C. Bronze valves shall be made with dezincification-resistant materials. All valves shall comply with the current edition of recognized industry standards for design, materials and testing. These standards include but are not limited to MSS SP-80 and MSS SP-110.

1.5 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 and plug 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. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged or grooved ends, unless otherwise indicated.

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

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:
   1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
   2. Gear Drive: For quarter-turn valves NPS 8 and larger.
   3. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

G. Extended Valve Stems: On insulated valves. Valves shall have 2-inch (50-mm) stem extensions and the following features:

1. Ball Valves: Shall have extended operating handle of non-thermal-conductive material, protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation, and memory stops that are fully adjustable after insulation is applied.

   1) NIBCO Nib-seal handle extension
   2) Conbraco Industries, Inc.; Apollo Div.
   3) Jamesbury, Inc.
   4) Kitz Insulated Stem Extension Model #ISE 1 thru 4
   5) Milwaukee Valve: The Insulator/MS

2. Butterfly Valves: Shall have extended necks.


I. Valve Grooved Ends: AWWA C606.

J. Solder Joint: With sockets according to ASME B16.18.

   1. Caution: Use solder with melting point below 840 deg F for check valves; below 421 deg F for ball valves.

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

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

2.2 COPPER-ALLOY BALL VALVES

A. Brass Ball Valves, General: MSS SP-110 and have a brass body complying with ASTM B 283.

B. Bronze Ball Valves, General: MSS SP-110 and have a copper alloy body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder [or press connection] ends, and blowout-proof stems.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: Chrome-plated bronze ball and bronze stem and; reinforced TFE seats; threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, solder or threaded [or press connection] ends; and 150 psig SWP 600-psigCWP rating.

   1. NIBCO Model S-585-80-LF or T-585-80-LF
   3. Crane Co.
   4. Watts Model
   5. Kitz Model 868 or 869
   6. Milwaukee UPBA450 or UPBA400
7. Hammond UP8311A or UP88301A

D. Two-Piece, Full-Port, Copper-alloy Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, reinforced TFE seats, threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, soldered or threaded [or press connection] ends; 150 psig SWP and 600-psig CWP ratings.

1. NIBCO Model S-585-66-LF or T-585-66-LF
3. Crane Co. Model
4. Watts Model
5. Kitz Model 868M or 896M
6. Milwaukee UPBA400S, UPBA450S
7. Hammond UP8303A, UP8313A

E. Three-Piece, Full Port, Copper-alloy Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, stainless nuts and bolts on valve body, soldered or threaded [or press connection] ends; 150 psig SWP and 600-psig CWP rating.

3. Crane Co.
4. Kitz Model 862M or 863M
5. Milwaukee UPBA350S, UPBA300S
6. Hammond UP8613, UP8603

2.3 [BRONZE BUTTERFLY VALVES]

A. Bronze Butterfly Valves, General: CTS 2 (DN50) – 8 (DN300), 300-psig CWP rating with offset, aluminum-bronze disc and bronze cast body. Bubble tight bi-directional and dead-end service at full rated pressure.

1. Victaulic Company Style 608N

2.4 DUCTILE or CAST IRON BUTTERFLY VALVES

A. Butterfly Valves, General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:

1. Full lug, grooved and flanged valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange. Valves NPS 12 and smaller shall not have exposed stem to disc fasteners and no exterior mounted fasteners to hold the liner.
2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.

B. Class 150: 175-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece Type 400 series stainless-steel
stem, bronze bushing, aluminum-bronze disc, and phenolic-backed EPDM seat (liner) attached to the body.

1. NIBCO Model LD-1000
2. Cooper Cameron Corp. Model NF-C (238 Series) 511435-A
3. DeZURIK; SPX Corporation Model BRS Series BHP, (Size), LD-DI-EPDM-EPDM-BZ-S4-*
4. Kitz Model #6123E
5. Crane
6. Milwaukee ML333E
7. Hammond 6411
8. Grinnell

C. Class 200: 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one-piece Type 400 series stainless-steel stem, copper bushing, fasteners and pins shall not be used to attach stem to disc, no pins or fasteners in waterway, aluminum-bronze disc, and molded-in EPDM seat (liner).

1. NIBCO Model LD-2000
2. Cooper Cameron Corp. Model NF-C (221 Series) 511435-*
3. DeZURIK; SPX Corporation Model BRS (Size) LD-DI-EPDM-EPDM-BZ-S4-*
4. Kitz Model #6123E
5. Crane
6. Milwaukee ML333E
7. Hammond 6411
8. Grinnell

D. Grooved-End, Ferrous-Alloy Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc or electroless nickel coated ductile iron disc with EPDM seal, Ductile-iron body or stainless steel body with grooved ends, polyamide coating inside and outside or alkyd enamel inside and outside, two-piece Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing or TFE lined fiberglass and brass bushing, fasteners and pins shall not be used to attach stem to disc, no pins or fasteners in waterway, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.

1. NIBCO Model GD-4765
2. Victaulic Co. of America. Model Vic-300-Master Seal Style 361 or Style 461

2.5 CARBON STEEL HIGH-PRESSURE BUTTERFLY VALVES

A. High-Pressure Butterfly Valves, General: MSS SP-68 API 609 seat pressure and temperature ratings, ANSI B1634A body pressure and temperature ratings, ANSI B16.5 flange dimensions, ISO 5211, EN 12116 actuator mounting top works, capable of bi-directional dead-end service at full-rated pressure without use of downstream flange, carbon-steel body, offset design, extended-neck for insulation, permanently lubricated 300-series stainless-steel bushings with graphite and modified PTFE seats, graphite packing and gasket, one-piece duplex stainless-steel stem, and stainless-steel disc. Valves NPS 6 and smaller shall have lever-lock operator; valves NPS 8 and larger shall have weatherproof gear operator.

B. Class 150, Full-Lug, 285 psig CWP Rating, High-Pressure Butterfly Valves:

1. NIBCO Model LCS6822
2. Jamesbury, Inc. Model (Size) 815L-11-22-36-TT-*
3. WKM Model (Size) Model B 113-05-SO1-11-*
4. Milwaukee HP1LCS
5. Hammond HP1LCS

2.6 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 125, Bronze, Lift Check Valves with TFE Disc: ASTM B-584 bronze body and integral seat with soldered or threaded end connections, and having 250-psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. Kitz Model 836 or 826
   3. NIBCO Model S-480-Y-LF or T-480-Y-LF
   4. Powell, Wm. Co.
   5. Milwaukee UP1548T, UP548T
   6. Hammond UP947, UP943

C. Class 125, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. Kitz Model 822T or 823T
   3. NIBCO Model S-413-Y-LF or T-413-Y-LF
   4. Powell, Wm. Co.
   5. Milwaukee UP1509, UP509
   6. Hammond UP912, UP904

D. Class 150, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 300 psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. Kitz #30T or #29T
   3. NIBCO Model S-433-Y or T-433-Y
   4. Powell, Wm. Co.
   5. Milwaukee 1510T, 510T
   6. Hammond IB945

2.7 IRON SWING CHECK VALVES


B. Class 125, Gray-Iron, Standard Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; bronze disc and seat; and having 200 psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. Kitz Model 78
   3. NIBCO Model F-918-N
   4. Powell, Wm. Co.
   5. Milwaukee F-2974-M
6. Hammond IR1126-HI

C. Grooved-End, Spring Assisted Check Valves: ASTM A536 Ductile-iron body with grooved ends, stainless steel spring and synthetic seats and having 250-psig CWP Rating.
   1. Anvil International, Inc.
   2. NIBCO Model G-917-W
   3. Victaulic Co. of America

2.8 IRON SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.

B. Class 125, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 200 psig CWP rating.
   1. NIBCO Model F-910-B-LF
   2. Metraflex Co.
   3. Kitz Model 7022
   4. Milwaukee 1800
   5. Hammond IR9354

2.9 CHAINWHEEL ACTUATORS

A. Manufacturers:
   1. Babbitt Steam Specialty Co.
   2. Roto Hammer Industries, Inc.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
   2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   3. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. 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.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
D. Examine threads on valve and mating pipe for form and cleanliness.

E. 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.

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

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or butterfly valves.
2. Throttling Service: Ball or butterfly valves.

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

C. Domestic Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, full port, stainless-steel trim, bronze.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full port, ferrous alloy.
5. High-Pressure Butterfly Valves, NPS 2-1/2 (DN 65) and Smaller: Single-flange full lug, 285 psig (1964 kPa) CWP rating.
6. [Grooved-End, Bronze Butterfly Valves, CTS 2 to 8 (DN 50 to DN 300): 300-psig (2070-kPa) CWP rating, EPDM-encapsulated aluminum-bronze or stainless steel disc.]
9. Lift Check Valves, NPS 2 and Smaller: Class 125, bronze with TFE disc.
10. Swing Check Valves, NPS 2 and Smaller: Class 150, bronze with TFE disc.
11. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, cast-iron, standard.
13. Spring-Loaded, Center-Guided, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Class 125, flanged end, iron.

D. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded [or press connection] ends.
2. For Copper Tubing, NPS 2-1/2: Flanged ends.
3. For Grooved-End, Copper Tubing: Valve ends may be grooved.
3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

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

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

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

F. Install chainwheel operators on valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer’s written instructions.

C. 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.

3.5 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.

END OF SECTION
1.1 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. Metal framing systems.
4. Fastener systems.
5. Pipe stands.
6. Pipe positioning systems.
7. 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 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.2 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."

1.3 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.

C. Pipe hangers and supports shall conform to the recommendations of ASHRAE, ASPE, ANSI, and MSS, unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For the following:
1. Steel pipe hangers and supports.
2. Fiberglass pipe hangers.
3. Thermal-hanger shield inserts.
4. Pipe positioning 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.

1.5 QUALITY ASSURANCE


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

1. AWS D1.1, "Structural Welding Code--Steel."
3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 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.
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.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.
14. Tolco Inc.
15. Anvil International

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.

2.2 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.

2.3 METAL FRAMING SYSTEMS

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

B. Available Manufacturers:

2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.
8. Anvil International

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

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

2.4 CUSHION CLAMPS FOR MEDICAL GAS

A. Clamps for trapeze style hangers, designed to isolate copper medical gas piping from dissimilar metals.

B. Manufacturers:

1. Tolco Inc.
2. HOLDRITE Corp.; Hubbard Enterprises.

2.5 FASTENER SYSTEMS

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

1. Available Manufacturers:
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/Caddy Pyramid
      b. MIRO Industries.

C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
   1. Available Manufacturers:
      a. MIRO Industries.
      b. Portable Pipe Hangers.
      c. ERICO/Caddy Pyramid

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/Caddy Pyramid
      b. MIRO Industries.
      c. Portable Pipe Hangers.
   2. Base: Plastic or 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.

1. Available Manufacturers:
   a. Pate.
   b. Thy Curb.

   1) Models:
      a) TC-1 for insulated roof decks.
      b) TC-2 for un-insulated and existing roof decks.
      c) TC-3 for Bulb-T roof decks.

2. Pipe curbs and rails with covers shall be all welded 18 gauge galvanized steel shell and baseplate, wood nailer, and TP-1 Duro EPDM cover or TP-2 pipe cover, as detailed on the drawings, for pipe penetration(s).

2.7 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. Manufacturers:
   2. HOLDRITE Corp.; Hubbard Enterprises.
   3. Samco Stamping, Inc.

2.8 EQUIPMENT SUPPORTS

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

1. Available Manufacturers:
   a. Pate.
   b. Thy Curb.

   1) Models:
      a) TEMS-1 for insulated roof decks.
      b) TEMS-2 for un-insulated and existing roof decks.
      c) TEMS-3 for single-ply roof systems.

2. Equipment supports shall be all welded 18 gauge galvanized steel shell, baseplate and counterflashing with internal bulkhead re-enforcement and wood nailer.
2.9 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.

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

PART 3 - EXECUTION

3.1 PREPARATION

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to proper placement of inserts, anchors and other building structural attachments.

3.2 HANGER AND SUPPORT APPLICATIONS

A. Use only one type hangers and supports, by one manufacturer, for each piping service.

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

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

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

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

F. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing or provide copper-plated hangers and supports for copper piping systems where hangers are in contact with bare pipe.

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

H. Horizontal-Piping Hangers and Supports, Select size of hangers and supports to exactly fit pipe size for bare piping, and around piping insulation with saddle or shield for insulated piping. Unless otherwise indicated and except as specified in piping system Sections, install the following types. 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 deg F 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. 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.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
10. Extension, Split Pipe- or Solid- Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/4 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. 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.

I. Vertical-Piping Clamps: Select size of vertical piping clamps to exactly fit pipe size of bare pipe. 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.

J. Hanger-Rod Attachments: Select size of hanger rod attachments to suit hanger rods. 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.

K. 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 37): 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.

L. 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.

M. Spring Hangers and Supports: Select spring hangers and supports to suit pipe size and loading. 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.

N. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
O. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.3 MEDICAL GAS 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 devices.
B. Use cushion clamps on all medical gas piping
c. Vertical Piping: MSS Type 8 or 42, clamps.
D. Individual, Straight, Horizontal Piping Runs:
   1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
   2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
F. Base of Vertical Piping: MSS Type 52, spring hangers.
G. Support horizontal piping within 12 inches of each fitting and coupling.
H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4: 60 inches with 3/8-inch rod.
2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
4. NPS 1: 96 inches with 3/8-inch rod.
6. NPS 1-1/2: 10 feet with 3/8-inch rod.
7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 3-1/2: 15 feet with 1/2-inch rod.
11. NPS 4: 16 feet with 1/2-inch rod.
12. NPS 5: 18 feet with 1/2-inch rod.
14. NPS 8: 23 feet with 3/4-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

3.4 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 by the following table to properly support piping from building structure.

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<td>1-1/4</td>
<td>8</td>
<td>7/8</td>
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</tbody>
</table>
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. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

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

E. Fastener System Installation:

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

F. 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.

G. 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.

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


J. 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.

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

L. 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.

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

N. 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.

O. 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:

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.

3.5 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.

3.6 METAL FABRICATIONS

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

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

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

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

B. Trim excess length of continuous-thread hanger and support rods to 1 inch

3.8 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.

END OF SECTION
SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 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.

1.3 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. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, laminated phenolic with a black surface and white substrate for mechanical engraving, 1/16 inch Minimum thick, and having predrilled holes for attachment hardware and beveled edges.
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 2-1/2 by 3/4 inch.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment’s Drawing designation or unique equipment number, as directed by the owner. Secondary lettering shall indicate date of installation.

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.

D. Punched plastic tape for labels is not acceptable.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 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 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1 inch for name of units. 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. Labels shall conform to ANSI A13.1 and the following table:

<table>
<thead>
<tr>
<th>Outside Diameter of Pipe of Covering</th>
<th>Height of Letters</th>
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<tr>
<td>¾&quot; to 1-1/4&quot;</td>
<td>½&quot;</td>
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Midwestern State University
Health Science & Human Services Center
RSA Project No. 1612.00

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
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### IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

<table>
<thead>
<tr>
<th>Size</th>
<th>Description</th>
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<td>3/4”</td>
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<tr>
<td>2-1/2” to 6”</td>
<td>1-1/4”</td>
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<td>8” to 10”</td>
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<td>Over 10”</td>
<td>3-1/2”</td>
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</table>

B. Available Manufacturers: Seton, Brady, or Westline.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or cover full circumference of pipe.

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

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, 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.

#### 2.4 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 and S-hook or beaded chain

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] [Approximately 4 by 7 inches] <Insert size>.
   2. Fasteners: [Brass grommet and wire] [Reinforced grommet and wire or string].
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
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 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. In no case shall an exposed line enter or leave a room without being identified.
   8. Secure identification markers to piping by firmly pressing markers in place, following removal of protective covering. Additionally secure by banding ends of markers in place using 1/2 inch wide aluminum bands of the type normally used to secure insulation in place.

C. Pipe Label Color Schedule: CORDINATE WITH OWNER

1. Low-Pressure, Compressed-Air Piping:
   a. Background Color: [Black] [Blue] [Red] [White] [Yellow] <Insert color>.
   b. Letter Color: [Black] [Blue] [Red] [White] [Yellow] <Insert color>.

2. Medium-Pressure, Compressed-Air Piping:
   a. Background Color: [Black] [Blue] [Red] [White] [Yellow] <Insert color>.
   b. Letter Color: [Black] [Blue] [Red] [White] [Yellow] <Insert color>.

3. Domestic Water Piping:
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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; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.5 WARNING-TAG INSTALLATION

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

END OF SECTION
SECTION 220700
PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
   a. Calcium silicate.
   b. Cellular glass.
   c. Flexible elastomeric.

2. Factory-applied jackets.
3. Field-applied cloths.
4. Field-applied jackets.
5. Adhesives.
7. Sealants.
8. Tapes.
10. Thermal Hanger-Shield Inserts

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Calculations: For insulation submitted outside of the conductivity range per the “Minimum Pipe Insulation Thickness” Table for the application listed, submit thickness calculations.

C. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
1. Sample Sizes:
   b. Sheet Form Insulation Materials: 12 inches square.
   d. Sheet Jacket Materials: 12 inches square.
   e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

E. Qualification Data: For qualified Installer.

F. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

G. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. 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.

1.4 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.

1.5 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

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1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 Manufacturers:

A. Owens-Corning
B. Johns-Manville
C. Pittsburg-Corning
D. Manson (Certain Teed)
E. Knauf Fiberglass
F. Aerocel EPDM
G. Armacell
H. Resolco Insul-Phen

2.2 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. Calcium Silicate:

1. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.
   1. Block Insulation: ASTM C 552, Type I.
   2. Special-Shaped Insulation: ASTM C 552, Type III.
   3. Preformed Pipe Insulation with Factory-Applied [ASJ] [ASJ-SSL]: Comply with ASTM C 552, Type II, Class 2.
   4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

2.3 ADHESIVES

A. Products: Subject to compliance with requirements, insulation manufacturer shall provide insulation adhesive and jacket manufacturer shall provide jacket adhesive.

B. 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.

C. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

D. Cellular-Glass Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.


F. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS

A. Products: Subject to compliance with requirements, insulation manufacturer shall provide mastics.

B. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

C. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 200 deg F.
3. Solids Content: 63 percent by volume and 73 percent by weight.

E. Color: White.

2.5 SEALANTS

A. Products: Subject to compliance with requirements, insulation manufacturer shall provide sealants.

B. Joint Sealants for Cellular-Glass Products:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Permanently flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 100 to plus 300 deg F.

C. FSK and Metal Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.

D. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
   5. PVDC Jackets
      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) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
         b. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96.
and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

c. for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.


6. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

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


2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket:

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, Division of ITW; Metal Jacketing Systems.

b. PABCO Metals Corporation; Surefit.

c. RPR Products, Inc.; Insul-Mate.


a. Factory cut and rolled to size.

b. Finish and thickness are indicated in field-applied jacket schedules.

c. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.

2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

3) Tee covers.

4) Flange and union covers.

5) End caps.

6) Beveled collars.

7) Valve covers.

8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
2.9 TAPES

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. Avery Dennison Corporation, Specialty Tapes Division.
2. Compac Corp.
4. Venture Tape.
5. Dow Chemical Company (The).

B. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

C. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.10 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, 3/4 inch wide with wing or closed seal.
2.11 PIPE INSULATION HANGER SHIELDS:

A. Provide shields for hangers on all insulated pipe.

B. Insulation and shields shall consist of a 180 degree galvanized sheet steel shield. Shield lengths and minimum sheet metal gauges shall be as directed below:

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>SHIELD LENGTH</th>
<th>MINIMUM GAUGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; to 8&quot;</td>
<td>12&quot;</td>
<td>16</td>
</tr>
<tr>
<td>10&quot; &amp; Larger</td>
<td>22&quot;</td>
<td>16</td>
</tr>
</tbody>
</table>

C. Shields shall be Model CS-CW, except for pipe roller applications and where pipe hanger spacing exceeds 10 feet, then provide Model CSX-CW.

D. At the Contractor's option, shop-fabricated galvanized metal shields may be provided based on approved shop drawings. Length and gauge of sheet metal shall be as specified above.

2.12 PREMANUFACTURED COVERS

A. Preformed manufactured PVC fitting covers with rigid one piece (half-shell) preformed rigid insulation.

PART 3 - EXECUTION

3.1 GENERAL

A. Materials shall be applied by a qualified insulation applicator/workman skilled in this trade. Insulation shall be installed in accordance with the manufacturers written instructions and in accordance with recognized industry standards. Mechanical fasteners shall be used whenever possible to assure permanent construction. Unsightly work shall be cause for rejection.

B. Materials shall be applied only after surfaces have been tested and thoroughly cleaned of all mill scale, grease and dirt.

C. Non-compressible insulation material shall be installed at hanger supports on cold piping to prevent damage to insulation and vapor barrier. All wet pipe insulation shall be replaced.

D. Insulation of cold surfaces shall be vapor-sealed to prevent condensation.

E. Minimum thickness of insulation shall be as scheduled.

F. Install Pipe Insulation Hanger Shields.

G. Where piping system insulation is specified, cover valves, strainers, unions, flanges, and fittings. Refer to Preformed fitting and valve covers.

H. Extend piping insulation without interruption through walls, floors and similar piping penetrations, there shall be no exceptions.

3.2 APPLICATION TYPES

A. Equipment
E1: Cut insulation to fit contour of equipment, and secure by means of bands or adhesives as required for each individual piece of equipment. Provide vapor barrier and finish as required for each specific application. Provide new cold surfaces of pumps with accessible boxes that easily separate coincidental with parting line of evaporator heads and pump casings. Resulting insulation joints shall be covered with a self-sealing, vapor-barrier tape. Seal all laps and penetrations in vapor barrier jacket with an approved vapor barrier mastic.

B. Piping

P1: Butt insulation together and securely tape. Install factory-furnished laps at the butt joints. Neatly bevel and finish insulation where it terminates. Use of double tape self-sealing adhesives systems will negate requirements for staples.

P2: Butt insulation together and securely tape. Install factory-furnished laps at the butt joints. Neatly bevel and finish insulation where it terminates. Seal all laps and penetrations in vapor barrier jacket with an approved vapor barrier mastic.

P3: Same as P2, except install insulation over heat trace tape. Finish with metal jacket.

3.3 INSULATION SCHEDULE KEYS

<table>
<thead>
<tr>
<th>Insulation Types Key</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>1. Calcium Silicate</td>
</tr>
<tr>
<td>2. Fiberglass (Rigid)</td>
</tr>
<tr>
<td>3. Foamed Glass (Cellular)</td>
</tr>
<tr>
<td>4. Foamed Plastic (Flexible)</td>
</tr>
<tr>
<td>5. Insulating Cement</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Finishes Key</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F1.</strong> 8-ounce glass cloth</td>
</tr>
<tr>
<td><strong>F2.</strong> Insulation cement</td>
</tr>
<tr>
<td><strong>F3.</strong> 0.016 aluminum, plain, up through 12” pipe size; 0.016 aluminum, corrugated, for pipe sizes 14” and larger</td>
</tr>
<tr>
<td><strong>F4.</strong> White all-service jacket (vapor barrier) with self-sealing lap, or taped joints</td>
</tr>
<tr>
<td><strong>F5.</strong> Two coats vinyl lacquer type white paint</td>
</tr>
</tbody>
</table>

3.4 EQUIPMENT AND PIPING INSULATION SCHEDULES

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following unless there is a potential for personnel injury.

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings.

C. Fitting and Valve Covers:

1. Fitting covers shall be of preformed PVC for indoor service and metal for outdoor service.
2. Insulation material shall be rigid and of the same or greater material type and thickness, density and conductivity as the adjoining pipe. Blanket inserts will not be allowed.
3. Field fabricated fitting covers of same or similar material as pipe covering with preformed rigid inserts as specified in paragraph 1 above

D. Exposed piping for ADA compliant lavatories shall be provided with premanufactured covers complying with ASTM E-84 for P-traps, waste piping and angle stop valves.

---

**EQUIPMENT AND PIPING INSULATION SCHEDULE**

<table>
<thead>
<tr>
<th>INSULATION TYPE</th>
<th>THICKNESS</th>
<th>APPLICATION TYPE</th>
<th>INDOOR CONCEALED</th>
<th>INDOOR EXPOSED</th>
<th>OUTDOOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic cold water; bottom of roof drains and overflow drains; horizontal storm drains and overflow drains within building; waste piping conveying cooling coil condensate; waste from chilled drinking water fountains.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indoor:</td>
<td>2</td>
<td>1&quot;</td>
<td>P2</td>
<td>F4</td>
<td>F4</td>
</tr>
<tr>
<td>Outdoor:</td>
<td>2</td>
<td>1&quot;</td>
<td>[P2][P3]</td>
<td>--</td>
<td>F4 &amp; F3</td>
</tr>
<tr>
<td>Domestic hot water supply &amp; recirculation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indoor:</td>
<td>2</td>
<td>Note 1</td>
<td>P1</td>
<td>F4</td>
<td>F4</td>
</tr>
<tr>
<td>Domestic water pumps.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indoor:</td>
<td>[2] [3] [4]</td>
<td>2&quot;</td>
<td>E1</td>
<td>--</td>
<td>[F1] [F2] [F3] [F5] [F3] [F5]</td>
</tr>
<tr>
<td>Domestic water storage tank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indoor:</td>
<td>2</td>
<td>1 1/2&quot;</td>
<td>E1</td>
<td>--</td>
<td>F2 &amp; F1</td>
</tr>
<tr>
<td>Medical vacuum pump exhaust piping</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indoor:</td>
<td>1</td>
<td>2&quot;</td>
<td>P1</td>
<td>--</td>
<td>F2</td>
</tr>
</tbody>
</table>

* Provide insulation where piping is heat traced.
** Refer to insulation types and finishes keys.
*** Table does not apply to factory insulated equipment

Note 1 – See “Domestic Hot Water Pipe Insulation Thickness” table below.

---

**DOMESTIC HOT WATER PIPE INSULATION THICKNESS**

<table>
<thead>
<tr>
<th>SUPPLY WATER TEMP °F</th>
<th>NON-CIRCULATING RUNOUTS UP TO 1&quot;</th>
<th>CIRCULATING MAINS AND BRANCHES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>UP TO 1 1/4&quot;</td>
</tr>
<tr>
<td>170-180</td>
<td>1&quot;</td>
<td>1&quot;</td>
</tr>
<tr>
<td>140-160</td>
<td>1&quot;</td>
<td>1&quot;</td>
</tr>
<tr>
<td>100-130</td>
<td>1&quot;</td>
<td>1&quot;</td>
</tr>
</tbody>
</table>

Note:
1. The above table is only applicable to insulations in the conductivity range of 0.23 to 0.25. For insulation outside these conductivity ranges, the minimum thickness (T) shall be determined by the following calculation and the calculation submitted for approval:

\[ T = r \left(1 + \frac{t}{r}\right)^{K/k} - 1 \]

- **T** = Thickness
- **r** = Actual outside radius of pipe (in.)
- **t** = Insulation thickness per the above table
- **K** = Conductivity of alternate material
- **k** = Upper value of the Conductivity Range per the above table

**END OF SECTION**
SECTION 221116
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. [Provide piping, valves, fittings and related products as listed on Drawings and described herein. All products to be purchased from Ferguson Enterprises.]

B. Section Includes:
   1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
   2. Encasement for piping.

C. Related Section:
   1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and fittings.
   2. Division 22 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.

B. Provide components and installation capable of producing domestic water piping systems with 80 psig, unless otherwise indicated.

1.3 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.


C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

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

B. Comply with NSF 61 and NSF 372 for potable domestic water piping and components.

C. Installer Qualifications:
1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings. Provide proof of training with Installer’s Credential Card.

1.5 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 Architect, Construction Manager and 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.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

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

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.

B. [Copper or Bronze Pressure-Seal Fittings:]

1. Manufacturers:
   a. Elkhart Products (Apolloxpress).
   b. NIBCO Inc. (Press System).
   c. Viega (ProPress).

2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer’s special tools.
5. Minimum 200-psig working-pressure rating at 250 deg F.
6. Smart Connect feature to guarantee identification of unpressed connections during the testing process.

C. [Deductive Alternate: Provide separate price for Copper or Bronze Pressure-Seal Fittings:]

1. Manufacturers:
   a. Viega (ProPress).

2. Housing: Copper

3. Fittings:
b. Size ½-inch thru 4-inch for use with ASTM B88 copper tube type K, L, or M and ½-inch up to include 1-1/4-inch annealed copper tube. EPDM sealing element.
c. Size 2-1/2-inch thru 4-inch shall have a 420 stainless steel grip ring, PBT separator ring, EPDM sealing element.

4. Tools: Manufacturer's special tools.
5. Minimum 200-psig working-pressure rating at 250 deg F.
6. Smart Connect feature to guarantee identification of unpressed connections during the testing process.
7. Grooved-Joint Copper-Tube Appurtenances:
   a. Manufacturers:
      1) Anvil International.
      2) Shurjoint Piping Products.
      3) Victaulic Company.
   b. Copper Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
   c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include rigid angled bolt pad design, ferrous housing sections, flush-seal grade E or installation-ready grade EHP gasket suitable and NSF 61 and NSF 372 approved for cold and hot water, and bolts and nuts.

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

2.2 DUCTILE-IRON PIPE AND FITTINGS
A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.

2.3 STAINLESS STEEL PIPE AND FITTINGS
A. Stainless Steel Pipe: ASTM A312, Type [304/304L] [316/316L], Sch. 10S, pipe, dimensions conforming to ANSI/ASME B36.19M-1085.
   1. Stainless Steel Pressure-Seal:
      a. Manufacturers:
         1) Victaulic Company of America (Vic-Press).
         2) Viega.
      b. Pipe: NPS 2 (DN50) and smaller.
      c. Fittings: 304 / 316, ASTM A-312 stainless steel housings with ASTM A-276 and A-312 outlets austenitic stainless steel plain or grooved ends, type 304, complete with synthetic rubber Grade “H” (HNBR) seals rated for
applicable services to +210 Deg F [+98 Deg C]; Grade “E” EPDM for applicable services to +250 Deg F [+120 Deg C]. System shall be rated to 500 psi (3447 kPa) unless noted otherwise. NSF 61 rated for hot and cold water services, NSF 372 rated lead free.]

2. [Deductive Alternate: Provide separate price for Stainless Steel Pressure-Seal:

   a. Manufacturers:

      1) Viega.

   b. Pipe: NPS 2 (DN50) and smaller.

   c. Fittings: 304 / 316, ASTM A-312 stainless steel housings with ASTM A-276 and A-312 outlets and austenitic stainless steel plain or grooved ends, type 304, complete with synthetic rubber Grade “H” (HNBR) seals rated for applicable services to +210 Deg F [+98 Deg C]; Grade “E” EPDM for applicable services to +250 Deg F [+120 Deg C]. System shall be rated to 500 psi (3447 kPa) unless noted otherwise. NSF 61 rated for hot and cold water services, NSF 372 rated lead free.]

3. Grooved Joint Stainless Steel Pipe Appurtenances:

   a. Manufacturers:

      1) Victaulic Company.

      2) Anvil International.

      3) Shurjoint Piping Products.

   b. Pipe: Roll groove stainless steel pipe with grooving tools specifically designed for stainless steel pipe.

   c. Grooved-End Couplings: Hot dip galvanized ductile iron conforming to ASTM A-536, grade 65-45-12 housing and synthetic EPDM gasket of central cavity pressure-response design; with nuts, bolts, locking pin, locking toggle or lugs to secure grooved pipe and fittings. NSF 61 rated for hot and cold water service, NSF 372 rated lead free.

      1) Flange Adapters: For use with stainless steel grooved end pipe and fittings, for mating to ANSI Class 150 raised-face flanges.

2.4 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.
2.5 ENCASEMENT FOR PIPING
A. Standard: ASTM A 674 or AWWA C105.
B. Form: Sheet or Tube.
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.

2.6 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.

2.7 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. Sleeve-Type Transition Coupling: AWWA C219.
   1. Manufacturers:
      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.

2.8 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:
      a. EPCO Sales, Inc.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
d. 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-Flange Kits:

1. Manufacturers:
   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] <Insert pressure>.
   c. Gasket: Neoprene or phenolic.
   d. Bolt Sleeves: Phenolic or polyethylene.
   e. Washers: Phenolic with steel backing washers.

D. Dielectric Couplings:

1. Manufacturers:
   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.

E. Dielectric Nipples:

1. Manufacturers:
   a. Perfection Corporation; a subsidiary of American Meter Company.
   b. Precision Plumbing Products, Inc.
   c. Victaulic Company.

2. Description:
   a. Copper-Silicon nipple complying with ASTM F 1545.
   b. Pressure Rating: [300 psig at 225 deg F] <Insert pressure and temperature>.
   c. End Connections: Male threaded or grooved.
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 ductile-iron pipe in PE encasement according to ASTM A674 or AWWA C105.

E. Install shutoff valve, hose-end drain valve, strainer and pressure gage 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 domestic water piping level with 0.25 percent slope downward toward drain and plumb.

G. 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.

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

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

J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

K. Install piping adjacent to equipment and specialties to allow service and maintenance.

L. Install piping to permit valve servicing.

M. 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.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.
P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

Q. 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.

R. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results for Plumbing."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

D. 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."

E. [Pressure-Sealed Joints:

1. Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.
2. Sealing element shall be verified for the intended use.
3. Tube ends shall be cut on a right angle (square) to the tube.
4. Tube ends shall be reamed and chamfered, all grease, oil or dirt shall be removed from the tube end with a clean rag.
5. Visually examine the fitting sealing element to ensure there is no damage, and it is properly seated into the fitting.
6. Utilizing an Insertion Depth Inspection Gauge mark the tube wall, with a felt tip pen, at the appropriate location, or insert the tube fully into the fitting and mark the tube wall at the face of the fitting.
7. Always examine the tube to ensure it is fully inserted into the fitting prior to pressing the joint.
8. Pressure-seal fittings ½-inch thru 4-inch shall be joined using appropriate sized tools.
9. Pressure-seal fittings shall be installed according to the most current edition of the Manufacturer's installation guidelines.]

1. All grooved components (including couplings, fittings, valves and accessories) to be supplied by one manufacturer. Grooving tools shall be of the same manufacturer as the groove components.

2. Grooving tools shall be equipped with roll sets specifically designed for pipe material. (Flaring of tube or fitting ends to accommodate IPS sized couplings is not permitted.)

3. A factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools, application of groove, and product installation. Factory representative shall periodically visit the job site and review installation. Contractor shall remove and replace any improperly installed products.

G. 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.

H. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems and provide Dielectric isolator.

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 valves for piping NPS 2 and smaller. Use butterfly valves for piping NPS 2-1/2 and larger.

C. Install hose end 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."

D. Install automatic balancing valves in each hot-water circulation return branch. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for automatic balancing valves.

E. Install automatic balancing valves with a strainer upstream and a check valve immediately downstream.

3.5 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. NPS 2 and Larger: Sleeve-type coupling.

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, nipples or unions.

C. Dielectric Fittings for NPS 2-1/2: Use dielectric flange kits.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

3.8 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.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

3.10 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. Perform the following tests on pressure-seal piping:

1. After fittings have been installed a “two step test” shall be followed.
   
   a. Pressurize the system with application appropriate test medium, water between 15 and 85 psi, or air/dry nitrogen between .5 and 45 psi.
   
   b. Check the pressure gauge for pressure loss.
   
   c. If the system does not hold pressure, walk the system and check for unpressed fittings.
   
   d. Should an un-pressed fitting/s be identified, ensure the tube is fully inserted into the fitting, and properly marked, prior to pressing the joint.
   
   e. After appropriate repairs have been made, retest the system per local code, or specification requirements, not to exceed 600 psi with water.]

E. Domestic water piping will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.11 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. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.12 CLEANING

A. Clean and disinfect potable and 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 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 for testing in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

3.13 PIPING SCHEDULE

A. [Where pressure-seal joints are indicated in the applications below, refer to Part 2: Deductive Alternate for pricing requirements.]
B. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
C. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
D. Under-building-slab, domestic water, building-service entrance piping, NPS 8 and smaller, shall be the following:
   1. Mechanical-joint, ductile-iron pipe; standard-pattern mechanical-joint fittings; and mechanical joints.
E. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type k; No joints below grade.
F. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L ASTM B 88; cast- or wrought- copper solder-joint fittings; and soldered joints.
   2. [Hard copper tube, ASTM B 88, Type L; copper pressure-seal fittings; and pressure-seal joints.]
   3. [Stainless steel pipe, ASTM A312, schedule 10S; stainless steel pressure-seal fittings; and pressure-seal joints.]
G. Aboveground domestic water piping, NPS 2 1/2 and larger, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L ASTM B 88; cast- or wrought- copper solder-joint fittings; and soldered joints.
   2. [Hard copper tube, ASTM B 88, Type L; copper pressure-seal fittings; and pressure-seal joints.]
3. Hard copper tube, ASTM B 88, Type L; grooved-joint copper-tube appurtenances; and grooved joints.
4. [Stainless steel pipe, ASTM A312, schedule 10S; grooved-joint stainless steel appurtenances; and grooved joints.]
5. [Stainless steel pipe, ASTM A312, schedule 10S; stainless steel pressure-seal fittings; and pressure-seal joints.]

H. Non-Potable-Water Piping: Use same materials as domestic water piping

3.14 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 valves for piping NPS 2 and smaller. Use butterfly valves with flanged [or grooved] ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly valves with flanged [or grooved] ends for piping NPS 2-1/2 and larger.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION
SECTION 221119
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. [Provide plumbing fixtures and drains as listed on Drawings and described herein. Fixture numbers are Zurn products. All products to be purchased from Ferguson Enterprises.]

B. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
5. Thermostatic mixing valves.
7. Outlet boxes.
8. Hose bibbs.
9. Wall hydrants.
10. Ground hydrants.
11. Drain valves.
12. Water hammer arresters.
13. Air vents.
15. Electrical trap-seal primer systems.

C. 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.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.
D. Operation and Maintenance Data: For domestic water piping specialties to include operation, and maintenance manuals.

1.4 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. NSF Compliance:
   2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."
   3. NSF Compliance: NSF 61-G for valve materials for potable-water service.

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Manufacturers:
      a. Conbraco Industries, Inc.
      b. FEBCO; SPX Valves & Controls.
      d. Zurn Plumbing Products Group; Wilkins Div.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   5. Inlet and Outlet Connections: Threaded.
   6. Finish: [Rough bronze] [Chrome plated].

B. Hose-Connection Vacuum Breakers:
   1. Manufacturers:
      a. Conbraco Industries, Inc.
      b. MIFAB, Inc.
      d. Woodford Manufacturing Company.
      e. Zurn Plumbing Products Group.
   5. Finish: Chrome or Rough bronze.

C. Pressure Vacuum Breakers:
1. Manufacturers:
   a. Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.
   d. Zurn Plumbing Products Group; Wilkins Div.
   e. Beeco, LLC.

3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Accessories:
   a. Valves: Ball type, on inlet.

D. Laboratory-Faucet Vacuum Breakers:

1. Manufacturers:
   a. Conbraco Industries, Inc.
   c. Woodford Manufacturing Company.
   d. Zurn Plumbing Products Group; Wilkins Div.

5. End Connections: Threaded.
6. Finish: Chrome plated.

E. Spill-Resistant Vacuum Breakers:

1. Manufacturers:
   a. Conbraco Industries, Inc.

3. Operation: Continuous-pressure applications.
4. Accessories:
   a. Valves: Ball type, on inlet.

2.2 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers:
   a. Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.
   c. Honeywell Water Controls.
   e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
5. End Connections: Union or solder joint.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers:
   a. Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.
   d. Zurn Plumbing Products Group; Wilkins Div.
   e. Beeco, LLC.

3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; [rising stem gate valve] [outside screw and yoke gate-type] with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Pressure Regulators:

1. Manufacturers:
   a. Conbraco Industries, Inc.
   b. Honeywell Water Controls.
   d. Zurn Plumbing Products Group; Wilkins Div.
   e. Beeco, LLC.

4. 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. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

B. Water Control Valves:

1. Manufacturers:
a. CLA-VAL Automatic Control Valves.

b. OCV Control Valves.

c. Watts Industries, Inc.; Watts ACV.

d. Zurn Plumbing Products Group; Wilkins Div.

e. Beeco, LLC.

2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve.

3. 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.

4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.

a. Pattern: Angle or Globe-valve design.

b. Trim: Stainless steel.

5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.4 BALANCING VALVES

A. Automatic Balancing Valves:

1. Manufacturers:


   b. Griswold Controls

2. Type: Ball valve with two readout ports and stainless steel flow regulating cartridge.


4. Size: Same as connected piping, but not larger than NPS 2.

5. Pressure Rating: 400-psig minimum CWP.


7. Seats and Seals: Replaceable.

8. End Connections: Solder joint or threaded.


10. Accuracy: plus or minus 5%

2.5 THERMOSTATIC MIXING VALVES

A. Thermostatic, Water Mixing Valves:

1. Manufacturers:

   a. Armstrong International, Inc. (RADA)

   b. Lawler Manufacturing Company, Inc.

   c. Leonard Valve Company.

   d. Powers; a Watts Industries Co.

   e. Symmons Industries, Inc.


4. Type: [Exposed-mounting] [Cabinet-type], thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded or union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
9. Valve Finish: [Chrome plated] [Polished, chrome plated] [Rough bronze].
10. Piping Finish: [Chrome plated] [Copper].
11. Cabinet: Factory-fabricated, stainless steel, for [recessed] [surface] mounting and with hinged, stainless-steel door.

B. Manifold, Thermostatic, Water-Mixing-Valve Assemblies:

1. Manufacturers:
   a. Leonard Valve Company.
   b. Powers; a Watts Industries Co.
   c. Symmons Industries, Inc.
   d. Armstrong International, Inc. (RADA)

2. Description: Factory-fabricated, [cabinet-type] [exposed-mounting], thermostatically controlled, water-mixing-valve assembly in [two] [three]-valve parallel arrangement.
3. Large-Flow Parallel: Thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.
6. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
7. Water Pressure Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
8. Component Pressure Ratings: 125 psig minimum, unless otherwise indicated.
10. Thermostatic Mixing Valve and Water Regulator Finish: [Chrome plated] [Polished, chrome plated] [Rough bronze].
11. Piping Finish: [Chrome plated] [Copper].

C. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Leonard Valve Company.
   b. Powers.
   c. Watts; a Watts Water Technologies company.
   d. Zurn Industries, LLC.

2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.020 inch.
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
   c. Strainers NPS 5 and Larger: 0.10 inch.

2.7 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers:
   b. Guy Gray Manufacturing Co., Inc.
   c. IPS Corporation. (Guy Gray)
   d. Oatey.
   e. Symmons Industries, Inc.
   g. Whitehall Manufacturing; a div. of Acorn Engineering Company.
   h. Zurn Plumbing Products Group.
4. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Supply Shutoff Fittings: NPS 1/2 ball valves and NPS 1/2 copper, water tubing.
6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.

B. Icemaker Outlet Boxes:

1. Manufacturers:
   b. IPS Corporation. (Guy Gray)
   c. Oatey.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 ball valve and NPS 1/2 copper, water tubing.
2.8  HOSE BIBBS

A.  Hose Bibbs:

   5.  Outlet Connection:  Garden-hose thread complying with ASME B1.20.7.
   8.  Refer to Plumbing Fixture Schedule on drawings for finishes.

2.9  WALL HYDRANTS

A.  Nonfreeze Wall Hydrants:

   1.  Manufacturers:

      b.  MIFAB, Inc.
      d.  Tyler Pipe; Wade Div.
      e.  Watts Drainage Products Inc.
      f.  Woodford Manufacturing Company.
      g.  Zurn Plumbing Products Group.

   2.  Standard:  ASME A112.21.3M for [concealed] [exposed]-outlet, self-draining wall hydrants.
   4.  Operation:  Loose key.
   5.  Casing and Operating Rod:  Of length required to match wall thickness.  Include wall clamp.
   6.  Inlet:  NPS 3/4 [or NPS 1].
   7.  Outlet:  Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
   8.  Box:  Deep, flush mounting with cover.
  10.  Operating Keys(s):  One with each wall hydrant.
  11.  Refer to Plumbing Fixture Schedule on drawings for finishes.

B.  Nonfreeze, Hot- and Cold-Water Wall Hydrants:

   1.  Manufacturers:

      c.  Tyler Pipe; Wade Div.
      d.  Watts Drainage Products Inc.
      e.  Woodford Manufacturing Company.
      f.  Zurn Plumbing Products Group.
2. Standard: ASME A112.21.3M for [concealed] [exposed]-outlet, self-draining wall hydrants.
4. Operation: Loose key.
5. Casings and Operating Rods: Of length required to match wall thickness. Include wall clamps.
7. Outlet: Concealed.
8. Box: Deep, flush mounting with cover.
10. Operating Keys(s): One with each wall hydrant.
11. Refer to Plumbing Fixture Schedule on drawings for finishes.

2.10 DRAIN VALVES
A. Ball-Valve-Type, Hose-End Drain Valves:
   2. Pressure Rating: 400-psig minimum CWP.
   3. Body: Copper alloy.
   4. Ball: Chrome-plated brass.
   5. Seats and Seals: Replaceable.
   7. Inlet: Threaded or solder joint.
   8. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.11 WATER HAMMER ARRESTERS
A. Water Hammer Arresters:
   1. Manufacturers:
      b. MIFAB, Inc.
      c. PPP Inc.
      d. Sioux Chief Manufacturing Company, Inc.
      e. Tyler Pipe; Wade Div.
      f. Watts Drainage Products Inc.
      g. Zurn Plumbing Products Group.
   3. Type: Copper tube with piston.
   4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.12 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.
5. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
5. Inlet and Vent Outlet End Connections: Threaded.

2.13 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

1. Manufacturers:
   a. MIFAB, Inc.
   b. PPP Inc.
   c. Sioux Chief Manufacturing Company, Inc.
   e. Watts Industries, Inc.; Water Products Div.

5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Distribution box as required.
8. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.14 ELECTRIC TRAP-SEAL PRIMER SYSTEMS

A. Electric Trap-Seal Primer Systems:

1. Manufacturers:
   a. PPP Inc.
   b. MIFAB, Inc.

2. Standard: ASSE 1044,
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: [Recessed] [Surface]-mounting steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
7. Number Outlets: as indicated on drawings.
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. 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.

2. Do not install bypass piping around backflow preventers.

C. Install water pressure 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 thermostatic mixing valves with check stops or shutoff valves and strainers on inlets and with shutoff valve on outlet.

1. Install thermometers on inlets and outlet 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 control valve, water pressure-reducing valve, solenoid 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 and drawings.

J. Install air vents at high points of water piping. Install drain piping and discharge to 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.

L. Install electric trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Intermediate atmospheric-vent backflow preventers.
3. Reduced-pressure-principle backflow preventers.
5. Pressure-reducing valves.
6. Automatic balancing valves.
7. Thermostatic mixing valves.
10. Supply-type, trap-seal primer valves.
11. Electric trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer, double-check backflow-prevention assembly and vacuum breaker assembly 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.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Confirm flow rate and direction of flow for automatic balancing valves.

C. Set field-adjustable temperature set points of thermostatic mixing valves.

END OF SECTION
SECTION 221123
DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic hot-water circulation:
   2. Close-coupled, vertically mounted, in-line centrifugal pumps.

B. Related Sections include the following:
   1. Division 22 Section "Domestic-Water Packaged Booster Pumps" for booster systems.

1.2 SUBMITTALS

A. Simultaneous Action Submittals: Domestic water pumps Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section "Overcurrent Protective Device Coordination Study." The release of plumbing equipment submittals is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Submittal Procedures” to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor’s failure to coordinate simultaneous action submittals will not be considered by the Owner.

B. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

C. Shop Drawings:
   1. Diagram power, signal, and control wiring.
   2. Short-circuit current rating of equipment assembly.

D. Operation and Maintenance Data: For domestic water pumps to include in emergency, operation, and maintenance manuals.

1.3 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. UL Compliance: Comply with UL 778 for motor-operated water pumps.
1.4 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Pump Manufacturers:

1. Armstrong Pumps Inc.
2. Aurora Pump; Pentair Pump Group (The).
3. Bell & Gossett Domestic Pump; ITT Industries.
4. Grundfos Pumps Corp.
5. Paco Pumps, Inc.
7. Taco, Inc.
8. Thrush Company, Inc.

2.2 Ratings:

A. Short-Circuit Current: Match rating of overcurrent protective device serving domestic water pumps.

B. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

2.3 CLOSE-COUPLERED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, overhung impeller, single-stage, close-coupled, horizontally mounted, in-line centrifugal pumps as defined in ANSI HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.

1. Pump Construction: All bronze.
   a. Casing: Radially split, cast iron, with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
   c. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
   d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
   e. Bearings: Oil-lubricated; bronze-journal or ball type.
2. Shaft Coupling: Rigid type if pump is provided with coupling.
3. Motor: Single speed, with grease-lubricated ball bearings. Comply with requirements in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

B. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.4 CLOSE-COUPLLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, overhung impeller, single-stage, close-coupled, vertically mounted, in-line centrifugal pumps as defined in ANSI HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted vertically.

1. Pump Construction: Bronze fitted.
   a. Casing: Radially split, cast iron, with wear rings and threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
   c. Shaft and Shaft Sleeve: Stainless-steel shaft, with copper-alloy shaft sleeve.
   d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
   e. Bearings: Oil-lubricated; bronze-journal or ball type.
2. Shaft Coupling: Rigid type if pump is provided with coupling.
3. Motor: Single speed, with grease-lubricated ball bearings; and directly mounted to pump casing. Comply with requirements in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

B. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.5 CONTROLS

A. Aquastats: Electric; adjustable for control of hot-water circulation pump.

1. Manufacturers:
   a. Honeywell International, Inc.
   b. Square D.
2. Type: Water-immersion sensor, for installation in hot-water circulation piping.
3. Range: 65 to 200 deg F.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
7. Settings: Start pump at 115 deg F and stop pump at 120 deg F.

B. Timers: Electric time clock for control of hot-water circulation pump.
1. Manufacturers:
   a. Honeywell International, Inc.
   b. Intermatic, Inc.
   c. Johnson Controls, Inc.
   d. TORK.

2. Type: Programmable, seven-day clock with manual override on-off switch.
3. Enclosure: Suitable for wall mounting.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
7. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

C. Time Delay Relay: Control for hot-water storage tank circulation pump.

1. Manufacturers:
   a. Honeywell International, Inc.
   b. Intermatic, Inc.
   c. Johnson Controls, Inc.
   d. Square D.
   e. White-Rodgers Div.; Emerson Electric Co.

2. Type: Adjustable time delay relay.
3. Range: Up to five minutes.
4. Setting: Five minutes.
5. Operation of Pump: On or off.
6. Transformer: Provide if required.
8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation plus maximum five minutes after the burner stops.

2.6 BUILDING-AUTOMATION-SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:

1. On-off status of each pump.
2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with ANSI HI 1.4.
B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install close-coupled, horizontally mounted, in-line centrifugal pumps with motor and pump shafts horizontal.

E. Install continuous-thread hanger rods and spring hangers [with vertical-limit stop] of sufficient size to support pump weight. Vibration isolation devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

3.3 CONTROL INSTALLATION

A. Install immersion-type aquastats in hot-water return piping.

B. Install timers.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 Section "Domestic Water Piping."

1. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for domestic water piping and Division 22 Section "Domestic Water Piping Specialties" for strainers.

2. Install pressure gages at suction and discharge of pumps. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and gage connectors.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect aquastats and timers to pumps that they control.

F. Interlock pump with water heater burner and time delay relay.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set aquastats and timers for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:
   
a. Verify bearing lubrication.
b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
c. Verify that pump is rotating in the correct direction.
6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 221123.13
DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes variable-speed, multiplex, packaged booster pumps for domestic water piping systems.

B. Related Sections include the following:
   1. Division 22 Section "Domestic Water Pumps" for domestic water circulation pumps.
   2. [Division 23 section “Variable-Frequency Drives”]
   3. [Division 26 section "Variable-Frequency Drives”]

1.2 SUBMITTALS

A. Product Data: For each packaged booster pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: For packaged booster pumps and accessories. Include plans, elevations, sections, details, and attachments to other work.
   1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
   4. Wiring Diagrams: Detail power, signal, and control wiring.
   5. Short-circuit current rating of controller assembly.

C. Manufacturer Seismic Qualification Certification: Submit certification that packaged booster pumps, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment.” Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Operation and Maintenance Data: For each packaged booster pump to include in emergency, operation, and maintenance manuals.

1.3 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged booster pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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. ASME Compliance: Comply with ASME B31.9 for piping.

D. Packaged booster pumps shall be listed and labeled as pumping systems by testing agency acceptable to authorities having jurisdiction.

1. The pumping package components shall be certified by an approved independent testing and certification organization as being compliant with the requirements of NSF/ANSI 61 for potable drinking water and NSF-61 Annex G for low lead content.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 VARIABLE-SPEED, MULTIPLEX BOOSTER PUMPS

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

1. Bell & Gossett; a Xylem brand.
2. Canariis Corporation.
3. Grundfos Pumps Corporation U.S.A.
4. SyncroFlo, Inc.
5. TIGERFLOW Systems, Inc.
B. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.

C. System Working-Pressure Rating: [150 psig] [175 psig] minimum.

D. Pump Arrangement: [Duplex, with two equal-size pumps] [Triplex, with one small lead and two large equal-size lag main pumps] [Triplex, with three equal-size pumps].

E. Pumps:
   1. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
   2. Casing: Radially split; [bronze] [cast iron] [stainless steel].
   3. Impeller: Closed, [ASTM B 584 cast bronze] [stainless steel]; statically and dynamically balanced and keyed to shaft.
   4. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
   5. Seal: Mechanical.
   6. Orientation: Mounted [horizontally] [or] [vertically].

F. Pumps:
   1. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, frame-mounted, separately coupled, single-stage, overhung-impeller, centrifugal pump.[Include back-pullout design.]
   2. Casing: Radially split; [bronze] [cast iron] [stainless steel].
   3. Impeller: Closed, [ASTM B 584 cast bronze] [stainless steel]; statically and dynamically balanced and keyed to shaft.
   4. Shaft and Shaft Sleeve: Stainless-steel shaft, with copper-alloy shaft sleeve and deflector.
   5. Seal: Mechanical.
   7. Coupling: Flexible, with metal guard.

G. Pumps:
   1. Type: In line, single stage as defined in HI 1.1-1.2 and HI 1.3 for in-line, single-stage, close-coupled, overhung-impeller, centrifugal pump.
   2. Casing: Radially split; [bronze] [cast iron] [stainless steel].
   3. Impeller: Closed, [ASTM B 584 cast bronze] [stainless steel]; statically and dynamically balanced and keyed to shaft.
   4. Shaft and Shaft Sleeve: Stainless-steel shaft, with copper-alloy shaft sleeve.
   5. Seal: Mechanical.

H. Pumps:
   1. Type: Vertical, multistage as defined in HI 1.1-1.2 and HI 1.3 for in-line, multistage, separately coupled, overhung-impeller, centrifugal pump.
   2. Casing: Cast-iron or steel base and stainless-steel chamber.
   3. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
   5. Seal: Mechanical.

I. Pumps:

Midwestern State University
Health Science & Human Services Center
RSA Project No. 1612.00

DOMESTIC-WATER
PACKAGED BOOSTER
PUMPS
GMP Documents
July 7, 2017
1. Type: Vertical, multistage can, as defined in HI 2.1-2.2 and HI 2.3 for in-line, barrel or can, lineshaft, vertical pump.
2. Impeller: Closed, ASTM B 584, cast bronze or 304/316 stainless steel; statically and dynamically balanced and keyed to shaft.
3. Bowls: [Epoxy-coated cast iron] [stainless steel].
5. Seals: Mechanical and stuffing-box types.

J. Motors: Single speed, with grease-lubricated, ball-type bearings. Select motors that will not overload through full range of pump performance curve.

K. Piping: ASME B31.9 for piping materials and installation. [Copper tube and copper fittings] [Stainless-steel pipe and fittings] [Stainless-steel pipe and fitting headers and copper tube and copper fittings between headers and pump]. [Piping, including valves and other components, may have grooved ends for grooved joints.]

L. Valves:
   1. Shutoff Valves NPS 2 and Smaller: two-piece, full-port ball valve, in each pump's suction and discharge piping.
   2. Shutoff Valves NPS 2-1/2 and Larger: lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers.
   3. Check Valves NPS 2 and Smaller: Silent or swing type in each pump's discharge piping.
   4. Check Valves NPS 2-1/2 and Larger: Silent type in each pump's discharge piping.
   5. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

M. Dielectric Fittings: With insulating material isolating joined dissimilar metals.

N. Control Panel: Factory installed and connected as an integral part of booster pump complying with NEMA ICS 2 and UL 508; automatic for multiple-pump, variable-speed operation, with load control and protection functions.
   1. Control Logic: Solid-state system with transducers, programmable microprocessor, VFD, and other devices in controller. Install VFD for pump motors larger than 25 hp in separate panel; same type as motor control panel enclosure.
      a. Control Voltage: 24 or 120-V ac, with integral control-power transformer.
   3. Enclosure: NEMA 250, [Type 1] [Type 3R] [Type 4] [Type 12].
   5. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.
      a. [Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.]
      b. [Triplex, Sequence (Lead-Lag-Lag) Starter: Switches lead pump to one lag main pump and to three-pump operation.]
   6. Pump Operation and Sequencing: [Pressure-sensing method] [or] [flow-sensing method] [Pressure-sensing method for lead pump and flow-sensing method for lag pumps].
a. Time Delay: Controls pump on-off operation; adjustable from [1 to 300] <Insert value> seconds.

7. VFD: Voltage-source, pulse-width, modulating-frequency converter for each pump.
8. Manual Bypass: Magnetic contactor arranged to transfer to constant-speed operation upon VFD failure.
10. Lights: Running light for each pump.
11. Alarm Signal Device: Sounds alarm when backup pumps are operating.

a. Time Delay: Controls alarm operation; adjustable from [1 to 300] <Insert value> seconds, with [automatic] [manual] reset.

12. Thermal-bleed cutoff.
13. [Low-suction-pressure] [Water-storage-tank, low-level] cutout.
15. High-discharge-pressure cutout.
16. Short Circuit Current Rating

a. Short-Circuit Current: Match rating of overcurrent protective device serving domestic water packaged booster pumps.
b. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

O. Base: Structural steel.

P. Manufacturer’s Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembling and testing. Protect flanges, pipe openings, and pump nozzles.

Q. Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.2 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Anamet, Inc.
2. Flex-Hose Co., Inc.
3. Hyspan Precision Products, Inc.
4. Metraflex, Inc.
5. Unaflex Inc.

B. Description: Corrugated, bronze inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze-welded to tubing. Include [150-psig] [175-psig] minimum working-pressure rating and ends according to the following:

1. Provide ends to match pump or system connections and pressure rating.
2.3 FACILITY MANAGMENT SYSTEM INTERFACE

A. The following communication features shall be provided to the Building Automation System via an onboard RS-485 port utilizing Johnson Controls Metasys N2, Modicon Modbus or BACnet MS/TP protocol:

1. All sensor process variables
2. Individual zone setpoints
3. Individual pump failure
4. Individual pump on/off status
5. Individual VFD on/off status
6. VFD speed
7. Individual VFD Failure
8. Individual sensor failure

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for packaged booster pumps to verify actual locations of connections before booster pump installation.

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for packaged booster pumps. Refer to Division 22 Section "Common Work Results for Plumbing."

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 BOOSTER PUMP INSTALLATION

A. Install packaged booster pumps level on concrete bases with access for periodic maintenance including removal of pumps, motors, impellers, couplings, and accessories.

1. Do not dismantle packaged booster pumps or remove individual components.

B. Vibration Isolation: Install on spring isolators. Vibration isolation devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

C. Support connected domestic water piping so weight of piping is not supported by packaged booster pumps.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect domestic water piping to packaged booster pumps. Install suction and discharge pipe equal to or greater than size of unit suction and discharge headers.
1. Install flexible connectors on piping connections to unit suction and discharge headers. Install flexible connectors same size as piping.
2. Install shutoff valves on piping connections to each booster pump suction and discharge headers. Install ball, butterfly, or gate valves same size as suction and discharge headers. General-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
3. Install union or flanged connections on pump suction and discharge headers at connection to domestic water piping.
4. Install piping adjacent to packaged booster pumps to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform the following startup service:
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers if any.
   4. Verify that pump controls are correct for required application.
   5. Verify that vibration isolator springs are not completely compressed.

B. Perform the following startup checks for each pump of packaged booster pump unit before starting:
   1. Verify bearing lubrication.
   2. Prime pumps by opening suction valves and closing discharge valves, and prepare pumps for operation.
   3. Start motors and Open discharge valves slowly.
   4. Adjust settings.

C. Start-up shall not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the owner or owner's designated representative. This job site visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting packaged booster pumps to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.6 LABELING AND IDENTIFICATION

A. Install identifying equipment markers and equipment signs on booster pumps. Labeling and identification materials are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."
3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged booster pumps. Refer to Division 01 Section "Demonstration and Training"

B. The system manufacturer's factory qualified representative shall be capable of providing on-site training for owner's personnel. This training shall fully cover maintenance and operation of all system components.

END OF SECTION
SECTION 221323
SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of interceptors outside the building:

1. Grease interceptors.
2. Oil interceptors.
4. Sediment interceptors.

1.2 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.
B. HDPE: High-density polyethylene plastic.
C. PE: Polyethylene plastic.
D. PP: Polypropylene plastic.

1.3 SUBMITTALS

A. Product Data: For each type of interceptor indicated. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

B. Shop Drawings: For each type and size of precast concrete interceptor indicated.

1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

C. Coordination Drawings: Interceptors, 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. Interceptors.
2. Piping connections. Include size, location, and elevation of each.
3. Interface with underground structures and utility services.

1.4 PROJECT CONDITIONS

A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:
1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of service.
2. Do not proceed with interruption of sewer services without Owner's written permission.

**PART 2 - PRODUCTS**

### 2.1 GREASE INTERCEPTORS

A. Grease Interceptors: Precast concrete complying with ASTM C 913. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.

1. **Protective Coating:** Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all exterior and interior concrete surfaces.
2. **Structural Design Loads:**
   a. **Heavy-Traffic Load:** Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
3. **Resilient Pipe Connectors:** ASTM C 923, cast or fitted into interceptor walls, for each pipe connection.
4. **Grade Rings:** Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
5. **Manhole Frames and Covers:** Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
   a. Include indented top design with lettering cast into cover, using wording equivalent to "GREASE INTERCEPTOR."

B. Grease Interceptor Capacity and Characteristics: REFER TO DRAWINGS

### 2.2 OIL INTERCEPTORS

A. Oil Interceptors: Precast concrete comply with ASTM C 913. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.

1. **Protective Coating:** Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all exterior and interior concrete surfaces.
2. **Structural Design Loads:**
   a. **Heavy-Traffic Load:** Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
3. **Resilient Pipe Connectors:** ASTM C 923, cast or fitted into interceptor walls, for each pipe connection.
4. **Grade Rings:** Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
5. **Manhole Frames and Covers:** Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
   a. Include indented top design with lettering cast into cover, using wording equivalent to "OIL INTERCEPTOR."
6. Waste-oil storage tank and piping are specified in Division 23 Section "Facility Fuel-Oil Piping."

B. Oil Interceptors: Factory-fabricated, cast-iron or steel body; with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.

1. Manufacturers:
   b. MIFAB Manufacturing Inc.
   c. Rockford Sanitary Systems, Inc.
   e. Wade Div.; Tyler Pipe.
   f. Watts Industries, Inc.
   g. Zurn Specification Drainage Products; Zurn Plumbing Products Group.

2. Inlet, Outlet, Vent, and Waste-Oil Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.

3. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.

4. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C 890, [A-03, walkway] <Insert other> load.

5. Protective Coating: Factory-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all ferrous surfaces, except basket or strainer, unless otherwise indicated.

6. Waste-oil storage tank and piping are specified in Division 23 Section "Facility Fuel-Oil Piping."

C. Oil Interceptor Capacity and Characteristics: REFER TO DRAWINGS

2.3 SAND INTERCEPTORS

A. Description: Factory-fabricated, cast-iron or steel body and inlet grate; with settlement chamber and removable basket or strainer.

1. Manufacturers:
   a. MIFAB Manufacturing Inc.
   b. Rockford Sanitary Systems, Inc.
   d. Wade Div.; Tyler Pipe.

B. Outlet Piping Connection: Hub, hubless, or threaded, unless otherwise indicated.

C. Grate: Cast iron or steel with reinforcement to provide ASTM C 890, [A-03, walkway] <Insert other> load.

D. Protective Coating: Factory-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all exterior and interior ferrous surfaces except basket or screens.

E. Sand Interceptor Capacity and Characteristics: REFER TO DRAWINGS
2.4 SEDIMENT INTERCEPTORS

A. Sediment Interceptors: Precast concrete comply with ASTM C 913. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.

2. Structural Design Loads:

3. Resilient Pipe Connectors: ASTM C 923, cast or fitted into interceptor sidewalls, for each pipe connection.
4. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
5. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
   a. Include indented top design with lettering cast into cover, using wording equivalent to the following:
      1) Sediment Interceptors in Sanitary or storm Sewerage System: “SEDIMENT INTERCEPTOR.”

6. Cast Ferrous Gratings: Frame and flat grate with small-square or short slotted drainage openings.
   a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
   c. Minimum Size: 24 by 24 inches, unless otherwise indicated.
   d. Free Area: Approximately 50 percent, unless otherwise indicated.

B. Sediment Interceptors: Factory-fabricated, cast-iron or steel body and cover; with settlement chambers; baffles; and removable basket, strainer, or screens.

1. Manufacturers:
   b. MIFAB Manufacturing Inc.
   c. Rockford Sanitary Systems, Inc.
   e. Wade Div.; Tyler Pipe.
   f. Watts Industries, Inc.
   g. Zurn Specification Drainage Products; Zurn Plumbing Products Group.

2. Inlet and Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.
3. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
4. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C 890. [A-03, walkway] <Insert other> load.
5. Protective Coating: Factory-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all ferrous surfaces except basket or strainer.
C. Sediment Interceptor Capacity and Characteristics: REFER TO DRAWINGS

2.5 PRECAST CONCRETE MANHOLE RISERS

A. Precast Concrete Manhole Risers: ASTM C 913, 36-inch ID. Include rubber-gasketed joints.

1. Structural Design Loads:

2. Length: From top of underground concrete structure to grade.
3. Riser Sections: 3-inch minimum thickness and 36-inch diameter.
4. Top Section: Eccentric cone, unless otherwise indicated. Include top of cone to match grade ring size.
5. Gaskets: ASTM C 443, rubber.
6. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12-to 16-inch intervals.

B. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.

C. Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all exterior and interior concrete surfaces.

D. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 22 Section "Earth Moving."

3.2 INSTALLATION

A. Install interceptor inlets and outlets at elevations indicated.

B. Install precast concrete interceptors according to ASTM C 891. Set level and plumb.

C. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

D. Set tops of manhole frames and covers flush with finished surface in pavements. Set tops 3 inches above finish surface elsewhere, unless otherwise indicated.

E. Set tops of grating frames and grates flush with finished surface.
F. Clean and prepare concrete surfaces to be field painted. Remove loose efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen surface as required to remove glaze. Paint the following concrete surfaces as recommended by paint manufacturer:

1. Precast Concrete Interceptors: All exterior and interior.

G. Clean and prepare metal surfaces to be field painted according to SSPC-PA 1. Paint the following metal surfaces according to SSPC-PA 1 and SSPC-Paint 16:

1. Metal Interceptors: All surfaces except baskets, screens, and strainers.
2. Do not paint metal surfaces with factory-applied, corrosion-resistant coating.

H. Set metal interceptors level and plumb.

I. Set tops of metal interceptor covers flush with finished surface in pavements. Set tops 3 inches above finish surface elsewhere, unless otherwise indicated.

J. Prepare and paint metal components, to be field painted, according to SSPC-Paint 16.

K. Install piping and oil storage tanks according to Division 23 Section “Facility Fuel-Oil Piping.”

L. Repair and restore protective coatings to original condition.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

3.4 IDENTIFICATION

A. Identification materials and installation are specified in Division 22 Section “Earth Moving.” Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.

1. Use warning tapes or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION
1.1 SUMMARY

A. [Provide piping, valves, fittings and related products as listed on Drawings and described herein. All products to be purchased from Ferguson Enterprises.]

B. This Section includes the following storm drainage piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.
   3. Encasement for underground metal piping.

C. Related Sections include the following:
   1. Division 22 Section "Sump Pumps."
   2. Division 31 Section "Earth Moving".
   3. Division 33 Section "Storm Utility Drainage Piping."
   4. Division 22 Section "Common Work Results for Plumbing."
   5. Division 22 Section "General-Duty Valves for Plumbing Piping."

1.2 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water.
   2. Storm Drainage, Force-Main Piping: 100 psig.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:
   1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
C. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

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

B. All cast iron Piping and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and be listed with NSF international.

C. For below grade applications comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Extra-Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: Assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.


   a. Manufacturers:

      1) Husky SD 4000
      2) Clamp-All Corp.-125

2. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.

   a. Manufacturers:

      1) MG Piping Products Co.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight. Include ends matching joining method.
B. Drainage Fittings: ASME B16.12, threaded, cast-iron drainage pattern.

C. Pressure Fittings:
   1. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.

D. Grooved-Joint Systems:
   1. Manufacturers:
      
a. Anvil International.
b. Victaulic Co. of America.
c. Ward Manufacturing, Inc.
   2. Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, malleable-iron casting; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
   3. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. 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. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Gaskets: AWWA C111, rubber.

C. Grooved-Joint Systems:
   1. Manufacturers:
      
a. Victaulic Co. of America.
b. Ward Manufacturing, Inc.
c. Anvil International.
   3. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

D. Flanges: ASME 16.1, Class 125, cast iron.
2.5 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

2.6 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:
   b. Fernco, Inc.
   c. Logan Clay Products Company (The).
   d. Mission Rubber Co.
   e. NDS, Inc.

2. Sleeve Materials:
   b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Available Manufacturers:
   b. Mission Rubber Co.

C. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

1. Available Manufacturers:
   b. Dresser, Inc.; DMD Div.
   c. EBAA Iron Sales, Inc.
   d. Ford Meter Box Company, Inc. (The); Pipe Products Div.
   e. JCM Industries, Inc.
   f. Romac Industries, Inc.
   g. Smith-Blair, Inc.
   h. Viking Johnson.

2. Center-Sleeve Material: Manufacturer's standard.
3. Gasket Material: Natural or synthetic rubber.
4. Metal Component Finish: Corrosion-resistant coating or material.

D. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with
AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Available Manufacturers:
   a. EBAA Iron Sales, Inc.
   b. Romac Industries, Inc.
   c. Star Pipe Products; Star Fittings Div.

2.7 ENCASEMENT FOR FERROUS PIPING
   A. Standard: ASTM A 674 or AWWA C105.
   B. Form: Sheet or Tube.
   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 DRIP PANS
   A. Of not less than 14-gauge galvanized steel with raised sides and galvanized steel pipe nipple drains welded in place at low points.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS
   A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
   B. PVC piping shall not be used within occupied spaces or plenums of occupied spaces.
   C. Aboveground storm drainage piping shall be any of the following:
      1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
      2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.
      3. Steel pipe, drainage fittings, and threaded joints.
      4. Dissimilar Pipe-Material Couplings: Flexible, Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
   D. Underground storm drainage piping shall be any of the following:
      1. Extra-heavy class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
      2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
      3. Dissimilar Pipe-Material Couplings: Flexible, Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
   E. Aboveground storm drainage force mains shall be any of the following:
1. Steel pipe, pressure fittings, and threaded joints.
2. Grooved-end steel pipe, grooved-joint system fittings and couplings, and grooved joints.

F. Underground storm drainage force mains shall be any of the following:
   1. Steel pipe, pressure fittings, and threaded joints.
   2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical-joint joints.
   3. Pressure pipe couplings if dissimilar pipe materials or piping with small difference in OD must be joined.

3.2 PIPING INSTALLATION

A. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."

C. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

D. Install underground, steel, force-main piping.[Install encasement on piping according to ASTM A 674 or AWWA C105.]

E. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside 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.

F. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
   1. Install encasement on piping according to ASTM A 674 or AWWA C105.

G. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.

H. 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.

I. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. 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.

J. Lay buried building storm 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.
K. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
   1. Building Storm Drain: 1 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 Storm-Drainage Piping: 1 percent downward in direction of flow.

L. Install force mains at elevations indicated.

M. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

N. Install underground PVC storm drainage piping according to ASTM D 2321.

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

P. Hubless cast-iron piping 6” and larger shall be restrained at any direction change using blocks, rods, bracing or other suitable methods.

Q. Provide drip pans under waste lines concealed above operating, cysto and delivery rooms, cath labs, nurseries, food preparation centers, food serving facilities, food storage areas, central services, electronic data processing areas, electric and telecommunication closets, and other sensitive areas, or as shown on the plans. Pans shall be of galvanized steel, arranged to drain outside these areas, or as noted on Drawings.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results Plumbing."


D. Grooved Joints: Cut groove ends of pipe and assemble grooved ends of pipes, grooved-end fittings, and grooved-end-piping couplings according to AWWA C606.

E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 VALVE INSTALLATION

A. Shutoff Valves: Install shutoff valve on each sump pump discharge.
   1. Install gate or full-port ball valve for piping NPS 2 and smaller.
   2. Install gate valve for piping NPS 2-1/2 and larger.

B. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.

C. Backwater Valves: Install backwater valves in piping subject to backflow.
1. Horizontal Piping: Horizontal backwater valves. Use normally closed type.
2. Install backwater valves in accessible locations.
3. Backwater valve are specified in Division 22 Section "Storm Drainage Piping Specialties."

3.5 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."

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

D. Connect force-main piping to sump pump discharge.

3.7 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.
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.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. 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.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping 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.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. 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.

3.8 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.

END OF SECTION
SECTION 221415
FACILITY SUB SOIL DRAINAGE PIPING
PART 1 - GENERAL

1.1 SUMMARY

A. [Provide piping, valves, fittings and related products as listed on Drawings and described herein. All products to be purchased from Ferguson Enterprises.]

B. This Section includes the following sub soil drainage piping inside and outside the building:
   1. Pipe and fittings.
   2. Special pipe fittings.
   3. Wrapping of piping with geotextile screen material

C. Related Sections include the following:
   1. Division 22 Section "Sump Pumps."
   2. Division 31 Section "Earth Moving".
   3. Division 33 Section "Storm Utility Drainage Piping."
   4. Division 22 Section "Common Work Results for Plumbing."

1.2 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

B. PE: Polyethylene

1.3 SUBMITTALS

A. Product Data: For pipe, fittings, and drainage fabric.

B. Field quality-control inspection and test reports.

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 Manufacturers:
   1. ADS
   2. HANCOR

2.2 SUB-SOIL DRAINAGE PIPING
   A. Perforated pipe: ASTM F2648, high density polyethylene conforming with the minimum requirement of cell classifications 424420C, perforated pipe conforming to AASHTO class II perforations, with a smooth interior and annular exterior corrugations. With Bell and spigot fittings or plain end pipe with snap couplings complying with ASTM F2306.
   B. Solid Wall pipe: ADS heavy duty polyethylene pipe with joints of split or snap couplings meeting ASTM F2306.
   C. Filter Wrap: Geotex 401 polypropylene, staple fiber, needlepunched nonwoven geotextile manufactured by Propex Geosynthetics or equal. The material shall be resistant to ultraviolet degradation and to biological and chemical environments normally found in soils and conform to ASTM D-4491, ASTM D-4751 and ASTM D-4355.

2.3 CLEANOUTS
   A. 8" Nyloplast series 2708AG inline drain fitting with 8" diameter solid ductile iron grate model number 0899CGC.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS
   A. Sub-Soil Drainage Piping shall be the following:
      1. High density polyethylene perforated pipe with Bell and spigot fittings or plain ends.
   B. Sub-Soil Drainage Piping up to clean outs shall be the following:
      1. High density polyethylene solid wall pipe with split or snap coupling fittings.

3.2 PIPING INSTALLATION
   A. The Sub-Soil drainage piping shall follow the bottom of the grade beam with the flow line the same elevation as the bottom of the grade beam. In this case the piping shall be laid level with no slope. There shall be no low points in the system such that drainage is trapped.
   B. Make changes in direction for sub-soil drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees.
C. Install cleanouts at grade and extend to where sub-soil drains connect to sump pump. Polyethylene piping shall be extended up to grade at each turn of 90 degrees and at each run of piping of 100 feet or multiples of 100 feet. At each point where the piping is extended up to grade a cleanout will be installed to be able to flush the piping from that point to the point where the piping enters into the sump pump. The covers on the cleanouts shall be labeled for “sub-soil” drainage.

D. Install cleanouts in the direction of flow.

E. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

F. Wrap perforated piping with geotextile fabric as indicated on the drawings.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results Plumbing."

B. Assemble piping in accordance with ASTM D-2321, and manufacturers written instructions.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect sub-soil drainage piping to sump pump.

3.5 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.

   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.

3.6 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.
SECTION 221423

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. [Provide plumbing fixtures and drains as listed on Drawings and described herein. Fixture numbers are Zurn products. All products to be purchased from Ferguson Enterprises.]

B. This Section includes the following storm drainage piping specialties:
   1. Backwater valves.
   2. Cleanouts.
   3. Trench drains.
   4. Through-penetration firestop assemblies.
   5. Roof drains.
   6. Miscellaneous storm drainage piping specialties.

C. Related Sections include the following:
   1. Division 07 Section "Sheet Metal Flashing and Trim"

1.2 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.5 COORDINATION

A. Coordinate size and location of roof penetrations.
PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Manufacturers:

2. MIFAB, Inc.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.
7. NDS Inc.
8. Oatey.

B. Horizontal, Cast-Iron Backwater Valves:

2. Size: Same as connected piping.
4. Cover: Cast iron with bolted or threaded access check valve.
5. End Connections: Hub and spigot.
6. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
7. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

C. Drain-Outlet Backwater Valves:

1. Size: Same as area drain outlet.
2. Body: Cast iron or bronze made for vertical installation in bottom outlet of area drain.
3. Check Valve: Removable ball float.
4. Inlet: Threaded.
5. Outlet: Threaded or spigot.

D. Horizontal, Plastic Backwater Valves:

1. Size: Same as connected piping.
2. Body: PVC.
3. Cover: Same material as body with threaded access to check valve.
4. Check Valve: Removable swing check.
5. End Connections: Socket type.

2.2 CLEANOUTS

A. Cleanouts

1. Basis-of-Design Product: Subject to compliance with requirements, Refer to table for area and provide the product indicated or a comparable product by one of the following:

   1) Linoleum Floors: J.R. Smith Series 4140 - round top with insert
   2) Carpeted Floors: J.R. Smith Series 4240-Y - round with carpet marker
3) Exterior: J. R. Smith 4240 - round with cast iron cover
4) Wall: J.R. Smith Series 4710
5) Quarry Floor: J.R. Smith Series 4053-PB - square bronze top
6) Ceramic Floor: J.R. Smith Series 4053-NB - square nickel bronze top
7) Concrete Floors: J. R. Smith Series 4100 – round galvanized cast iron top.
8) Truck/Loading Dock Areas: J. R. Smith Series 4231 – ductile iron top.

b. MIFAB, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Body Material: cast-iron as required to match connected piping.
4. Closure: Countersunk or raised-head, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.3 TRENCH DRAINS

A. Trench Drains:

1. Manufacturers:

b. MIFAB, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

3. Material: Ductile or gray iron.
4. REFER TO FIXTURE SCHEDULE FOR FIXTURE PARAMETERS.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Available Manufacturers:

a. ProSet Systems Inc.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected pipe.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

2.5 ROOF DRAINS

A. Metal Roof Drains:
1. Manufacturers:
   b. MIFAB, Inc.
   c. Portals Plus, Inc.
   d. Prier Products, Inc.
   e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   f. Tyler Pipe; Wade Div.
   g. Watts Drainage Products Inc.
   h. Zurn Plumbing Products Group.

2. Standard: ASME A112.21.2M.

3. REFER TO FIXTURE SCHEDULE FOR UNIT DESCRIPTION.

2.6 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Expansion Joints:
   1. Standard: ASME A112.21.2M.
   2. Body: Cast iron with bronze sleeve, packing, and gland.
   3. End Connections: Matching connected piping.
   4. Size: Same as connected piping.

B. Downspout Boots:
   1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
   2. Size: Inlet size to match downspout.
   3. Description: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.
   4. Size: Same as or larger than connected downspout.

C. Downspout Nozzles:
   1. REFER TO FIXTURE SCHEDULE.

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 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 100 feet.
   4. Locate at base of each vertical stack.
   5. Do not locate cleanouts above finished ceilings.
C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor. Do not install in public areas.

D. For cleanouts located in concealed locations, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface.

F. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.

   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.

G. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

H. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

I. Install manufactured, gray-iron downspout boots at grade with top [6 inches] [12 inches] [18 inches] <Insert dimension> above grade. Secure to building wall. Provide splash block.

J. Install cast-iron soil pipe downspout boots at grade with top of hub [6 inches] [12 inches] [18 inches] <Insert dimension> above grade. Provide splash block.

K. Install downspout nozzles at exposed bottom of conductors where they spill onto grade. Provide splash block.

L. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 PROTECTION

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

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

END OF SECTION
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SECTIONS 223100
DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes commercial water softeners.
   1. Chemicals.
   2. Water testing kits.

1.2 DEFINITIONS

B. FRP: Fiberglass-reinforced plastic.
C. PE: Polyethylene plastic.
D. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Water Softeners. Include rated capacities, operating characteristics, furnished
      specialties, and accessories.
   2. Water testing kits.

B. Shop Drawings: For water softeners. Include plans, elevations, sections, details, and
   connections to piping systems.

C. Manufacturer Seismic Qualification Certification: Refer to Architect for seismic criteria. Submit
   certification that indicated steel mineral tanks, accessories, and components will withstand
   seismic forces defined in Division 22 Section “Vibration and Seismic Controls for Plumbing
   Piping and Equipment.” Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of
      assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any
         parts from the device when subjected to the seismic forces specified and the unit
         will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate
      and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Manufacturer Certificates: Signed by manufacturers certifying that water softeners comply with requirements.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

I. Maintenance service agreement.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of water softeners and are based on the specific system indicated. Refer to Division 01 Section “Product Requirements.”

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. ASME Compliance:

1. Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, where indicated.

1.5 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.

1.6 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of water softener that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures of mineral and brine tanks.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   d. Attrition loss of resin exceeding 3 percent per year.
   e. Mineral washed out of system during service run or backwashing period.
   f. Effluent turbidity greater and color darker than incoming water.
2. Commercial Water Softener, Warranty Period: From date of Substantial Completion.
   
   a. Mineral Tanks:
      
      1) Steel Tanks: 1 year.
      2) Fiberglass Tanks: 5 years.

   b. Brine Tanks: 5 years.
   c. Controls: 1 year.
   d. Underdrain Systems: 5 years.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Salt for Brine Tanks: Furnish same form as and at least [four] [two] times original load, but not less than [200 lb] [1000 lb] <Insert weight>.
   
   2. Deliver salt on pallets in 50-lb bags
   3. Store salt on raised platform where directed by Owner. Do not store in contact with concrete floor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

   a. Marlo, Inc.
   b. Culligan International Company
   c. Ecodyne Water Treatment
   d. Hungerford & Terry, Inc.
   e. Unity
   f. Lakeside Water Treatment
   g. Watt's Water Conditioning

2.2 COMMERCIAL WATER SOFTENERS

A. Description: Factory-assembled, pressure-type water softener.

   1. Comply with NSF 61, "Drinking Water System Components--Health Effects."
   2. Configuration: [Single unit with one mineral tank] [Twin unit with two mineral tanks]
      [Triple unit with three mineral tanks] <Insert configuration> and one brine tank, factory mounted on skids.
a. Construction: Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section X, "Fiber-Reinforced Plastic Pressure Vessels."

b. Pressure Rating: [100 psig] [125 psig] <Insert pressure> minimum.

c. Wetted Components: Suitable for water temperatures from [40 to at least 100 deg F] [40 to at least 120 deg F] [40 to at least 150 deg F] <Insert temperature>.

d. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.

e. Support Legs or Skirt: Constructed of structural steel, welded to tank before testing and labeling.

f. Upper Distribution System: Single, point type, fabricated from non-metallic pipe and fittings.

g. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from nonmetallic pipe and fittings with individual, fine-slotted, nonclogging plastic strainers; arranged for even flow distribution through resin bed.

h. Liner: PE, ABS, or other material suitable for potable water.

4. Mineral Tanks: [Steel] [Stainless steel], electric welded; pressure-vessel quality.

a. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

b. Construction: Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels."

c. Pressure Rating: [100 psig] [125 psig] [150 psig] <Insert pressure> minimum.

d. Wetted Components: Suitable for water temperatures from [40 to at least 100 deg F] [40 to at least 120 deg F] [40 to at least 150 deg F] <Insert temperature>.

e. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.

f. Handholes: 4 inches round or 4 by 6 inches elliptical, in top head and lower sidewall of tanks 30 inches and smaller in diameter.

g. Manhole: 11 by 15 inches in top head of tanks larger than 30 inches in diameter.

h. Support Legs or Skirt: Constructed of structural steel, welded to tank before testing and labeling.

i. [Finish: Exterior of tank spray painted with rust-resistant prime coat, 2- to 3-mil dry film thickness. Interior sandblasted and lined with epoxy-polyamide coating, 8- to 10-mil dry film thickness.]

j. Upper Distribution System: Single, point type, fabricated from non-metallic pipe and fittings.

k. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even flow distribution through resin bed.

l. Liner: PE, ABS, or other material suitable for potable water.

5. Controls: Fully automatic; factory mounted on unit and factory wired.

a. PLC programmable logic controller in a NEMA-4X enclosure featuring digital display flow rate, peak flow rate, batch volume remaining, totalizer, and a regeneration cycle timer/indicator. A regeneration required visual alarm is provided and is located on the controller front panel display. PLC controller is provided with extra I/O cards for future expansion. Provided with Modbus for connection to BMS. Controller is programmed to operate the system in either an alternating/additive flow (based on flow requirement) mode.

b. Adjustable duration of various regeneration steps.

c. Push-button start and complete manual operation.
d. Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.

e. Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration and return to service.

f. Pointer on pilot-control valve shall indicate cycle of operation.

g. Means of manual operation of pilot-control valve if power fails.

h. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

1) Slow opening and closing, nonslam operation.
2) Diaphragm guiding on full perimeter from fully open to fully closed.
3) Isolated dissimilar metals within valve.
4) Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
5) Valve for single mineral-tank unit with internal automatic bypass of raw water during regeneration.
6) Sampling cocks for soft water.
7) Special tools are not required for service.

i. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressures, and that does not require field adjustments.

1) Meter Control: Equip each mineral tank with signal-register-head water meter that will produce electrical signal indicating need for regeneration on reaching hand-set total in gallons. Design so signal will continue until reset.
2) Demand-Initiated Control: Equip single mineral-tank units with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons. Design so head automatically resets to preset total in gallons for next service run.
3) Demand-Initiated Control: Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meters that electrically activate cycle controllers to initiate regeneration at preset total in gallons. Design so heads automatically reset to preset total in gallons for next service run. Include electrical lockout to prevent simultaneous regeneration of both tanks.
4) Demand-Initiated Control: Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tank. Set to repeat with other tank. Include electrical lockout to prevent simultaneous regeneration of both tanks.
5) Demand-Initiated Control: Equip each mineral tank of multiple mineral-tank units with automatic-reset-head water meters that electrically activate cycle controllers to automatically regenerate at preset total in gallons. Design so heads automatically reset to preset total in gallons for next service run. Include electrical lockouts to prevent simultaneous regeneration of more than one tank.
6) Demand-Initiated Control: Equip each mineral tank of multiple mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tanks. Set to repeat with other tanks. Include electrical lockouts to prevent simultaneous regeneration of more than one tank.

6. Brine Tank: Combination measuring and wet-salt storing system.
DOMESTIC WATER SOFTENERS

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7. Factory-Installed Accessories:
   a. Piping, valves, tubing, and drains.
   b. Sampling cocks.
   c. Main-operating-valve position indicators.
   d. Water meters.

B. Capacity and Characteristics:
   1. Service: [Cold] [Hot] water.
   2. Water Analysis:
      a. Hardness: <Insert grains/gal. or ppm.>
      d. Concentration: <Insert pH.>
      e. Inlet Water Pressure: <Insert psig.>
      f. Water Temperature: <Insert deg F.>

   3. Refer to schedule on drawings

2.3 CHEMICALS

A. Mineral: High-capacity, sulfonated-poly styrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.

   1. Exchange Capacity: [30,000 grains/cu. ft.] <Insert capacity> of calcium carbonate of resin when regenerated with 15 lb of salt.

B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

2.4 WATER TESTING SETS

A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

2.5 SOURCE QUALITY CONTROL

A. Hydrostatically test mineral tanks before shipment to minimum of one and one-half times pressure rating.

B. Prepare test reports.
**PART 3 - EXECUTION**

3.1 CONCRETE BASES

A. Install concrete bases of dimensions indicated for commercial water softeners. Refer to Division 22 Section "Common Work Results for Plumbing."

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.2 WATER SOFTENER INSTALLATION

A. Install commercial water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure.

C. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.

D. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.

E. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

3.3 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. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Dielectric fittings are specified in Division 22 Section "Common Work Results for Plumbing."

D. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.

   1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
   2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
   3. Exception: Water softeners with factory-installed shutoff valves at locations indicated.

E. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."

   1. Exception: Water softeners with factory-installed pressure gages at locations indicated.
   2. Exception: Water softeners in hot-water service.
F. Install valved bypass water piping around water softeners.
   1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
   2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
   3. Water piping is specified in Division 22 Section "Domestic Water Piping."

G. Install drains as indirect wastes to spill into open drains or over floor drains.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. 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 field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

B. Add water to brine tanks and fill with salt.

C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
   2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
   4. ASTM D 1126, "Test Method for Hardness in Water."
   5. ASTM D 1129, "Terminology Relating to Water."
3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water softeners. Refer to Division 01 "Demonstration and Training" Section

END OF SECTION
SECTION 223300

ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following electric water heaters:

1. Electric booster heaters.
2. Storage electric water heaters.
3. Expansion tanks.

1.2 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Diagram power, signal, and control wiring.
2. Short-circuit current rating of equipment assembly.

C. Product Certificates: For each type of electric water heater, signed by product manufacturer.

D. Manufacturer Seismic Qualification Certification: Refer to Architect for seismic criteria. Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control test reports.

F. Field quality-control test reports.
G. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.4 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.5 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including storage tank and supports.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   d. Consider “rusty water” a failure.

2. Warranty Period(s): From date of Substantial Completion:

   a. Electric Water Heaters:

      1) Storage Tank: Five years.
      2) Controls and Other Components: One year.

   b. Expansion Tanks: Five years.
PART 2 - PRODUCTS

2.1 ELECTRIC WATER HEATERS

A. Commercial Electric Booster Heaters: Comply with UL 1453 requirements for booster-type water heaters.

1. Manufacturers:
   b. Lochinvar Corporation.
   d. Smith, A. O. Water Products Company.

2. Storage-Tank Construction: [Corrosion-resistant metal] [Corrosion-resistant metal or steel].
   b. Pressure Rating: 150 psig.
   c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into Fittings.

3. Factory-Installed Storage-Tank Appurtenances:
   a. Anode Rod (if needed): Replaceable magnesium.
   b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   c. Insulation: Comply with ASHRAE/IESNA 90.1.
   d. Heating Elements: Electric, screw-in or bolt-on immersion type.
      1) Option: Booster heaters with 9 kW or less total may have 2 or 3 elements.
      2) Staging: Input not exceeding [36 kW] <Insert kW> per step.
   e. Temperature Control: Adjustable thermostat, to setting of at least 180 deg F.
   f. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   g. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3, combination temperature and pressure relief valve. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
   h. Gages: Combination temperature and pressure type or separate thermometer and pressure gage.

4. Special Requirements: NSF 5 construction.

5. Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS

B. Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.

1. Manufacturers:
   a. Patterson-Kelly
   c. Lochinvar Corporation.
   d. PVI Industries, LLC.
f. Smith, A. O. Water Products Company.
g. State Industries, Inc.

2. Storage-Tank Construction: ASME-code, steel vertical or horizontal arrangement.
   a. Fittings: Factory fabricated of materials compatible with tank and piping connections.
      1) NPS 3 and Smaller: Threaded ends according to ASME B1.20.1.
      2) NPS 4 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
   b. Pressure Rating: [150 psig] <Insert psig (kPa)>.

3. Factory-Installed Storage-Tank Appurtenances:
   a. Anode Rod (if needed): Replaceable magnesium.
   b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   c. Insulation: Comply with ASHRAE/IESNA 90.1.
   d. Jacket: Steel with enameled finish.
   e. Heating Elements: Electric, screw-in or bolt-on immersion type.
      1) Staging: Input not exceeding [36 kW] <Insert kW> per step.
   f. Temperature Control: Adjustable thermostat.
   g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.


5. Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.2 EXPANSION TANKS

A. Description: Steel ASME pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

1. Manufacturers:
   a. AMTROL Inc.
   b. Taco, Inc.
   c. Watts Regulator Co.
   d. ELBI
2. Construction:
   a. Fittings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.3 WATER HEATER ACCESSORIES

   A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

   B. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.

   C. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

   D. Piping-Type Heat Traps for non-circulated systems: Field-fabricated piping arrangement according to International Plumbing Code.

2.4 SOURCE QUALITY CONTROL

   A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

   B. Hydrostatically test water heater storage tanks before shipment to minimum of one and one-half times pressure rating.

   C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

   A. Install water heaters on concrete bases.

      1. Exception: Omit concrete bases for water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.

      2. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

   B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
C. Install seismic restraints for water heaters. Anchor to substrate.

D. Install combination temperature and pressure relief valves in top portion of water heaters. Use relief valves with sensing elements that extend into tanks. Extend water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains.

F. Install thermometer on inlet and outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

G. Install pressure gage(s) on inlet and outlet of commercial electric water-heater piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

H. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

I. Fill water heaters with water.

J. Charge expansion tanks with air.

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 water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.
3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain electric water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 223500

DOMESTIC WATER HEAT EXCHANGERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following heat exchangers:

2. Circulating, storage heat exchangers.
3. Expansion tanks.

1.2 SUBMITTALS

A. Product Data: For each type and size of heat exchanger indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Product Certificates: For each type of [Semi-instantaneous] [circulating] heat exchanger, signed by product manufacturer.

D. Manufacturer Seismic Qualification Certification: Refer to Architect for seismic criteria. Submit certification that heat exchangers, accessories, and components will withstand seismic forces defined in Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control test reports.

F. Field quality-control test reports.
G. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of heat exchangers through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of heat exchangers and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with water.

1.4 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.5 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of heat exchangers that fail in materials or workmanship within specified warranty period.

   1. Failures include, but are not limited to, the following:

      a. Structural failures including heat exchanger, storage tank, and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
      d. Consider "rusty water" a failure

   2. Warranty Period(s): From date of Substantial Completion:

      a. Instantaneous Heat Exchangers:

         1) Tube Coil and Shell: Five years.
         2) Controls and Other Components: Five years.

      b. Circulating, Storage Heat Exchangers:

         1) Storage Tank: Five years.
2) Tube Coil: Five years.
3) Controls and Other Components: Five years.

c. Expansion Tanks: Five years.

**PART 2 - PRODUCTS**

2.1 **SEMI-INSTANTANEOUS HEAT EXCHANGERS**

A. Semi-Instantaneous Heat Exchangers:

1. Manufacturers:

   a. Aerco
   b. Patterson-Kelley
   c. PVI Industries, LLC.

2. Description: Packaged assembly of heat-exchanger coil, controls, and specialties for heating domestic water in shell with [heating hot water] [steam] in coil.


   a. Configuration: [Horizontal] [Vertical].
   b. Shell Fittings: Factory fabricated of materials compatible with water heater shell. Attach fittings to shell before testing and labeling.

      1) NPS 3 and Smaller: Threaded ends according to ASME B1.20.1.
      2) NPS 4 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

   c. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature.
   d. Heat-Exchanger Coil: Copper, [double] [single]-wall, for heating fluid.

      1) Tube Pressure Rating: Equal to or greater than heating-fluid supply pressure.

4. Temperature Control: Adjustable thermostat that operates [water control valve] [steam-control valve] and that is capable of maintaining outlet-water temperature within +/- 5 deg F of setting.

5. Safety Control: Automatic, high-temperature-limit cutoff device or system.

6. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into shell.

7. Miscellaneous Components for Heating Hot-Water Unit: Control valve, valves, and piping.

8. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gage, thermometer, and piping.


10. Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS
2.2 CIRCULATING, STORAGE HEAT EXCHANGERS

A. Circulating, Storage Heat Exchangers:

1. Manufacturers:
   a. Patterson-Kelley.
   b. PVI Industries, LLC.
   c. Smith, A. O. Water Products Company.

2. Description: Packaged, large-capacity, hot-water storage tank with heat-exchanger coil, circulator, controls, and specialties for heating domestic water with [heating hot water] [steam] in coil.

3. Flow Pattern: Standard-flow arrangement, with water from bottom of storage tank circulated across heat-exchanger coil and returned to tank. Include hot-water outlet located at top of tank and temperature sensor in tank.

4. Flow Pattern: Reverse-flow arrangement, with water from storage tank drawn across heat-exchanger coil and returned to bottom of tank. Include hot-water outlet and temperature sensor located in or at coil shell.

   a. Configuration: [Horizontal] [Vertical].
   b. Manhole: 11 by 15 inches in 36" diameter and greater storage tank shell.
   c. Fittings: Factory fabricated of materials compatible with tank. Attach fittings to tank before testing and labeling.
      1) NPS 3 and Smaller: Threaded ends according to ASME B1.20.1.
      2) NPS 4 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
   d. Lining: [Plastic] [Glass] [Nickel plate] [Copper] complying with NSF 61 barrier materials for potable-water tank linings. Apply interior finish after tank fabrication.
   e. Anode Rods (if needed): Factory installed, magnesium.
   f. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire storage tank and nozzle except connections and controls.

   a. Heat-Exchanger Pressure Rating: Equal to or greater than heating-fluid supply pressure.

7. Temperature Control: Adjustable temperature aquastat, mounted in storage tank shell head, unless otherwise indicated.

8. Safety Control: Automatic, high-temperature-limit cutoff device or system. Include automatic low-water cutoff device or system.

9. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.

11. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, [125-psig] <insert psig (kPa)> minimum working-pressure rating, and 225 deg F continuous-water-temperature rating.

   a. Pump Control: Sensor for operating pump and control valve.


14. Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.3 EXPANSION TANKS

A. Description: Steel, ASME pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

   1. Manufacturers:
      a. AMTROL Inc.
      b. Taco, Inc.
      c. Watts Regulator Co.
      d. ELBI

   2. Construction:
      a. Fittings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
      b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      c. Air-Charging Valve: Factory installed.

   3. Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.4 HEAT-EXCHANGER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select relief valves with sensing element that extends into heat-exchanger storage tank.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect heat-exchanger storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
B. Hydrostatically test heat-exchanger storage tanks before shipment to minimum of one and one-half times pressure rating.

C. Prepare test reports.

PART 3 - EXECUTION

3.1 HEAT-EXCHANGER INSTALLATION

A. Install heat exchangers on concrete bases.
   1. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Install heat exchangers level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. Anchor heat exchangers to substrate.

D. Install seismic restraints for heat exchangers. Anchor to substrate.

E. Install temperature and pressure relief valves in top portion of storage tank shells of heat exchangers with domestic water storage. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install combination temperature and pressure relief valves in water piping for heat exchangers without storage. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

G. Install heat-exchanger drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for heat exchangers that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.

H. Install thermometer on each heat-exchanger domestic-water inlet and outlet piping, and install thermometer on each heat-exchanger heating-fluid inlet and outlet piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

I. Install pressure gages on heat-exchanger heating-fluid piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

J. Fill heat exchangers with water.

K. Charge compression tanks with air.

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 heat exchangers to allow service and maintenance. Arrange piping for easy removal of heat exchangers.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace heat exchangers that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 224000

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:

1. Faucets for [lavatories] [bathtubs] [bathtub/showers] [showers] [and] [sinks].
2. Flushometers.
3. Toilet seats.
4. Protective shielding guards.
5. P-traps, Supplies and strainers.
6. Fixture supports.
7. [Interceptors.]
8. Shower receptors.
10. Disposers.
11. Hot-water dispensers.
13. Urinals.
14. Lavatories.
15. Sinks.
17. Wash fountains.
18. Bathtubs.
19. Showers.
20. [Whirlpool bathtubs.]
22. Service basins.
23. Laundry trays.

B. Related Sections include the following:

1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
3. Division 22 Section "Healthcare Plumbing Fixtures."
4. Division 22 Section "Emergency Plumbing Fixtures."
5. Division 22 Section "Drinking Fountains and Water Coolers."
6. Division 31 Section "Facility Water Distribution Piping" for exterior plumbing fixtures and hydrants.

1.2 DEFINITIONS


B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

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

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.


1.3 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

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.


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

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
10. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
15. Vitreous-China Fixtures: ASME A112.19.2M.
17. Water-Closet, Flushometer Tank Trim: ASSE 1037.
18. Whirlpool Bathtub Fittings: ASME A112.19.8M.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
5. Hose-Connection Vacuum Breakers: ASSE 1011.

I. Comply with the following applicable standards and other requirements specified for bathtub/shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

2. Brass and Copper Supplies: ASME A112.18.1.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
4. Floor Drains: ASME A112.6.3.
5. Grab Bars: ASTM F 446.
8. Off-Floor Fixture Supports: ASME A112.6.1M.

1.5 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures of unit shell.
   b. Faulty operation of controls, blowers, pumps, heaters, and timers.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period for Commercial Applications: One year(s) from date of Substantial Completion.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
5. Water-Closet Tank, Repair Kits: Equal to 5 percent of amount of each type installed.
6. Toilet Seats: Equal to 5 percent of amount of each type installed.
7. Dry Urinal Trap-Seal Cartridges: 10 of each type installed.
8. Dry Urinal Trap-Seal Liquid: Equal to 1 gal for each urinal installed.

PART 2 - PRODUCTS

2.1 LAVATORY AND SINK FAUCETS

A. Lavatory and Sink Faucets:

1. Manufacturers:
   a. American Standard Companies, Inc.
   b. Chicago Faucets.
   c. Delta Faucet Company.
   d. Eljer.
   e. Elkay Manufacturing Co.
   f. Just Manufacturing Company.
   g. Kohler Co.
   h. Moen, Inc.
   i. Speakman Company.
   j. T & S Brass and Bronze Works, Inc.
   k. Zurn Plumbing Products Group.

2.2 BATHTUB/SHOWER FAUCETS

A. Bathtub/Shower Faucets:

1. Manufacturers:
   a. American Standard Companies, Inc.
   b. Chicago Faucets.
   c. Delta Faucet Company.
   d. Eljer.
   e. Kohler Co.
   f. Moen, Inc.
   g. Speakman Company.
   h. Symmons Industries, Inc.
   i. T & S Brass and Bronze Works, Inc.
   j. Zurn Plumbing Products Group.
2.3 FLUSHOMETERS

A. Flushometers:
   1. Manufacturers:
      a. Coyne & Delany Co.
      b. Sloan Valve Company.
      c. Zurn Plumbing Products Group.

2.4 TOILET SEATS

A. Toilet Seats:
   1. Manufacturers:
      a. American Standard Companies, Inc.
      b. Bemis Manufacturing Company.
      c. Centoco Manufacturing Corp.
      d. Church Seats.
      e. Eljer.
      f. Kohler Co.
      g. Olsonite Corp.
      h. Sperzel.

2.5 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
   1. Manufacturers:
      a. Engineered Brass Co.
      b. McGuire Manufacturing Co., Inc.
      c. TRUEBRO, Inc.
      d. Zurn Plumbing Products Group.
   2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements and ASTM E-84.

2.6 P-TRAPS, SUPPLIES, STRainers

A. Manufacturers:
   1. McGuire Manufacturing Co., Inc.
   2. Elkay Manufacturing Co.
   3. American Standard Companies, Inc.
   4. Kohler Co.
   5. Engineered Brass Co.
2.7 FIXTURE SUPPORTS

A. Manufacturers:

1. Josam Company.
2. MIFAB Manufacturing Inc.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.

2.8 INTERCEPTORS

A. Manufacturers:

1. Josam Company.
2. MIFAB Manufacturing Inc.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.

B. Hair Interceptors:

1. Description: Manufactured unit with removable screen or strainer and removable cover; designed to trap and retain hair.


C. Sediment Interceptors:

1. Description: Manufactured unit with removable screens or strainer and removable cover; designed to trap and retain waste material.

   a. Material: carbon-steel body with acid-resistant lining and coating.
   b. Pipe Connections: [NPS 1-1/2] [NPS 2].

2.9 SHOWER RECEPTORS

A. Shower Receptors:

1. Manufacturers:

   b. Florestone Products Co., Inc.
   c. LASCO Bathware.
   d. Acorn Engineering Company.
   e. Precast Terrazzo Enterprises, Inc.
   f. Stern-Williams Co., Inc.
   g. Bradley Corporation.
   h. Formica Corporation.
   i. Jacuzzi, Inc.
2.10 DISHWASHER AIR-GAP FITTINGS

A. Dishwasher Air-Gap Fittings:

1. Manufacturers:
   b. Dearborn Brass; a div. of Moen, Inc.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Watts Brass & Tubular; a division of Watts Regulator Co.

2. Description: Fitting suitable for use with domestic dishwashers and for deck mounting; with plastic body, chrome-plated brass cover; and capacity of at least 5 gpm; and inlet pressure of at least 5 psig at a temperature of at least 140 deg F. Include 5/8-inch-ID inlet and 7/8-inch-ID outlet hose connections.

3. Hoses: Rubber and suitable for temperature of at least 140 deg F.
   a. Inlet/Outlet Hose: 5/8-inch ID and 48 inches long.

2.11 DISPOSERS

A. Disposers:

1. Manufacturers:
   a. In-Sink-Erator; a div. of Emerson Electric Co.
   b. KitchenAid.

2. Description: Batch-feed household, food-waste disposer. Include reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-1/2 outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.

2.12 HOT-WATER DISPENSERS

A. Hot-Water Dispensers:

1. Manufacturers:
   a. In-Sink-Erator; a div. of Emerson Electric Co.
   b. Just Manufacturing Company.

2.13 WATER CLOSETS

A. Water Closets:

1. Manufacturers:
   a. American Standard Companies, Inc.
b. Zurn Plumbing Products Group.
c. Eljer.
d. Kohler Co.

2.14 URINALS

A. Urinals:
   1. Manufacturers:
      a. American Standard Companies, Inc.
      b. Zurn Plumbing Products Group.
      c. Eljer.
      d. Kohler Co.

2.15 LAVATORIES

A. Lavatories:
   1. Manufacturers:
      a. American Standard Companies, Inc.
      b. Eljer.
      c. Kohler Co.
      d. Zurn Plumbing Products Group.

2.16 SINKS

A. Sinks:
   1. Manufacturers:
      a. Elkay Manufacturing Co.
      b. Just Manufacturing Company.
      c. Metal Masters Foodservice Equipment Co., Inc.

2.17 SHAMPOO BOWLS

A. Shampoo Bowls:
   1. Manufacturers:
      a. Belvedere USA Corporation; a Subsidiary of the Wella Corporation, North America.
      b. Marble Products USA; a division of Takara Belmont.

2.18 WASH FOUNTAINS

A. Wash Fountains:
   1. Manufacturers:
2.19 BATH TUBS

A. Bathtubs:

1. Manufacturers:

   a. Eljer.
   b. Kohler Co.
   c. American Standard Companies, Inc.

2.20 SHOWERS

A. Showers, <Insert drawing designation>:

1. Manufacturers:

   a. Aqua Glass Corporation.
   b. Florestone Products Co., Inc.
   c. LASCO Bathware.
   d. Swan Corporation (The).
   e. Aqua Bath Company, Inc.
   f. Kohler Co.

2.21 [WHIRLPOOL BATHTUBS]

A. [Whirlpool Bathtubs, <Insert drawing designation>:

1. Manufacturers:

   a. Eljer.
   b. Kohler Co.
   c. <Insert manufacturer’s name.>
   d. Aker Plastics Co., Inc.
   e. Best Bath Systems; a div. of Fiberglass Systems, Inc.
   f. Clarion Bathware.
   g. Praxis Industries, Inc.; Aquarius Products.
   h. Sterling Plumbing Group, Inc.
   i. <Insert manufacturer’s name.>
   j. Aker Plastics Co., Inc.
   k. American Standard Companies, Inc.
   l. American Whirlpool Products Corp.
   m. Aqua Glass Corporation.
   n. Aquatic Industries, Inc.
   o. Benjamin Manufacturing Co., Inc.
   p. Clarion Bathware.
   q. Clarke Products, Inc.
   r. Crane Plumbing, L.L.C./Fiat Products.
   s. Eljer.
2. Description: Packaged, [enameled, cast-iron] [FRP] [PMMA] [porcelain-enameled, formed-steel] hydromassage bathtub with air-entrained-water jet nozzles and water circulation.

a. Seating Capacity: [One] [Two] <Insert number> person(s).

b. Bathing Surface: Slip resistant.

c. Size: [60 by 30 inches] [66 by 30 inches] [60 by 42 inches] <Insert dimensions>.


e. Base for Drop-in Unit: <Insert description> with access panel.

f. Apron: Matching unit, covering exposed front and sides, and with access panel.

g. Color: [White] <Insert color>.

h. Drain Location: [Left] [Right] end.

i. Controls: For pump, timer, [and water heater].

j. Faucet: Fixture manufacturer's [individual valves] [mixing valve] with over- rim tub filler.

k. Supplies: NPS 1/2 copper tubing with ball, gate, or globe valves.

l. Drain: NPS 1-1/2; chrome-plated exposed parts; brass pop-up waste and overflow.

m. Drain Piping: NPS 1-1/2 cast-brass P-trap and waste.

n. Drain Piping: Schedule 40 [ABS] [or] [PVC], NPS 1-1/2 P-trap and waste.

o. Water-Circulating System: Electric circulating pump and plastic piping.


q. Unit Electrical Characteristics:

1) Volts: [120] [240] [277] [480] <Insert number> V.

2) Phase(s): [One] [Three].

3) Hertz: [60] <Insert number> Hz.

4) Full-Load Amperes: <Insert value> A.

5) Minimum Circuit Ampacity: <Insert value> A.

6) Maximum Overcurrent Protection: <Insert value> A.

2.22 SERVICE SINKS

A. Service Sinks:

1. Manufacturers:

   a. American Standard Companies, Inc.
b. Eljer.
c. Kohler Co.
d. Zurn Plumbing Products Group.

2.23 SERVICE BASINS

A. Service Basins:

1. Manufacturers:
   b. Florestone Products Co., Inc.
   c. Stern-Williams Co., Inc.

2.24 LAUNDRY TRAYS

A. Laundry Trays:

1. Manufacturers:
   a. Eljer.
   b. Swan Corporation (The).
   c. Zurn Plumbing Products Group; Light Commercial Operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

   1. Exception: Use ball valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section “General-Duty Valves for Plumbing Piping.”

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install trap-seal liquid in dry urinals.

P. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

R. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

S. Install shower flow-control fittings with specified maximum flow rates in shower arms.

T. Install traps on fixture outlets.
   
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

U. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
V. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install in sink deck. Connect inlet hose to dishwasher and outlet hose to disposer.

W. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.

X. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

Y. Set shower receptors in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

Z. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
B. Operate and adjust [disposers] [hot-water dispensers] [and] [controls]. Replace damaged and malfunctioning units [and controls].

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

E. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers’ recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION
SECTION 224500
EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. [Provide plumbing fixtures and drains as listed on Drawings and described herein. Fixture numbers are Zurn products. All products to be purchased from Ferguson Enterprises.]

B. This Section includes the following emergency plumbing fixtures:

1. Emergency showers.
2. Eyewash equipment.
3. Eye/face wash equipment.
4. Hand-held drench hoses.
5. Combination units.
6. Water-tempering equipment.

C. Related Sections include the following:

1. Division 22 Section “Sanitary Waste Piping Specialties” for floor drains.

1.2 DEFINITIONS

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

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Tepid: Moderately warm.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

B. Product Certificates: Submit certificates of performance testing specified in “Source Quality Control” Article.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals.
1.4 QUALITY ASSURANCE


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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers for Emergency Showers, Eyewash Equipment, Eye/Face-wash Equipment, Hand held Drench Hoses and Combination Units:

2. Guardian Equipment Co.
4. Lab Safety Supply Inc.
5. Speakman Company.

2.2 EMERGENCY SHOWERS

A. Emergency Showers, <Insert drawing designation>:

1. Description: Plumbed, single-shower-head [horizontal, wall-mounting] [vertical, ceiling-mounting] [freestanding] emergency shower.
   a. Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1-1/4 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Pull [rod] [chain].
   d. Shower Head: 8-inch minimum diameter, [chrome-plated brass or stainless steel] [plastic].

B. Emergency Showers, <DECONTAM SHOWER>:

1. Manufacturers:
   a. Guardian Equipment Co.
   b. Haws Corporation.
   c. Speakman Company.

2. Description: Plumbed, multiple-spray emergency shower with [eight] [12] small shower heads or nozzles.
   a. Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
b. Supply Piping: NPS 1-1/4 minimum chrome-plated brass or stainless steel with flow regulator and stay-open control valve.

2.3 EYEWASH EQUIPMENT

A. Eyewash Equipment, <Insert drawing designation>:

1. Description: Plumbed, freestanding eyewash equipment.
   a. Capacity: Deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   d. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.
   e. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

B. Eyewash Equipment, <Insert drawing designation>:

1. Description: Plumbed, accessibility, wall-mounting eyewash equipment with receptor and wall bracket.
   a. Capacity: Deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   d. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.
   e. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

C. Eyewash Equipment, <Insert drawing designation>:

1. Description: Plumbed, adjacent-to-sink, swivel, counter-mounting eyewash equipment.
   a. Capacity: Deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.

2.4 EYE/FACE WASH EQUIPMENT

A. Eye/Face Wash Equipment, <Insert drawing designation>:

1. Description: Plumbed, [accessible,] wall-mounting eye/face wash equipment with receptor and wall bracket.
   a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.


d. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.

e. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

2.5 HAND-HELD DRENCH HOSES

A. Hand-Held Drench Hoses, <Insert drawing designation>:

1. Description: Plumbed, wall-mounting, hand-held drench hose with wall bracket.

   a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.

   b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.


   d. Hose: Coiled, rubber or plastic.

   e. Spray Heads: [Single] [Twin].

B. Hand-Held Drench Hoses, <Insert drawing designation>:

1. Description: Plumbed, counter-mounting, hand-held drench hose.

   a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.

   b. Supply Fitting: NPS 1/2 brass with flow regulator.

   c. Hose: Rubber or plastic.

   d. Control-Valve Actuator: Hand-held squeeze valve.

   e. Spray Heads: [Single] [Twin].

2.6 COMBINATION UNITS

A. Combination Units, <Insert drawing designation>:

1. Description: Plumbed, accessible, freestanding, with emergency shower and eye/face wash equipment.

   a. Piping: Chrome-plated brass or stainless steel.

      1) Unit Supply: NPS 1-1/2 from [top] [side].
      2) Unit Drain: Outlet at side near bottom.
      3) Shower Supply: NPS 1 with flow regulator and stay-open control valve.
      4) Eye/Face Wash Supply: NPS 1/2 with flow regulator and stay-open control valve.

   b. Shower Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.

      1) Control-Valve Actuator: [Pull rod] [Pull chain].
      2) Shower Head: 8-inch minimum diameter; [chrome-plated brass or stainless steel] [plastic].
2.7 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment, <Insert drawing designation>:

1. Manufacturers:
   b. Bradley Corporation.
   c. Haws Corporation.
   d. Lawler Manufacturing Co., Inc.
   e. Leonard Valve Company.
   f. Powers, a Watts Industries Co.

2. Description: Factory-fabricated, hot- and cold-water-tempering equipment with thermostatic mixing valve.
   a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 2 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.

2.8 SOURCE QUALITY CONTROL

A. Certify performance of plumbed emergency plumbing fixtures by independent testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.
D. Install shutoff valves in water-supply piping to fixtures. Use ball valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Division 22 Section "Common Work Results for Plumbing."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Thermometers are specified in Division 22 Section "Meters and Gages for Plumbing Piping."

G. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.

H. Install indirect waste piping to wall on drain outlet of fixture receptors that are indicated to be indirectly connected to drainage system. Drainage piping is specified in Division 22 Section "Sanitary Waste and Vent Piping."

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

J. Install equipment nameplates or equipment markers on fixtures and equipment signs on water-tempering equipment. Identification materials are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment.

C. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.

D. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary drainage and vent piping.

E. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary drainage piping.

3.4 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.

B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
C. Report test results in writing.

3.5 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION
SECTION 224700

DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 SUMMARY

A. [Provide plumbing fixtures and drains as listed on Drawings and described herein. Fixture numbers are Zurn products. All products to be purchased from Ferguson Enterprises.]

B. This Section includes the following water coolers and related components:
   1. Electric water coolers.
   2. Remote water coolers.
   3. Fixture supports.

1.2 DEFINITIONS

A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.

B. Cast Polymer: Dense, cast-filled-polymer plastic.

C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

D. Fitting: Device that controls flow of water into or out of fixture.

E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.

F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.

G. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.3 SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.
1.4 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.


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


F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Halsey Taylor.
3. Elkay

2.2 DRINKING FOUNTAINS

2.3 ELECTRIC WATER COOLERS

A. Electric Water Coolers, REFER TO FIXTURE SCHEDULE:

1. Description: Accessible, ARI 1010, wall-mounting electric water cooler for adult & child-mounting height.

   a. Cabinet: Bilevel with two attached cabinets, all stainless steel.
   b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
   c. Control: Push button.
   d. Supply: NPS 3/8 with ball or angle stop valve.
   e. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
f. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
2) Electrical Characteristics: 120-V ac; single phase; 60 Hz.

g. Support: Type [I] [II], water cooler carrier. Refer to “Fixture Supports” Article.

h. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.

2.4 FIXTURE SUPPORTS

A. Manufacturers:

1. Josam Co.
2. MIFAB Manufacturing, Inc.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Use carrier floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Set remote water coolers above ceiling, unless otherwise indicated.
D. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

A. Install floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball or angle stop valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls.

   1. Remove and replace malfunctioning units and retest as specified above.
   2. Report test results in writing.

3.6 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.
B. Adjust water cooler temperature settings.

3.7 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer’s written instructions.

END OF SECTION
1.1 SUMMARY
A. [Provide piping, valves, fittings and related products as listed on Drawings and described herein. All products to be purchased from Ferguson Enterprises.]

B. This Section includes the following:
1. Medical air piping and specialties, designated "medical air," operating at 50 to 55 psig.
2. Gas-powered-tool air piping and specialties, designated "instrument air," operating at 175 psig.

C. Related Sections include the following:
1. Division 12 Section "Healthcare Casework" for compressed-air outlets in medical casework.
2. Division 22 Section "General-Service Compressed-Air Piping" for general-service compressed-air piping.
3. Division 22 Section "Compressed-Air Equipment for Healthcare Facilities" for medical air compressors.
4. Division 22 Section "Compressed-Air Piping for Laboratory Facilities" for laboratory air piping.
5. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for hangers and supports.
6. Division 22 Section "Common Work Results for Plumbing" for Sleeves and Escutcheons.

1.2 DEFINITIONS
A. D.I.S.S.: Diameter-index safety system.

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. Medical Compressed-Air Piping Systems: Include medical air and instrument air piping systems.

1.3 SUBMITTALS
A. Product Data: For the following:
1. Medical / Instrument-air tubes and fittings.
2. Medical / Instrument-air valves and valve boxes.
3. Medical compressed-air outlets.
4. Medical compressed-air manifolds.
5. Medical compressed-air alarm system components.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Piping Material Certification: Signed by Installer certifying that medical compressed-air piping materials comply with NFPA 99 requirements.

D. Qualification Data: For Installer and testing agency.

E. Brazing certificates.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For Medical compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Compressed-Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the piping testing indicated, that is [a member of the Medical Gas Professional Healthcare Organization or is] an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

C. Source Limitations: Obtain Medical Air outlets of same type and from same manufacturer provided for in Division 22 Section "Gas Piping for Healthcare Facilities."


E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


1.5 PROJECT CONDITIONS

A. Interruption of Existing Medical Compressed-Air Service(s): Do not interrupt medical compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
1. Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of medical compressed-air service(s).
2. Do not proceed with interruption of medical compressed-air service(s) without Owner's written permission.

1.6 COORDINATION

A. Coordinate medical compressed-air service connections with other service connections. Medical vacuum service connections are specified in Division 22 Section “Vacuum Piping for Healthcare Facilities,” and medical gas service connections are specified in Division 22 Section “Gas Piping for Healthcare Facilities.”

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Types K and L, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking “OXY,” “MED,” “OXY/MED,” “OXY/ACR,” or “ACR/MED” in green for Type K tube and in blue for Type L tube.

1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.

B. Memory-Metal Couplings “SMART TAP”: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

1. Manufacturers:
   a. Smart Technology, Inc.
   b. <Insert manufacturer's name>.

C. Copper Water Tube: ASTM B 88, Type M, seamless, drawn temper.


D. PVC Pipe: ASTM D 1785, Schedule 40. (Protective conduit)

1. PVC Fittings: ASTM D 2466, Schedule 40, socket type.]

2.2 JOINING MATERIALS

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

B. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.]
2.3 Manufacturers for All products listed below including valves, zone valve boxes, alarms and manifolds:

   a. Allied Healthcare Products, Inc.
   b. Amico Corporation.
   c. BeaconMedaes.

2.4 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
   1. Pressure Rating: 300 psig minimum.
   2. Ball: Full-port, chrome-plated brass.
   3. Seats: PTFE or TFE.
   4. Handle: Lever type with locking device.
   5. Stem: Blowout proof with PTFE or TFE seal.

C. Check Valves: In-line pattern, bronze.
   1. Pressure Rating: 300 psig minimum.
   2. Operation: Spring loaded.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
   1. Pressure Rating: 300 psig minimum.
   2. Ball: Full-port, chrome-plated brass.
   3. Seats: PTFE or TFE.
   4. Handle: Lever.
   5. Stem: Blowout proof with PTFE or TFE seal.
   7. Pressure Gage: Manufacturer installed on one copper-tube extension.

E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple zone valves with pressure gages and in sizes required to permit manual operation of zone valves.
   1. Interior Finish: Factory-applied white enamel.
   2. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
   3. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

F. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

G. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.
2.5 MEDICAL COMPRESSED-AIR OUTLETS

A. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

1. Roughing-in Assembly:
   a. Steel outlet box for recessed mounting and concealed piping.
   b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
   c. Double seals that will prevent air leakage.
   d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

2. Finishing Assembly:
   a. Brass housing with primary check valve.
   b. Double seals that will prevent air leakage.
   c. Cover plate with gas-service label.

3. Quick-Coupler gas outlets: Pressure outlet with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

4. D.I.S.S. gas outlets: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

5. Cover Plates: One piece, [stainless steel, with NAAMM AMP 503, No. 4 finish] [metal, with chrome-plated finish] [anodized aluminum] and permanent, color-coded, identifying label matching corresponding service.

2.6 INSTRUMENT COMPRESSED-AIR PRESSURE CONTROL PANELS

A. Description: Steel box and support brackets for recessed roughing in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.

2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
3. Pressure Gages: 0- to 300-psig range.
5. Before final assembly, provide temporary dust shield and U-tube for testing.
6. Label cover plate "Air Pressure Control."
2.7 MEDICAL COMPRESSED-AIR MANIFOLDS

A. General Requirements for Medical Compressed-Air Manifolds: Comply with NFPA 99, "Manifolds for Gas Cylinders without Reserve Supply."

B. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, pressure changeover switch, line-pressure regulator, shutoff valves, and safety valve.

C. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig minimum inlet pressure. Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.

D. Compressed-Air Cylinders: [Will be furnished by Owner] [Number and type of compressed-air cylinders required for complete manifold systems].

E. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.

F. Mounting: [Wall with mounting brackets for manifold control cabinet and headers] [Floor with support legs for manifold control cabinet].

G. Label manifold control unit with permanent label identifying compressed air and system operating pressure.

H. Medical Air Manifolds: For <Insert number of cylinders per bank> at 55-psig line pressure.

I. Instrument Air Manifolds: For <Insert number of cylinders and capacity> capacity at 200-psig minimum line pressure.

2.8 COMPRESSED-AIR-CYLINDER STORAGE RACKS

A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.

B. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

2.9 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEMS

A. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.

B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

C. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed
valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.

1. Operation: Chilled-mirror method or hygrometer moisture analyzer with sensor probe.

D. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.

1. Low-Pressure Operating Range: 0- to 100-psig.
2. High-Pressure Operating Range: Up to 250-psig.

E. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.

F. General Requirements for Medical Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

1. Mounting: Recessed installation.
2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

G. Master Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.

1. Include alarm signals when the following conditions exist:
   a. Medical Air: Pressure drops below 40 psig or rises above 60 psig, backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig, dew point rises above 39 deg F at 55 psig, carbon monoxide level rises above 10 ppm, and high water level is reached in receiver for liquid-ring, medical air compressor systems.
   b. Instrument Air: Pressure drops below \[165 \text{ psig}\] <Insert pressure> or rises above \[185 \text{ psig}\] <Insert pressure>.

H. Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.

1. Include alarm signals when the following conditions exist:
   a. Medical Air: Pressure drops below 40 psig or rises above 60 psig.
   b. Instrument Air: Pressure drops below \[165 \text{ psig}\] <Insert pressure> or rises above \[185 \text{ psig}\] <Insert pressure>.

2.10 COMPUTER INTERFACE CABINET

A. Description: Wall-mounting, welded-steel control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical compressed-air-piping-system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing all alarm signals.
2.11 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Hyspan Precision Products, Inc.
   5. Metraflex, Inc.
   6. Proco Products, Inc.
   7. Unaflex.
   8. Universal Metal Hose; a Hyspan Co.

B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   2. End Connections: Threaded copper pipe or plain-end copper tube.

2.12 NITROGEN

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen, for blow down and testing.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
   1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
   2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
      a. Scrub to ensure complete cleaning.
      b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

A. Connect new tubing to existing tubing with memory-metal couplings.

B. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

C. Instrument Air Piping:
1. NPS 3 and Smaller: Use [Type K] [Type L], copper medical gas tube; wrought-copper fittings; and brazed joints.
2. NPS 3-1/2 and Larger: Use Type K, copper medical gas tube; wrought-copper fittings; and brazed joints.

D. Drain Piping: Use the following piping materials:
   1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

E. [Protective Conduit: Use PVC pipe, PVC fittings, and solvent-cemented joints.]

3.3 PIPING INSTALLATION

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

B. Comply with ASSE Standard #6010 for installation of compressed-air piping.

C. Install piping concealed from view and protected from physical contact by building occupants 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 and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install nipples, special fittings and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.

H. Install branch connections to compressed-air mains from top of main.

I. Install piping to permit valve servicing.

J. Install piping free of sags and bends.

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

L. Install medical compressed-air piping to medical compressed-air outlets.

M. Install seismic restraints on compressed-air piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

N. Install compressed-air outlets recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

O. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.

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P. [Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings.]

3.4 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
E. Install safety valves on compressed-air receivers where required by NFPA 99 and where recommended by specialty manufacturers.
F. Install pressure regulators on compressed-air piping where reduced pressure is required.
G. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain so contents spill over or into it.
H. Install flexible pipe connectors in discharge piping of each air compressor.

3.5 JOINT CONSTRUCTION

A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
B. Threaded Joints: Apply appropriate tape to external pipe threads.
C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
D. Memory-Metal Coupling “SMART TAP” Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
E. [Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. Apply primer and join according to ASME B31.9 for solvent-cemented joints, and ASTM D 2672.]

3.6 MEDICAL COMPRESSED-AIR SERVICE COMPONENT INSTALLATION

A. Install compressed-air pressure control panel in walls. Attach to substrate.
B. Install compressed-air manifolds anchored to substrate.
C. Install compressed-air cylinders and connect to manifold piping.

D. Install compressed-air manifolds with seismic restraints as required.

E. Install compressed-air-cylinder wall storage racks attached to substrate.

3.7 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEM INSTALLATION

A. Alarm panels for medical compressed-air piping systems may be combined in single panels with medical vacuum piping systems and medical gas piping systems.

B. Install alarm system components for medical compressed-air-piping according to and in locations required by NFPA 99.

C. Install area and master alarm panels for medical compressed-air piping system where indicated.

D. Install computer interface cabinet with connection to medical compressed-air-piping alarm system and to facility computer.

3.8 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Medical Air: Black letters on yellow background.
2. Instrument Air: White letters on red background.

3.9 FIELD QUALITY CONTROL FOR MEDICAL COMPRESSED-AIR PIPING IN HEALTHCARE FACILITIES

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical compressed-air piping in healthcare facilities and prepare test reports.

B. Perform tests and inspections of medical compressed-air piping systems in healthcare facilities and prepare test reports.

C. Tests and Inspections:

1. Medical Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air piping systems concurrently with tests, inspections, and certification of medical vacuum piping and medical gas piping systems.

2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:

   a. Initial blowdown.
   b. Initial pressure test.
   c. Cross-connection test.
   d. Piping purge test.
   e. Standing pressure test for positive-pressure medical compressed-air piping.
   f. Repair leaks and retest until no leaks exist.
3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:

   a. Standing pressure test.
   b. Individual-pressurization or pressure-differential cross-connection test.
   c. Valve test.
   d. Master and area alarm tests.
   e. Piping purge test.
   f. Piping particulate test.
   g. Piping purity test.
   h. Final tie-in test.
   i. Operational pressure test.
   j. Medical air purity test.
   k. Verify correct labeling of equipment and components.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

   a. Inspections performed.
   b. Procedures, materials, and gases used.
   c. Test methods used.
   d. Results of tests.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.10 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical compressed-air alarm systems. Refer to Division 01 Section “Demonstration and Training.”

END OF SECTION
SECTION 226119

COMPRESSED-AIR EQUIPMENT FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, oil-free reciprocating air compressors.
2. Packaged, oilless reciprocating air compressors.
3. Packaged, rotary-scroll air compressors.
4. Inlet-air filters.
5. Desiccant compressed-air dryers.
6. Compressed-air purification systems.
7. Compressed-air filter assemblies.
8. Medical compressed-air equipment alarm systems.

1.2 DEFINITIONS

A. Actual Air: Air delivered at air-compressor outlet. Flow rate is compressed air delivered and measured in acfm.

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. Medical Air Equipment: Compressed-air equipment and accessories for healthcare facilities.

D. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design compressed-air equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to [SEI/ASCE 7] <Insert requirement>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Wiring Diagrams: For power, signal, and control wiring.
2. Short-circuit current rating of controller assembly.

B. Delegated-Design Submittal: For compressed-air equipment mounting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of supports.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

C. Qualification Data: For qualified Installer and testing agency.

D. Seismic Qualification Certificates: For air compressors, accessories, and components, from manufacturers.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control reports.

F. Operation and Maintenance Data: For compressed-air equipment to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Air System Equipment for Healthcare Facilities: Qualify installers according to ASSE 6010.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the compressed-air equipment testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.

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.
D. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

E. Comply with NFPA 99, "Health Care Facilities," for compressed-air equipment and accessories for medical air systems.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Medical Compressed-Air Service(s): Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

1.7 COORDINATION

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS

A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; with inlet air filters and dryers, Single point of connection. continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.

1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
3. Control Voltage: 120-V ac or less, using integral control power transformer.
5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Wired for two power circuits, equal number of pumps per circuit.
7. Automatic control switches to [alternate lead-lag air compressors for duplex] [and] [sequence lead-lag air compressors for multiplex] air compressors.
8. Instrumentation: Include discharge-air and receiver pressure gages, air-filter maintenance indicator, hour meter, air-compressor discharge-air and coolant temperature gages, and control transformer.
9. Alarm Signal Device: For connection to alarm system to indicate high dewpoint, CO2 level high and when stand-by air compressor is operating.
10. Short Circuit Current Ratings:

   a. Short-Circuit Current: Match rating of overcurrent protective device serving medical air compressors.
b. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   1. Pressure Rating: At least as high as highest discharge pressure of connected air compressors and bearing appropriate code symbols.
   2. Interior Finish: Corrosion-resistant coating.
   3. Accessories: Include safety valve, pressure gage, automatic drain, and pressure regulator.

D. Mounting Frame: Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.2 MANUFACTURERS

A. Manufacturers for fully assembled packaged air compressor units:
   1. Allied Healthcare Products, Inc.
   2. BeaconMedas
   3. Amico
   4. Pattons Medical

2.3 OIL-FREE, RECIPROCATING AIR COMPRESSORS

A. Description: Packaged unit.

B. Air Compressor(s): Oil-free, reciprocating-piston type with nonlubricated compression chamber and lubricated crankcase, and of construction that prohibits oil from entering compression chamber.
   1. Submerged gear-type oil pump, and oil filter.
   2. Intercooler between stages of two-stage units.
   3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
   4. Belt guard totally enclosing pulleys and belts.

C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.4 OILLESS, RECIPROCATING AIR COMPRESSORS

A. Description: Packaged unit.

B. Air Compressor(s): Single- or two-stage, oilless (nonlubricated), reciprocating-piston type, with sealed oil-free bearings, that will deliver air of quality equal to intake air.
   1. High discharge-air temperature switch.
   2. Belt guard totally enclosing pulleys and belts.
   3. Intercooler between stages of two-stage units.
C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.5 ROTARY-SCROLL AIR COMPRESSORS

A. Description: Packaged unit.

B. Air Compressor(s): Single-stage, oil-free, rotary, scroll type of construction that prohibits oil from entering compression chamber.

2. Air Filter: Dry type, with maintenance indicator and cleanable replaceable filter element.
4. Capacity Control: Capacity modulation between 0 and 100 percent air delivery, with operating pressures between 50 and 100 psig. Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.6 INLET-AIR FILTERS

A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match capacity of air compressor, with collection efficiency of 99 percent retention of particles larger than 10 micrometers.

B. Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match total capacity of connected air compressors, with collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.7 DESICCANT COMPRESSED-AIR DRYERS

A. Manufacturers:

1. BeaconMedaes.
2. Domnick Hunter Limited; ZANDER, Inc.
3. EMSE Corporation.
5. Ingersoll-Rand; Air Solutions Group.
6. Kaeser Compressors, Inc.
7. Zeks Compressed Air Solutions.
B. Description: Twin-tower unit with purge system, mufflers, and capability to deliver plus 10 deg F, 100-psig air at dew point. Include dew point controlled purge, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.8 COMPRESSED-AIR PURIFICATION SYSTEMS

A. Manufacturers:

2. Domnick Hunter Limited; ZANDER, Inc.
3. Ingersoll-Rand; Air Solutions Group.
4. Kaeser Compressors, Inc.

B. Description: Compressed-air purification system sized for maximum connected equipment capacity with coalescing, particulate, and activated-charcoal filters; compressed-air dryer; catalytic converter; gages and thermometers; and controls.

1. Include the following capabilities:
   a. Removal of excessive moisture, solid particulates, oil and oil mist, carbon monoxide, and hydrocarbon vapors.
   b. Automatic ejection of condensate from airstream.
   c. Production of air complying with USP - NF for medical air.
   d. Capacity and dew point indicated, but not higher than [35 deg F at 100 psig] <Insert pressure>.

2. Filters: Parallel duplex filters, each sized for maximum system demand, with valved bypass for filter servicing.

   a. Inlet Filters: 5 micrometers.
   b. Outlet Filters: 1 micrometer(s).

3. Accessories: Inlet and outlet pressure gages, thermometers, safety valves, and shutoff valves; and automatic ejection of condensate from airstream.

4. Differential Pressure Switch: Adjustable, diaphragm type, with electrical connections for alarm system, to indicate when air-pressure drop through filters rises to more than 2 psig greater than when new and clean.

   a. Inlet Connection: From inlet to particulate filter.
   b. Outlet Connection: To outlet from final activated-charcoal filter.

5. Compressed-Air Dryer: Twin-tower desiccant type with automatic controls, purge system, and mufflers.

C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.9 MEDICAL COMPRESSED-AIR EQUIPMENT ALARM SYSTEMS

A. General Requirements for Medical Compressed-Air Equipment Alarm System: Compatible alarm panels, remote sensing devices, and other related components as required by NFPA 99
for Level 1 alarm systems. Refer to Division 22 Section "Compressed-Air Piping for Laboratory and Healthcare Facilities" for medical compressed-air piping and alarm systems. Power wiring is specified in Division 26 Sections.

B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

C. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.

1. Operation: Chilled-mirror method or hygrometer moisture analyzer with sensor probe.

D. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.

1. Low-Pressure Switches: 0- to 100-psig operating range.
2. High-Pressure Switches: Up to 250-psig operating range.

E. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.

F. General Requirements for Medical Compressed-Air Equipment Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

2.10 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.11 COMPUTER INTERFACE CABINET

A. Description:

1. Wall mounting.
2. Welded steel with white-enamel finish.
3. Gasketed door.
4. Grounding device.
5. Factory-installed signal circuit boards.
7. Circuit breaker.
8. Wiring terminal board.
9. Internal wiring capable of interfacing all alarm signals.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean compressed-air equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for medical air applications, according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."

3.2 COMPRESSED-AIR EQUIPMENT INSTALLATION

A. Install compressed-air equipment for healthcare facilities according to ASSE 6010 and NFPA 99.

B. Equipment Mounting: Install vacuum producers on concrete bases using [elastomeric pads] [elastomeric mounts] [restrained spring isolators]. Comply with requirements in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

1. Minimum Deflection: [1/4 inch] [1 inch] <Insert dimension>.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Install equipment anchored to substrate.

D. Orient equipment so controls and devices are accessible for servicing with clearances per the NEC.

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. General Requirements for Compressed-Air Equipment Installation:

1. Install compressed-air equipment to allow maximum headroom unless specific mounting heights are indicated.
2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces unless otherwise indicated.
3. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
4. Install equipment to allow right of way for piping installed at required slope.
5. Install the following devices on compressed-air equipment:

a. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.

b. Pressure Regulators: Install downstream from air compressors, dryers, purification units, and filter assemblies.
c. **Drain Valves:** Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

### 3.3 MEDICAL COMPRESSED-AIR EQUIPMENT ALARM SYSTEM INSTALLATION

A. Alarm panels for medical compressed-air equipment may be combined in single panels with medical vacuum equipment and medical gas piping systems.

B. Install medical compressed-air equipment alarm system components in locations required by and according to NFPA 99.

### 3.4 COMPUTER INTERFACE CABINET INSTALLATION

A. Install computer interface cabinet with connection to medical compressed-air piping alarm system and to facility computer.

### 3.5 CONNECTIONS

A. Comply with requirements for water-supply piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for drain piping specified in Division 22 Section "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Comply with requirements for compressed-air piping specified in Division 22 Section "Compressed-Air Piping for Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.

D. Install piping adjacent to equipment to allow service and maintenance.

E. Connect compressed-air piping to compressed-air equipment, accessories, and specialties with shutoff valve and union or flanged connection.

### 3.6 IDENTIFICATION

A. Identify medical compressed-air equipment system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment." and comply with NFPA 99.

### 3.7 FIELD QUALITY CONTROL FOR HEALTHCARE-FACILITY MEDICAL COMPRESSED-AIR EQUIPMENT

A. **Testing Agency:** Engage a qualified testing agency to perform tests and inspections.

B. **Manufacturer’s Field Service:** Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. **Perform tests and inspections.**
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Medical Compressed-Air Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air equipment concurrently with tests, inspections, and certification of medical vacuum equipment, medical vacuum piping, medical compressed-air piping and medical gas piping systems.

2. Preparation: Perform medical compressed-air equipment tests according to requirements in NFPA 99 for the following:
   a. Air-quality purity test.
   b. System operation test.

3. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for verification of medical compressed-air equipment.

4. Replace damaged and malfunctioning controls and equipment.

5. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
   a. Inspections performed.
   b. Procedures, materials, and gases used.
   c. Test methods used.
   d. Results of tests.

E. Components will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that air-compressor inlet filters and piping are clear.
5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure but not higher than rating of system components.
7. Check for proper seismic restraints.
8. Drain receiver tanks.
9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
10. Test and adjust controls and safeties.
3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors[, compressed-air dryers] [compressed-air purification units].

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY
A. [Provide piping, valves, fittings and related products as listed on Drawings and described herein. All products to be purchased from Ferguson Enterprises.]
B. This Section includes the following:
   1. Medical surgical vacuum piping and specialties, designated “medical vacuum” operating at [15 inches mercury] [20 inches mercury] [30 inches mercury] <Insert vacuum>.
   2. Waste anesthetic gas disposal piping and specialties, designated "WAGD evacuation" operating at [14 inches mercury] [15 inches mercury] <Insert vacuum>.
C. Related Sections include the following:
   1. Division 11 Section "Laboratory Fume Hoods" for vacuum outlets in laboratory fume hoods.
   2. Division 12 Section "Laboratory Casework" for vacuum outlets in casework.
   3. Division 12 Section "Healthcare Casework" for vacuum outlets in metal medical casework.
   4. Division 22 Section "Vacuum Equipment for Healthcare Facilities" for medical vacuum producers.
   5. Division 22 Section “Vacuum Piping for Laboratory Facilities” for laboratory vacuum piping.
   6. Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment” for hangers and supports.
   7. Division 22 Section “Common Work Results for Plumbing” for Sleeves and Escutcheons.

1.2 DEFINITIONS
A. D.I.S.S.: Diameter-index safety system.
B. HVE: High-volume (oral) evacuation.
C. 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.
D. WAGD: Waste anesthetic gas disposal.
E. Medical vacuum piping systems include medical vacuum and WAGD evacuation piping systems.

1.3 SUBMITTALS
A. Product Data: For the following:
1. Vacuum pipes tubes and fittings.
2. Vacuum valves and valve boxes.
3. Medical vacuum outlets and vacuum-bottle brackets.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.

D. Qualification Data: For Installer and testing agency.

E. Brazing certificates.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is [a member of the Medical Gas Professional Healthcare Organization or is] an NRTL, and that is acceptable to authorities having jurisdiction.
   1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

C. Source Limitations: Obtain vacuum outlets of same type and from same manufacture as provided for in Division 22 Section "Gas Piping for Healthcare Facilities."


E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


1.5 PROJECT CONDITIONS

A. Interruption of Existing Medical Vacuum Service(s): Do not interrupt medical vacuum service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
1. Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of medical vacuum service(s).
2. Do not proceed with interruption of medical vacuum service(s) without Owner’s written permission.

1.6 COORDINATION

A. Coordinate medical vacuum outlets with other medical gas outlets. Medical compressed-air outlets are specified in Division 22 Section "Medical Compressed-Air Piping for Healthcare Facilities." and medical gas outlets are specified in Division 22 Section "Gas Piping for Healthcare Facilities."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.

1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.

B. Copper Water Tube: ASTM B 88, Type M, seamless, drawn temper.


C. Memory-Metal Couplings “SMART TAP”: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

1. Manufacturers:
   a. Smart Technology, Inc.
   b. <Insert manufacturer’s name>.

D. [PVC Pipe: ASTM D 1785, Schedule 40. (Protective conduit)]

1. PVC Fittings: ASTM D 2466, Schedule 40, socket type.]

2.2 JOINING MATERIALS

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

B. Threaded-Joint Tape: PTFE.
C. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.

D. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

E. [Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.]

2.3 Manufacturers for All products listed below including valves, zone valve boxes and alarms:

   a. Allied Healthcare Products, Inc.
   b. Amico Corporation.
   c. BeaconMedaes.

2.4 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
   1. Pressure Rating: 300 psig minimum.
   2. Ball: Full-port, chrome-plated brass.
   3. Seats: PTFE or TFE.
   4. Handle: Lever type with locking device.
   5. Stem: Blowout proof with PTFE or TFE seal.

C. Copper-Alloy Butterfly Valves:
   1. Pressure Rating: 300 psig minimum.
   2. Ball: Full-port, chrome-plated brass.
   3. Seats: PTFE or TFE.
   4. Handle: Lever type with locking device.
   5. Stem: Blowout proof with PTFE or TFE seal.

D. Bronze Check Valves: In-line pattern.
   1. Pressure Rating: 300 psig minimum.
   2. Operation: Spring loaded.

E. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
   1. Pressure Rating: 300 psig minimum.
   2. Ball: Full-port, chrome-plated brass.
   3. Seats: PTFE or TFE.
   4. Handle: Lever.
   5. Stem: Blowout proof with PTFE or TFE seal.
   7. Vacuum Gage: Manufacturer installed on one copper-tube extension.
F. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.

1. Interior Finish: Factory-applied white enamel.
2. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
3. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

G. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.

2.5 MEDICAL VACUUM OUTLETS

A. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

1. Roughing-in Assembly:
   a. Steel outlet box for recessed mounting and concealed piping.
   b. Brass-body inlet block.
   c. Seals that will prevent vacuum leakage.
   d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

2. Finishing Assembly:
   a. Brass housing with primary check valve.
   b. Seals that will prevent vacuum leakage.
   c. Cover plate with gas-service label.

3. Quick-Coupler gas outlets: Suction inlets for medical vacuum and WAGD evacuation service outlets with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

4. D.I.S.S. gas outlets: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

5. Vacuum Slides: One piece, with pattern and finish matching corresponding service cover plate.

6. Cover Plates: One piece, [stainless steel, with NAAMM AMP 503, No. 4 finish] [metal, with chrome-plated finish] [anodized aluminum] and permanent, color-coded, identifying label matching corresponding service.
2.6 MEDICAL VACUUM PIPING ALARM SYSTEMS

A. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.

B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

C. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Vacuum Operating Range: 0- to 30-in. Hg.

D. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   1. Mounting: Recessed installation.
   2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

E. Master Alarm Panels: With separate trouble alarm signals, vacuum gages, and indicators for medical vacuum piping systems.
   1. Include alarm signals when the following conditions exist:
      a. Medical Vacuum: Vacuum drops below 12-in. Hg and backup vacuum pump is in operation.
      b. WAGD Evacuation: Vacuum drops below 12-in. Hg.

F. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   1. Include alarm signals when the following conditions exist:
      a. Medical Vacuum: Vacuum drops below 12-in. Hg.
      b. WAGD Evacuation: Vacuum drops below 12-in. Hg.

2.7 COMPUTER INTERFACE CABINET

A. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical vacuum piping system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing all alarm signals.

2.8 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Hyspan Precision Products, Inc.
5. Metraflex, Inc.
6. Proco Products, Inc.
7. Unaflex.
8. Universal Metal Hose; a Hyspan Co.
9. <Insert manufacturer's name>.

B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

2. End Connections: Threaded copper pipe or plain-end copper tube.

2.9 NITROGEN

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen, for blow down and testing.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
   a. Scrub to ensure complete cleaning.
   b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

A. Connect new copper tubing to existing tubing with memory-metal couplings.

B. Medical Vacuum Piping: Use the following piping materials for each size range:

1. NPS 8 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

C. WAGD Evacuation Piping: Use the following piping materials for each size range:

1. NPS 4 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

D. Drain Piping: Use the following piping materials:
1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

E. [Protective Conduit: Use PVC pipe, PVC fittings, and solvent-cemented joints.]

3.3 PIPING INSTALLATION

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

B. Comply with ASSE Standard #6010 for installation of vacuum piping.

C. Install piping concealed from view and protected from physical contact by building occupants 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 and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install nipples, special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.

H. Install piping to permit valve servicing.

I. Install piping free of sags and bends.

J. Install medical vacuum piping to medical vacuum outlets specified in this Section and to equipment specified in other Sections requiring medical vacuum service.

K. Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

L. Install medical vacuum outlets recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

M. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.

N. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.

O. [Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings.]

3.4 VALVE APPLICATIONS

A. Valves for Copper Vacuum Tubing:
1. NPS 4 and Smaller: Use copper alloy ball and bronze check types.
2. NPS 6 (DN 200) and larger: Use copper alloy butterfly type.

3.5 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from vacuum equipment and specialties.
B. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.
C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
E. Install safety valves on vacuum receivers, where required by NFPA 99, and where recommended by specialty manufacturers.
F. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain, so contents spill over or into it.
G. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

3.6 JOINT CONSTRUCTION

A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Threaded Joints: Apply appropriate tape to external pipe threads.
D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
E. Flanged Joints:
   1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
F. Memory-Metal Coupling Joints “SMART TAP”: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
G. [Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.]
3.7 MEDICAL VACUUM PIPING ALARM SYSTEM INSTALLATION

A. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air piping systems and medical gas piping systems.

B. Install medical vacuum piping system alarm system components in locations required by and according to NFPA 99.

C. Install medical vacuum piping system area and master alarm panels where indicated.

D. Install computer interface cabinet with connection to medical vacuum piping alarm system and to facility computer.

3.8 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Medical Vacuum: Black letters on white background.
2. WAGD: White letters on violet background.

3.9 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.

B. Perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.

C. Tests and Inspections:

1. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.

2. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:

a. Initial blow down.
b. Initial pressure test.
c. Cross-connection test.
d. Piping purge test.
e. Standing pressure test for vacuum systems.
f. Repair leaks and retest until no leaks exist.

3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:

a. Standing pressure test.
b. Individual-pressurization or pressure-differential cross-connection test.
c. Valve test.
d. Master and area alarm tests.
e. Piping purge test.
f. Final tie-in test.
g. Operational vacuum test.
h. Verify correct labeling of equipment and components.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

a. Inspections performed.
b. Procedures, materials, and gases used.
c. Test methods used.
d. Results of tests.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.10 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems. Refer to Division 01 Section “Demonstration and Training.”

END OF SECTION
SECTION 226219

VACUUM EQUIPMENT FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Packaged, oil-free, rotary claw vacuum pumps.
   2. Packaged, oil-free, rotary, sliding-vane vacuum pumps.
   3. Packaged, oil-sealed, rotary, sliding-vane vacuum pumps.
   4. Medical vacuum equipment alarm systems.

1.2 DEFINITIONS

A. Actual Air: Air delivered at vacuum producer inlet. Flow rate is air measured in expanded cfm.

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. Medical vacuum equipment includes medical vacuum equipment and accessories for healthcare facilities.

D. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.


1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design vacuum equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Vacuum equipment shall withstand the effects of earthquake motions determined according to [SEI/ASCE 7] <Insert requirement>.

   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
1. Wiring Diagrams: For power, signal, and control wiring.
2. Short-circuit current rating of controller assembly.

B. Delegated-Design Submittal: For vacuum-producing equipment mounting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of supports.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

C. Qualification Data: For qualified Installer and testing agency.

D. Seismic Qualification Certificates: For vacuum producers, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control reports.

F. Operation and Maintenance Data: For vacuum equipment to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Medical Vacuum System Equipment for Healthcare Facilities: Qualify installers according to ASSE 6010.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum equipment testing indicated, that is[ a member of the Medical Gas Professional Healthcare Organization or is] an NRTL, and that is acceptable to authorities having jurisdiction.
   1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.

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.

D. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

E. Comply with NFPA 99, "Health Care Facilities," for vacuum equipment and accessories for medical vacuum systems.
1.6  PROJECT CONDITIONS

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

1. Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of service.
2. Do not proceed with interruption of 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  GENERAL REQUIREMENTS FOR PACKAGED VACUUM PUMPS

A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty vacuum pumps and receivers, with a single point of connection.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.

1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
3. Control Voltage: 120-V ac or less, using integral control power transformer.
5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Wired for two power circuits, equal number of pumps per circuit.
7. Automatic control switches to [alternate lead-lag vacuum pumps for duplex] [and] [sequence lead-lag vacuum pumps for multiplex] vacuum pumps.
8. Instrumentation: Include vacuum pump inlet and receiver vacuum gages, hour meter, vacuum pump discharge-air and coolant temperature gages, and control transformer.
9. Alarm Signal Device: For connection to alarm system to indicate when stand-by vacuum pump is operating.
10. Short Circuit Current Ratings:

   a. Short-Circuit Current: Match rating of overcurrent protective device serving vacuum equipment.
   b. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1; bearing appropriate code symbols.

1. Interior Finish: Corrosion-resistant coating.
2. Accessories: Include vacuum relief valve, vacuum gage, and drain.
D. Mounting Frame: Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.2 MANUFACTURERS

A. Manufacturers for fully assembled packaged vacuum pump units:

1. Allied Healthcare Products, Inc.
2. BeaconMedas
3. Amico
4. Pattons Medical

2.3 OIL-FREE, ROTARY CLAW VACUUM PUMPS

A. Description: Packaged unit.

B. Vacuum Pump(s): Oil-free, rotary, claw type.

1. Air-cooled
2. Direct drive
3. Heavy duty precision timing gears
4. Outlet silencers on discharge connections.

C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.4 OIL-FREE, ROTARY, SLIDING-VANE VACUUM PUMPS

A. Description: Packaged unit.

B. Vacuum Pump(s): Nonpulsating, oil-free, rotary, sliding-vane type.

1. Cleanable inlet screens.
2. Outlet silencers on discharge connections.

C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.5 OIL-SEALED, ROTARY, SLIDING-VANE VACUUM PUMPS

A. Description: Packaged unit.

B. Vacuum Pumps: Nonpulsating, oil-sealed, rotary, sliding-vane type.

1. Cleanable inlet screens.
2. Outlet silencers and oil-mist separators on discharge connections.

C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS
2.6 MEDICAL VACUUM EQUIPMENT ALARM SYSTEMS

A. General Requirements for Medical Vacuum Equipment Alarm System: Compatible alarm panels, remote sensing devices, and other related components as required by NFPA 99 for Level 1 alarm systems. Refer to Division 22 Section "Vacuum Piping for Healthcare Facilities" for medical vacuum piping and alarm systems. Power wiring is specified in Division 26 Sections.

B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include a minimum of two step-down transformers.

C. Vacuum Switches or Transducer Sensors: Continuous equipment monitoring with electrical connections for alarm system.
   1. Vacuum Switches: 0- to 30-in. Hg vacuum operating range.

D. General Requirements for Medical Vacuum Equipment Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

2.7 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.8 COMPUTER INTERFACE CABINET

A. Description:
   1. Wall mounting.
   2. Welded steel with white-enamel finish.
   3. Gasketed door.
   4. Grounding device.
   5. Factory-installed signal circuit boards.
   7. Circuit breaker.
   8. Wiring terminal board.
   9. Internal wiring capable of interfacing all alarm signals.
**PART 3 - EXECUTION**

3.1 **PREPARATION**

A. Clean vacuum equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for medical vacuum applications, according to CGA G4.1, "Cleaning Equipment for Oxygen Service."

3.2 **VACUUM EQUIPMENT INSTALLATION**

A. Install vacuum equipment for healthcare facilities according to ASSE 6010 and NFPA 99.

B. Equipment Mounting: Install vacuum producers on concrete bases using [elastomeric pads] [elastomeric mounts] [restrained spring isolators]. Comply with requirements in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

1. Minimum Deflection: [1/4 inch] [1 inch] <Insert dimension>.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Install vacuum equipment anchored to substrate.

D. Orient equipment so controls and devices are accessible for servicing with clearances per the NEC.

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. General Requirements for Compressed-Air Equipment Installation:

1. Install compressed-air equipment to allow maximum headroom unless specific mounting heights are indicated.
2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces unless otherwise indicated.
3. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
4. Install equipment to allow right of way for piping installed at required slope.
5. Install the following devices on vacuum equipment:
   a. Thermometer, Vacuum Gage, and Pressure Relief Valve: Install on each vacuum pump receiver.
   b. Drain Valves: Install on receivers. Discharge receiver condensate over nearest floor drain. Discharge separator oral evacuation fluids by direct connection into sanitary waste piping system.

3.3 **MEDICAL VACUUM EQUIPMENT ALARM SYSTEM INSTALLATION**

A. Alarm panels for medical vacuum equipment may be combined in single panels with medical air equipment and medical gas piping systems.
B. Install medical vacuum equipment alarm system components in locations required by and according to NFPA 99.

3.4 COMPUTER INTERFACE CABINET INSTALLATION
A. Install computer interface cabinet with connection to medical vacuum piping alarm system and to facility computer.

3.5 CONNECTIONS
A. Comply with requirements for drain piping specified in Division 22 Section "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Comply with requirements for vacuum piping specified in Division 22 Section "Vacuum Piping for Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.
C. Install piping adjacent to equipment to allow service and maintenance.
D. Connect vacuum piping to vacuum equipment, accessories, and specialties with shutoff valve and union or flanged connection.

3.6 IDENTIFICATION
A. Identify medical vacuum equipment system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment." and with NFPA 99.

3.7 FIELD QUALITY CONTROL FOR HEALTHCARE-FACILITY MEDICAL VACUUM EQUIPMENT
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
C. Perform tests and inspections.
   1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
D. Tests and Inspections:
   1. Medical Vacuum Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum equipment concurrently with tests, inspections, and certification of medical compressed-air equipment, medical compressed-air piping, medical vacuum piping and medical gas piping systems.
   2. Preparation: Perform medical vacuum equipment tests according to requirements in NFPA 99 for the following:
      a. System operation test.
b.  **<Insert additional requirements>**.

3. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for verification of medical vacuum equipment.
4. Replace damaged and malfunctioning controls and equipment.
5. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
   
   a. Inspections performed.
   b. Procedures and materials used.
   c. Test methods used.
   d. Results of tests.

E. Components will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 **STARTUP SERVICE**

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer’s written instructions.
2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that vacuum producer outlet piping is clear.
5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
6. Check safety valves for correct settings.
7. Check for proper seismic restraints.
8. Drain receiver tank.
9. **Operational Test:** After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
10. Test and adjust controls and safeties.

B. Verify that vacuum equipment is installed and connected according to the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer’s submittal and written installation requirements in Division 26 Sections.

D. Prepare written report documenting testing procedures and results.

3.9 **DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain vacuum producers.

**END OF SECTION**
SECTION 226313
GAS PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. [Provide piping, valves, fittings and related products as listed on Drawings and described herein. All products to be purchased from Ferguson Enterprises.]

B. This Section includes the following:

1. Carbon dioxide piping and specialties designated “medical carbon dioxide” operating at [50 to 55 psig] <Insert pressure range>.
2. Helium piping, designated “medical helium” operating at [50 to 55 psig] <Insert pressure range>.
3. Nitrogen piping and specialties designated “medical nitrogen” operating at [160 to 185 psig] [higher than 200 psig] <Insert pressure range>.
5. Oxygen piping and specialties designated “medical oxygen” operating at [50 to 55 psig] <Insert pressure range>.
6. <Insert specialty gas> piping and specialties designated "specialty <Insert designation>" operating at [50 to 55 psig] <Insert pressure range>.

C. Owner-Furnished Material:

1. Medical gas manifolds.
2. Ceiling columns.
5. Modular Headwalls.
6. Owner will furnish gases for medical gas concentration testing specified in this Section.

D. Related Sections include the following:

1. Division 12 Section "Healthcare Casework" for gas outlets in metal medical casework.
2. Division 22 Section "Compressed-Air Piping for Healthcare Facilities" for compressed-air piping systems for healthcare facilities.
3. Division 22 Section "Vacuum Piping for Healthcare Facilities" for vacuum piping systems for healthcare facilities.
4. Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment” for hangers and supports.
5. Division 22 Section “Common Work Results for Plumbing” for Sleeves and Escutcheons.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. D.I.S.S.: Diameter-index safety system.
C. 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.

D. Medical gas piping systems include [medical carbon dioxide] [medical helium] [medical nitrogen] [medical nitrous oxide] [and] [medical oxygen] <Insert medical gas> nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: [Gas manifolds] and piping shall withstand the effects of earthquake motions determined according to [SEI/ASCE 7] <Insert code requirement>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 SUBMITTALS

A. Product Data: For the following:

1. Tubes and fittings.
2. Valves and valve boxes.
3. Medical gas outlets.
4. Electrical service connections.
5. Medical nitrogen pressure control panels.
7. Gas manifolds.
8. Medical gas alarm system components.
9. Gas cylinder storage racks.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.

D. Qualification Data: For Installer and testing agency.

E. Brazing certificates.

F. Manufacturer Seismic Qualification Certification: Submit certification that [gas manifolds], accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For [specialty] [and] [medical] gas piping specialties to include in emergency, operation, and maintenance manuals.
1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. ASME Compliance: Fabricate and label bulk medical gas storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

F. NFPA Compliance:

1. Comply with NFPA 99, for bulk oxygen storage tanks.


H. UL Compliance:


1.6 PROJECT CONDITIONS

A. Interruption of Existing [Specialty] [and] [Medical] Gas Service(s): Do not interrupt [specialty] [or] [medical] gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of [specialty] [and] [medical] gas service(s).
2. Do not proceed with interruption of [specialty] [and] [medical] gas service(s) without Owner's written permission.
1.7 COORDINATION

A. Coordinate medical gas outlets with other service connections. Compressed-air service connections are specified in Division 22 Sections "Compressed-Air Piping for Healthcare Facilities” and "Vacuum Piping for Healthcare Facilities."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Types K and L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.

1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
3. Memory-Metal Couplings (Smart Tap): Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory-alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

   a. Manufacturers:

      1) Smart Technology, Inc.
      2) <Insert manufacturer's name>.

B. [PVC Pipe: ASTM D 1785, Schedule 40. (Protective conduit)]

1. PVC Fittings: ASTM D 2466, Schedule 40; socket type.]

2.2 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. [Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.]}

2.3 Manufacturers for all products listed below including valves, zone valve boxes, alarms and manifolds:

   a. Allied Healthcare Products, Inc.
   b. Amico Corporation.
   c. BeaconMedaes.

2.4 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
   1. Pressure Rating: 300 psig minimum.
   2. Ball: Full-port, chrome-plated brass.
   3. Seats: PTFE or TFE.
   4. Handle: Lever type with locking device.
   5. Stem: Blowout proof with PTFE or TFE seal.

C. Check Valves: In-line pattern, bronze.
   1. Pressure Rating: 300 psig minimum.
   2. Operation: Spring loaded.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
   1. Pressure Rating: 300 psi minimum.
   2. Ball: Full-port, chrome-plated brass.
   3. Seats: PTFE or TFE.
   4. Handle: Lever.
   5. Stem: Blowout proof with PTFE or TFE seal.
   7. Pressure Gage: Manufacturer-installed on one copper-tube extension.

E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
   1. Interior Finish: Factory-applied white enamel.
   2. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
   3. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

F. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
   1. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
   2. Inlet: Manufacturer-installed, NPS 1, ASTM B 819, copper tubing with NPS 1 minimum ball valve and plugged inlet.
   3. Safety Valve: Bronze-body, pressure relief valve set at 75 or 80 psig.
   4. Instrumentation: Pressure gage.

G. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

H. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.
2.5 MEDICAL GAS OUTLETS

A. General Requirements for Medical Gas Outlets: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

1. Roughing-in Assembly:
   a. Steel outlet box for recessed mounting and concealed piping.
   b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
   c. Double seals that will prevent gas leakage.
   d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

2. Finishing Assembly:
   a. Brass housing with primary check valve.
   b. Double seals that will prevent gas leakage.
   c. Cover plate with gas-service label.

3. Quick-Coupler gas outlets: Pressure outlets for [carbon dioxide] [nitrous oxide] [oxygen] [and] <Insert medical gas> service connections with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

4. D.I.S.S. gas outlets: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
   a. Medical Carbon Dioxide outlets: D.I.S.S. No. 1080.
   d. Medical Nitrous Oxide outlets: D.I.S.S. No. 1040.
   e. Medical Oxygen outlets: D.I.S.S. No. 1240.
   f. <Insert medical gas> outlets: <Insert D.I.S.S. number>, [pressure outlet] [suction inlet].

5. Cover Plates: One piece, [stainless steel, with NAAMM AMP 503, No. 4 finish] [metal, with chrome-plated finish] [anodized aluminum] and permanent, color-coded, identifying label matching corresponding service.

2.6 ELECTRICAL SERVICE CONNECTIONS

A. Power Outlets: UL 498, Hospital Grade, 125-V receptacles; color selected by Architect. Include the following configurations complying with NEMA WD 1:
   1. L5-20R, locking type, 20 A, single or duplex.
   2. L5-20R, isolated ground, locking type, 20 A, single or duplex.
   3. <Insert outlet type>.
   4. Explosion proof, 20 A, 2 pole, 3 wire, single; suitable for Class I, Group C hazardous location and interchangeable with receptacles used in nonhazardous areas; flush mounted.
5. <Insert outlet type>.
6. 5-20R, straight blade, 20 A, duplex.
7. 5-20R, isolated ground, straight blade, 20 A, duplex.
8. <Insert outlet type>.

B. Electrical Accessory Outlets: Provide the following configured receptacles in color selected by Architect:
1. Patient Equipment Ground Jack: Single pole, 30 A.
2. Patient Monitoring: Single, [5] [and] [37] <Insert number> pin.
3. <Insert outlet type>.

C. Wall Outlet Cover Plates: One piece, [stainless steel, with NAAMM AMP 503, No. 4 finish] [metal, with chrome-plated finish] [anodized aluminum] and permanent identifying label.

2.7 MEDICAL NITROGEN PRESSURE CONTROL PANELS

A. Description: Steel box and support brackets for recessed roughing-in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
3. Pressure Gages: 0- to 300-psig range.
5. Before final assembly, provide temporary dust shield and U-tube for testing.
6. Label cover plate "Nitrogen Pressure Control."

2.8 CEILING HOSE ASSEMBLIES

A. Fixed Hose Service Assemblies: Individual, concealed hose connection with stainless-steel face plates, steel mounting boxes, factory- or field-fabricated mounting brackets, and color-coded service hoses with retractor device and service connections matching hoses. Include 72 inches of conductive, CR, 1/4- or 5/16-inch-, ID, medical gas hoses rated for 200-psig minimum working pressure, and the following service hose connections:
1. Instrument Air Hose: D.I.S.S. No. 1160 pressure outlet.
3. Medical Carbon Dioxide Hose: [Quick-coupler] [D.I.S.S. No. 1080] pressure outlet.
5. Medical Nitrous Oxide Hose: [Quick-coupler] [D.I.S.S. No. 1040] pressure outlet.
8. WAGD Evacuation Hose: [Quick-coupler] [D.I.S.S. No. 2220] suction inlet.
9. <Insert medical gas> Hose: <Insert number and type>.

2.9 GAS MANIFOLDS

A. Medical Gas Manifolds: Comply with NFPA 99, Ch. 5, for high-pressure medical gas cylinders.
1. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, pressure changeover switch, line-pressure regulator, shutoff valves, and safety valve.

2. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig minimum inlet pressure, except nitrous oxide manifolds may be designed for 800 psig and carbon dioxide manifolds may be designed for 1500 psig <Insert pressure>. Include cylinder bank headers with inlet (pigtails) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.

3. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.

4. Medical Carbon Dioxide Manifolds: For <Insert number of cylinders per bank> at [55-psig] <Insert pressure> line pressure.

5. Medical Helium Manifolds: For <Insert number of cylinders per bank> at [55-psig] <Insert pressure> line pressure.

6. Medical Nitrous Oxide Manifolds: For <Insert number of cylinders per bank> at [55-psig] <Insert pressure> line pressure, with electric heater or orifice design that will prevent freezing during high demand.

7. Medical Nitrogen Manifolds: For <Insert number of cylinders per bank> at [180-psig] [higher than 200-psig] <Insert pressure> line pressure.

8. Medical Oxygen Manifolds: For <Insert number of cylinders per bank> at [55-psig] <Insert pressure> line pressure.

9. Medical Gas Cylinders: [Will be furnished by Owner] [Number and type of medical gas cylinders required for complete manifold systems].

10. Label manifold control unit with permanent label identifying medical gas type and system operating pressure.

11. Mounting: [Wall with mounting brackets for manifold control cabinet and headers] [Floor with support legs for manifold control cabinet].

2.10 GAS CYLINDER STORAGE RACKS

A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.

B. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

2.11 BULK GAS STORAGE TANKS

A. Contractor to coordinate with owner and bulk gas supplier for bulk gas storage tanks and systems.

2.12 MEDICAL GAS PIPING ALARM SYSTEMS

A. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.
B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

C. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Low-Pressure Operating Range: 0- to 100-psig.
   2. High-Pressure Operating Range: Up to 250-psig.

D. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   1. Mounting: Recessed installation.
   2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

E. Master Alarm Panels: With separate trouble alarm signals, pressure gages, and indicators for medical gas piping systems.
   1. Include alarm signals when the following conditions exist:
      a. Medical Carbon Dioxide: Pressure drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.
      b. Medical Helium: Pressure drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.
      c. Medical Nitrogen: Pressure drops below 145 psig or rises above 200 psig and changeover is made to alternate bank.
      d. Medical Nitrous Oxide: Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig, changeover is made to reserve, reserve is in use, and reserve level is low.
      e. Medical Nitrous Oxide: Pressure drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.
      f. Medical Oxygen: Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig, changeover is made to reserve, reserve is in use, reserve level is low, and reserve pressure is low.
      g. Medical Oxygen: Pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.

F. Area Alarm Panels: Separate trouble alarm signals; pressure gages; and indicators for medical gas piping systems.
   1. Include alarm signals when the following conditions exist:
      a. Medical Carbon Dioxide: Pressure drops below 40 psig or rises above 60 psig.
      b. Medical Helium: Pressure drops below 40 psig or rises above 60 psig.
      c. Medical Nitrous Oxide: Pressure drops below 40 psig or rises above 60 psig.
      d. Medical Nitrogen: Pressure drops below 145 psig or rises above 200 psig.
      e. Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig.

2.13 COMPUTER INTERFACE CABINET

A. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical gas system
alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing all alarm signals.

2.14 NITROGEN

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen for blow down and testing.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction, perform the following procedures:

1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, “Cleaning Equipment for Oxygen Service.”
2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
   a. Scrub to ensure complete cleaning.
   b. Rinse with clean, hot water to remove cleaning solution.

3.2 EARTHWORK

A. Comply with requirements in Division 31 Section “Earth Moving” for excavating, trenching, and backfilling and for underground warning tapes.

3.3 PIPING APPLICATIONS

A. Medical Gas Piping Except Nitrogen: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

B. Medical Nitrogen Piping NPS 2-1/2 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

C. Medical Nitrogen Piping NPS 3 and Larger: Type K, copper tube; wrought-copper fittings; and brazed joints.

D. [Protective Conduit: Use PVC pipe, PVC fittings, and solvent-cemented joints.]

3.4 PIPING INSTALLATION

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

B. Comply with ASSE Standard #6010 for installation of medical gas piping.

C. Install piping concealed from view and protected from physical contact by building occupants 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 and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install nipples, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.

H. Install piping to permit valve servicing.

I. Install piping free of sags and bends.

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

K. [Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings.]

L. Install seismic restraints on gas piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

M. Install medical gas outlets recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

N. Connect medical gas piping to medical gas sources and to medical gas outlets and equipment requiring medical gas service.

3.5 VALVE INSTALLATION

A. Install shutoff valve at each connection to healthcare equipment and specialties.

B. Install check valves to maintain correct direction of gas flow from healthcare gas supplies.

C. Install zone valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in zone valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install pressure regulators on gas piping where reduced pressure is required.
F. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.6 JOINT CONSTRUCTION

A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

B. Threaded Joints: Apply appropriate tape to external pipe threads.

C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

D. Memory-Metal Coupling “Smart Tap” joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

E. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.

3.7 GAS SERVICE COMPONENT INSTALLATION

A. Assemble patient headwall units with outlets. Install with supplies concealed, in walls. Attach console box or mounting bracket to substrate.

B. Install nitrogen pressure-control panels in walls. Attach to substrate.

C. Assemble ceiling assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

D. Install gas manifolds anchored to substrate.

E. Install gas cylinders and connect to manifold piping.

F. Install gas manifolds with seismic restraints as indicated.

3.8 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION

A. Install medical gas alarm system components in locations required by and according to NFPA 99.

B. Install medical gas area and master alarm panels where indicated.

C. Install computer interface cabinet with connection to medical compressed-air-piping alarm system and to facility computer.
3.9 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Carbon Dioxide: Black or white letters on gray background.
5. Oxygen: White letters on green background or green letters on white background.

3.10 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.

B. Perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.

C. Tests and Inspections:

1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.

2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:

   a. Initial blow down.
   b. Initial pressure test.
   c. Cross-connection test.
   d. Piping purge test.
   e. Standing pressure test for positive pressure medical gas piping.
   f. Standing pressure test for vacuum systems.
   g. Repair leaks and retest until no leaks exist.

3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:

   a. Standing pressure test.
   b. Individual-pressurization or pressure-differential cross-connection test.
   c. Valve test.
   d. Master and area alarm tests.
   e. Piping purge test.
   f. Piping particulate test.
   g. Piping purity test.
   h. Final tie-in test.
   i. Operational pressure test.
   j. Medical gas concentration test.
   k. Medical air purity test.
   l. Verify correct labeling of equipment and components.
   m. Verify the following source equipment:
1) Medical gas supply sources.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
   
   a. Inspections performed.
   b. Procedures, materials, and gases used.
   c. Test methods used.
   d. Results of tests.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.11 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical gas alarm system. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 230130.51
HVAC AIR DUCT CLEANING

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes cleaning of the following duct systems:
   1. Supply system.
   2. Return system.
   3. Exhaust system.
B. Related Sections:
   1. Division 23 Section "Metal Ducts" for duct construction and connection methods.
   2. Division 23 Section “Air Duct Accessories” for additional duct connection requirements.

1.2 DEFINITIONS
A. ASCS: Air system cleaning specialist.
C. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.3 INFORMATIONAL SUBMITTALS
A. Manufacturer Certificates: Signed by manufacturers certifying that products comply with requirements.
B. Qualification Data: For ASCS.
C. Field quality-control test reports.

1.4 QUALITY ASSURANCE
A. ASCS Qualifications: A certified member of NADCA.
   1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
   2. Supervisor Qualifications: Certified as an ASCS by NADCA.
   3. Experience: Submit records of experience in the field of HVAC systems cleaning.
   4. Equipment, Materials, and Labor: Have equipment, materials, and labor required to perform specified services.
B. Comply with current published standards of NADCA.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine systems to determine appropriate methods, tools, and equipment required for performance of work.
B. Prepare written report listing conditions detrimental to performance of work.
C. Proceed with work only after unsatisfactory conditions have been corrected.

3.2 CLEANING

A. Engage a qualified ASCS to clean the following systems:
   1. Supply system.
   2. Return system.
   3. Exhaust system.
B. Perform cleaning before air balancing or mark position of dampers and air-directional mechanical devices before cleaning.
C. Use duct-mounted access doors, as required, for physical and mechanical entry and for inspection.
   1. Install additional duct-mounting access doors to comply with duct cleaning standards. Comply with requirements in Division 23 Section "Air Duct Accessories" for additional duct-mounting access doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection. Replace damaged and deteriorated flexible ducts. Comply with requirements in Division 23 Section "Air Duct Accessories" for flexible ducts.
   3. Disconnect and reconnect flexible connectors as needed for cleaning and inspection. Replace damaged and deteriorated flexible connectors. Comply with requirements in Division 23 Section "Air Duct Accessories" for flexible connectors.
   4. Reseal rigid-fiberglass-duct systems according to NAIMA recommended practices.
   5. Replace damaged fusible links on fire and smoke dampers. Replacement fusible links shall be same rating as those being replaced. Comply with requirements in Division 23 Section "Air Duct Accessories" for fusible links.
   6. Remove and reinstall ceiling components to gain access for duct cleaning. Clean ceiling components after they have been removed and replaced.
D. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.
E. Particulate Collection and Odor Control:
   1. Where venting vacuuming system inside building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or greater) particles.
2. When venting vacuuming system outside building, use filtration to contain debris removed from the HVAC system and locate exhaust down wind and away from air intakes and other points of entry into building.

F. Clean the following metal-duct system components by removing visible surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling-unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   5. Return-air ducts, dampers, and actuators, except in ceiling plenums and mechanical room.
   7. Dedicated exhaust and ventilation components.

G. Mechanical Cleaning Methodology:
   1. Clean metal-duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of ducts so areas being cleaned are under negative pressure.
   3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts or duct liner.
   4. Clean fibrous-glass duct liner with HEPA vacuuming equipment, and do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
   5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
   6. Provide operative drainage system for washdown procedures.
   7. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present; use according to manufacturer's written instructions after removal of surface deposits and debris.

H. Cleanliness Verification:
   1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
   2. Visually inspect metal-duct systems for contaminants.
   3. Where contaminants are discovered, reclean and reinspect duct systems.

3.3 CONNECTIONS

A. Reconnect ducts to fans and air-handling units with existing flexible connectors after cleaning ducts and flexible connectors. Replace existing damaged and deteriorated flexible connectors.

B. For fans developing static pressures of 5-inch wg and higher, cover replacement flexible connectors with loaded vinyl sheet held in place with metal straps.
C. Reconnect terminal units to supply ducts with existing flexible ducts or replace damaged and deteriorated existing flexible ducts with maximum 12-inch lengths of new flexible duct.

D. Reconnect diffusers or light troffer boots to low-pressure ducts with existing flexible ducts or replace damaged and deteriorated existing flexible ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

E. Reconnect existing and new flexible ducts to metal ducts with methods described in Division 23 Section "Metal Ducts".

3.4 FIELD QUALITY CONTROL

A. Gravimetric Analysis: Sections of metal-duct system, chosen randomly by Architect may be tested for cleanliness according to NADCA vacuum test gravimetric analysis.

1. If analysis determines that levels of debris are equal to or lower than suitable levels, system shall have passed cleanliness verification.
2. If analysis determines that levels of debris exceed suitable levels, system cleanliness verification will have failed and metal-duct system shall be recleaned and reverified.

B. Verification of Coil Cleaning: Cleaning shall restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

C. Report results of tests in writing.

END OF SECTION
1.1 SUMMARY

A. This Section includes the following:

1. Common terminology and requirements used throughout this Division.
2. Requirements for Acceptance Testing Agency.
3. Requirements for Professional Engineers responsible for Delegated Design.
4. Piping materials and installation instructions common to most piping systems.
5. Transition fittings.
6. Dielectric fittings.
7. Mechanical sleeve seals.
8. Sleeves.
10. Grout.
11. HVAC demolition.
12. Equipment installation requirements common to equipment sections.
13. Painting and finishing.
14. Concrete bases.
15. Supports and anchorages.

1.2 RELATED DOCUMENTS

A. In addition to Division 01 Specification Sections, related sections include the following:

1. Division 01 Section "Cutting and Patching"
2. Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
3. Division 03 Sections "Cast-in-Place Concrete" and "Miscellaneous Cast-in-Place Concrete".
4. Division 05 Section "Metal Fabrications" for structural steel.
5. Division 09 Sections "Interior Painting" and "Exterior Painting".
6. Division 08 Section "Access Doors and Frames" for access panels and doors.

1.3 DEFINITIONS

A. This section includes the following definitions that are common to most Division 23 Specifications.

1. Definitions found within this section, Division 23 “Common Work Results for HVAC,” are considered to generally apply to all sections unless otherwise noted.
2. Other sections may increase or decrease the scope and usage of a particular word, phrase, or abbreviation for the section in which it appears.
B. AHJ: Authority Having Jurisdiction. This abbreviation is the general term for all agencies having oversight and/or inspection authority for a scope of work, trade, or system. AHJ includes agencies such as local and state fire marshals, city inspectors, et. al.

C. AHU: Air handling unit. This abbreviation is the general term for systems that filter and/or changes the sensible and/or latent properties of air supplied to a space. Its use is synonymous with RTU, roof top unit, irrespective of a system’s physical location.

D. Bound Material: Bound refers to materials permanently bound, as by stitching or glue, or materials securely fastened in their covers by multiple fasteners that penetrate all papers. Ring binders, spiral binders, brads and screw posts are acceptable fasteners. Loose papers clipped together or stapled at one (1) corner are not acceptable.

E. Business Day: Where this Section and other Sections of this Division use the term “Business Day” it shall mean Monday thru Friday, excluding Holidays recognized by Federal, State and Local government.

F. CAV: Constant air volume.

G. 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.

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

I. CPVC: Chlorinated polyvinyl chloride plastic.

J. DDC: Direct-digital controls.

K. ECM: Electrically commutated motor.

L. EPDM: Ethylene propylene diene monomer rubber.

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

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

O. 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, crawlspace, and tunnels.

P. FMS: Facility Management System. May be used interchangeably with BAS, Building Automation System.

Q. Furnish: The material, equipment, etc. to be supplied, but not installed by the supplier.

R. Manufacturers:
   1. Available Manufacturers: When used, this allows any manufacturer in compliance with the requirements to be submitted and used for the system indicated, pending engineer’s approval. The list of manufacturers is intended to illustrate typical providers.
2. **Basis-of-Design**: The manufacturer indicated as such is required to be furnished. The Owner reserves the right to select additional manufacturers listed and adjust the bid amount up or down as is indicated on the bid form for the selected manufacturer.

3. **Manufacturers**: When used, restricts the list of acceptable manufacturers to only the entities indicated that comply with the requirements detailed.
   a. Where the product of a single manufacturer is mentioned by trade name or manufacturer's name in this Division, it is the only acceptable manufacturer.
   b. Where two (2) or more manufacturers are named, only those manufacturers will be considered or approved.

S. **NBR**: Acrylonitrile-butadiene rubber.

T. **NRTL**: Nationally Recognized Testing Laboratory.

U. **PE**: Polyethylene plastic.

V. **Products and Materials**: Components and assemblies for the construction of the systems as indicated in the Documents including, but not limited to pipes, tubes, ducts, and equipment.

W. **Products or Materials**: See “Products and Materials”.

X. **Provide**: The materials and equipment described shall be furnished, installed and connected under this Division, complete for operation, unless specifically noted to the contrary. Identical to the phrase “furnish and install”.

Y. **PVC**: Polyvinyl chloride plastic.

Z. **RTU**: Rooftop unit. The abbreviations means packaged, outdoor, central station AHUs. This abbreviation may be used regardless of whether the unit is located on a roof or at grade.

AA. **VAV**: Variable air volume.

BB. **VFD**: Variable frequency drive. This may be used interchangeably with VSD (variable speed drive), VSC (variable speed controller), and VFMC (variable frequency motor controller). This technology varies the frequency of the incoming electrical signal to change the speed of driven equipment.

1.4 **RELATED REQUIREMENTS**

A. All conditions imposed by these documents shall be applicable to all portions of the Work under this Division. These references are intended to point out specific items to the Contractor, but in no way relieve him of the responsibility of reading and complying with all relevant parts of the entire Specification.

B. The Contractor shall examine and coordinate with all Contract Drawings and Specifications, and all Addenda issued. Failure to comply shall not relieve them of responsibility. The omission of details of other portions of the Work from this Division shall not be used as a basis for a request for additional compensation.

C. The specific features and details for other portions of the Work related to the construction in progress or to the building(s) shall be determined by examination at the site.
1.5 RELATED REQUIREMENTS

A. All conditions imposed by these documents shall be applicable to all portions of the Work under this Division. These references are intended to point out specific items to the Contractor, but in no way relieve him of the responsibility of reading and complying with all relevant parts of the entire Specification.

1.6 ORDINANCES, PERMITS AND CODES

A. It shall be the Contractor’s duty to perform the work and provide the materials covered by these Specifications in conformance with all ordinances and regulations of all authorities having jurisdiction.

B. All work herein shall conform to all applicable laws, ordinances, and regulations of the local utility companies.

C. The work shall be in accordance with, but not limited to, the requirements of:

1. National Fire Protection Association
2. Wichita Falls Building Codes
3. Texas Safety Code
4. Texas Boiler Code
5. Texas Department Of State Health Services

D. Codes and standards referred to are minimum standards. Where the requirements of these Specifications or drawings exceed those of the codes and regulations, the drawings, and Specifications govern.

E. The Contractor shall obtain permits, plan checks, connection and specification fees, inspections, and approvals applicable to the Work as required by the regulatory authorities.

F. Fees and costs of any nature whatsoever incidental to permits, inspections, and approvals shall be assumed and paid by the Contractor.

G. The pro-rata costs, if any, for utilities serving this property will be paid for by the Owner and shall not be included as part of this Contract.

1.7 REFERENCE STANDARDS

A. Where differences between building codes, state laws, local ordinances, industry standards, utility company regulations and the Contract Documents occur, the most stringent shall govern. The Contractor shall promptly notify the Owner’s Representative in writing of any such difference.

B. Should the Contractor perform any Work that does not comply with local codes, laws and ordinances, industry standards or other governing regulations, the Work shall be corrected on noncompliance deficiencies with the Contractor bearing all costs.

C. In addition to the aforementioned ordinances, industry standards published by the following organizations shall apply:

1. AIA - AMERICAN INSTITUTE OF ARCHITECTS
2. AABC - ASSOCIATED AIR BALANCE COUNCIL
3. AASHO - AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS
4. ACI - AMERICAN CONCRETE INSTITUTE
5. ADC - AIR DIFFUSION COUNCIL
6. AGA - AMERICAN GAS ASSOCIATION
7. AHRI - AIR CONDITIONING HEATING & REFRIGERATION INSTITUTE
8. AISC - AMERICAN INSTITUTE OF STEEL CONSTRUCTION
9. AMCA - AIR MOVING AND CONDITIONING ASSOCIATION
10. ANSI - AMERICAN NATIONAL STANDARDS INSTITUTE
11. API - AMERICAN PETROLEUM INSTITUTE
12. ASCE - AMERICAN SOCIETY OF CIVIL ENGINEERS
13. ASHRAE - AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR CONDITIONING ENGINEERS, INC.
14. ASME - AMERICAN SOCIETY OF MECHANICAL ENGINEERS
15. ASTM - AMERICAN SOCIETY FOR TESTING AND MATERIALS
16. AWSC - AMERICAN WELDING SOCIETY CODE
17. AWWA - AMERICAN WATER WORKS ASSOCIATION
18. CDA - COPPER DEVELOPMENT ASSOCIATION
19. CISPI - CAST IRON SOIL PIPE INSTITUTE
20. CTI - COOLING TOWER INSTITUTE
21. FGI - FACILITY GUIDELINES INSTITUTE
22. FMG - FACTORY MUTUAL GLOBAL
23. ICC - INTERNATIONAL CODE COUNCIL
24. IRI - INDUSTRIAL RISK INSURERS
25. NBS - NATIONAL BUREAU OF STANDARDS
26. NFPA - NATIONAL FIRE PROTECTION ASSOCIATION
27. OSHPD - OFFICE OF STATEWIDE HEALTH PLANNING AND DEVELOPMENT
28. PDI - PLUMBING AND DRAINAGE INSTITUTE
29. SMACNA - SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION
30. TDLR - TEXAS DEPARTMENT OF LICENSING AND REGULATION
31. TSDHS - TEXAS DEPARTMENT OF STATE HEALTH SERVICES
32. UL - UNDERWRITER'S LABORATORIES

D. Where the Documents exceed the above requirements, the Documents shall govern. In no case shall Work be installed contrary to or below the minimum legal standards.

1.8 DRAWINGS AND SPECIFICATIONS

A. The inter-relations of the specifications, the drawings, and the schedules are as follows:

1. The specifications provide the written requirements for the quality, standard, nature of the materials, equipment and construction systems.
2. The drawings establish the quantities, approximate dimensions, details and location of equipment.
3. The schedules give the capacities, characteristics and components.

B. For any individual project, if there is conflict between the drawings and or specifications, they are equivalent in authority and priority. Should they disagree in themselves, or with each other, prices shall be based on the most expensive combination of quality and quantity of work indicated. In the event of the above mentioned disagreements the resolution shall be determined by the Architect.

C. Contractor is responsible to bring any conflicts in drawings and/or specifications to the attention of the Architect, immediately, prior to any work being done.
D. Review all construction details illustrated on the architectural and structural drawings and be guided thereby.

1.9 SUBMITTAL PROCEDURES

A. Simultaneous Action Submittals: When submittals are required and a simultaneous action is indicated, the equipment is to be coordinated across trades prior to forwarding to the Engineer.

1. The release of mechanical equipment submittals (pumps, air handling units, chillers, fans, cooling towers, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study as required by Division 26.

2. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Submittal Procedures” to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement.

3. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process.

4. Delay claims arising due to Contractor’s failure to coordinate simultaneous action submittals will not be considered by the Owner.

B. Documents for submittal may be hard copies in a three ring binder or soft copies in an electronic file using the Portable Document Format (PDF) standard. In any case, where multiple products, trades, floors, disciplines, etc. are combined into one (1) submittal, provide tabs for binders or ‘bookmarks’ for PDF files for efficient navigation between items to be reviewed and a table of contents at the front. Documents that do not conform may be rejected.

C. Common Requirements for Product Data: Where this Section and other Sections of this Division require Product Data to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:

1. Submit hardcopy of Product Data in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of product data submittals shall be bound materials as defined above. Separate products under distinct subheadings that correspond to paragraphs in specification text. Divide sections in binder with labeled divider tabs.

2. In addition to hardcopies required by Division 01, submit one copy of product data in electronic format. All files shall be in Portable Document Format (.pdf).

3. Product Data shall not consist of manufacturer’s catalogs or cut sheets that contain no indication of the exact item offered. The submission on individual items shall designate the exact item offered.

D. Common Requirements for Shop Drawings: Where this Section and other Sections of this Division require Shop Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:

1. Prepare Shop Drawings using computerized drafting software compatible with AutoDesk’s AutoCAD®.

2. Submit hardcopy of Shop Drawings in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of Shop Drawings shall have each sheet clearly labeled with a unique sheet identification number.

3. In addition to hardcopies required by Division 01, submit one (1) copy of Shop Drawings in electronic format. Files shall include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).
4. Shop Drawings shall be of appropriate scale based on the following:

   a. Ductwork and Piping Systems, including all underfloor work: Minimum 1/8" = 1'-0".

      1) Double-line congested areas.
      2) Double-line duct widths greater than 24".

   b. Mechanical rooms: 1/4" = 1’ – 0”.

      1) Double-line all systems.

   c. Temperature Control Diagrams with Sequence of Operations on same drawing.

5. Shop drawings shall include the following items:

   a. Concrete pads and foundations.
   b. Equipment room layouts with actual dimensions and offsets for all systems.
   c. Roof layouts.
   d. Trench locations and sizes.
   e. Dimensioned floor drain locations.

E. Common Requirements for Coordination Drawings: Where this Section and other Sections of this Division require Coordination Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures" and Division 01 Section "Project Management and Coordination". In addition to the requirements of Division 01 comply with the following:

   1. Prepare Coordination Drawings using computerized drafting software compatible with AutoDesk’s AutoCAD®. Drawings files must be composite with multiple distinctive layers for each of the various trades.
   2. Submit hardcopy of Coordination Drawings in the quantity as required under Division 01. Hardcopies of Coordination Drawings shall have each sheet clearly labeled with a unique sheet identification number.
   3. In addition to hardcopies required by Division 01, submit one (1) copy of Shop Drawings in electronic format. Files shall include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).
   4. Coordination Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.

F. Coordination Drawings: Prepare drawings showing dimensioned layout for the following:

   1. Penetration and Structural Opening: Floor plans showing sleeves and formed structural penetrations. Show sleeve and formed penetration layouts and relationships between structural components and other adjacent building elements, including but not limited to pre-tensioning and post-tensioning members where used.
   2. Reflected Ceiling Plans: ceiling plans, sections, and other necessary details showing dimensioned layouts for equipment located in or on the ceiling plane. Base dimensions on exact dimensioned data obtained from product submittals for products to be included in the Work. Differentiate between field measurements and assumed dimensions. Include the all items in the ceiling plane coordinated with each other, based on input from installers of the items involved.
   3. Include the following items coordinated with each other, based on input from installers of the items involved:

      a. Suspended ceiling components.
b. Structural members to which suspension systems for luminaires will be attached.

c. Perimeter moldings, decorative ceiling elements, and Architectural features.

d. Luminaires.

e. HVAC Diffusers, Registers and Grilles.

f. Speakers.

g. Sprinklers.

h. Fire Alarm initiating devices, including but not limited to the following:

   1) Smoke detectors.
   2) Heat detectors.

i. Fire Alarm notification appliances.

j. Occupancy sensors.

k. Access panels.

l. Security cameras and occupancy detectors.

m. Wireless Access Points.

n. Wiring Diagrams

   o. Short-circuit current rating of equipment assembly.

4. HVAC Layouts:

a. Single-line drawings of duct and piping systems are satisfactory except for the following, which shall be double-lined:

   1) All mechanical equipment rooms.
   2) Main duct runs to and from air handling equipment rooms.
   3) Ductwork and piping in congested areas.
   4) Ductwork with widths 36" and greater.

b. Shop drawings shall be provided for the following:

   1) Sheet Metal and Duct Systems, including all underfloor work (prepared at a minimum scale of 1/8"=1'-0")
   2) Piping and equipment systems for chilled water, condenser water, refrigerant, heating water, steam and other HVAC piping systems. (Preferably at 1/4" = 1’ – 0” and not less than 1/8" = 1’ – 0”).
   3) Equipment room layouts with actual equipment, piping, and duct at 1/4" = 1’ – 0” scale. Show clearances, access spaces, relative heights of piping, main ducts, outside and relief louvers. Provide at least one (1) section through each equipment room showing the same.
   4) Temperature Control Diagrams with Sequence of Operations on same drawing.
   5) Housekeeping and equipment concrete pads.
   6) Dimensioned floor drain locations and the equipment each serves.
   7) Roof layouts.
   8) Trench locations and sizes.
   9) Catwalk or equipment maintenance platform assemblies.

c. Equipment support locations, type of support, and weight on each support.

d. Location of structural supports for structure-supported raceways.

e. For floor mounted equipment: concrete base dimension, outline of equipment, and required clearances.

f. Location of structural supports for seismic bracing.
G. Common Requirements for Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures" for "Other Informational Submittals". In addition to the requirements of Division 01 comply with the following:

1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with "Compliance". Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.
   a. "C" for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
   b. "D" for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.
   c. "A" for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.
   d. "N/A" for Not Applicable: By noting the term "not applicable" or "N/A" in the margin, it shall be understood that the specified item is not applicable to the project.

H. Common Requirements For Qualification Data:

1. Professional Engineer Qualifications: Where this Section and other Sections of this Division require a licensed Professional Engineer to be responsible for Delegated Design requirements; Submit Qualification data for Professional Engineer including, but not limited to, proof of licensing registration in the state where the Project is located.

2. Independent Testing and Inspecting Agency Certification: Where this Section and other Sections of this Division require an Independent Testing and Inspecting agency to be responsible for Acceptance Testing and Field Quality Control requirements; submit certification documentation for such agency that demonstrates compliance with the Quality Assurance paragraph of this Section.

I. Qualification Data: For Independent Testing and Inspecting Agency.

J. Welding certificates.

1.10 PRODUCT SUBSTITUTIONS

A. Comply with provisions of Division 01 Section “Product Requirements”.

1. If item of equipment or device offered as Substitution differs in dimension or configuration from that indicated in the Contract Documents, provide, as part of the substitution submittal, a drawing that shows that the equipment or devices proposed for Substitution can be installed in the space available without interfering with other trades or with access requirements for operations and maintenance in the completed project. Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.

2. Where substitute equipment or devices requires different arrangement or connections from that indicated in the Contract Documents, install the equipment or devices to
operate properly and in accordance with the requirements of the Contract Documents. Make incidental changes necessary in piping, ductwork or wiring which results from the inclusion of the substitute equipment or device without any additional cost to the Owner. Pay all additional costs incurred by other trades in connection with changes required by the inclusion of the substituted equipment or device in the Work.

3. When submitting a manufacturer that is not the Basis of Design, the Contractor shall provide an itemized list of all deviations from and compliances with the information detailed in both the specification section and schedule. An additional itemized list shall account for scope increase and deductions based on substitutions for the following minimum items:

   a. Electrical panels, distribution, and safeties.
   b. Structural modifications.
   c. Civil modifications.
   d. Plumbing modifications.
   e. Duct and pipe connections or arrangements.
   f. Space heating and cooling requirements.
   g. Exhaust or ventilation modifications.
   h. Seismic restraint modifications.
   i. Vibration isolation requirements.

B. Manufacturers not listed are subject to design Engineer’s review and may not be acceptable. The substitute manufacturer shall submit a complete copy of the appropriate technical specification section minimum ten (10) business days prior to bid with each sub-paragraph noted with the comment, “compliance”, “deviation”, “alternate” or “not applicable” as described above. In the case of non-primary, vendor-supplied items, the name of the sub-vendor supplying said item, including model number, shall be indicated.

C. Where substitute products or materials requiring different arrangement or connections from that indicated are accepted by the Owner’s Representative, install the equipment or devices to operate properly and in harmony with the intent of the Documents, making all incidental changes in piping, ductwork, wiring, and any other trade resulting from the substitution without any additional cost to the Owner.

D. The Owner’s Representative reserves the right to call for samples of any item of product or material offered in substitution, together with a sample of the specific item when, in their opinion, the quality of the item and/or the appearance is involved, and it is deemed that an evaluation of the item may be better made by visual inspection.

E. When any request for a substitution of a product or material is submitted and rejected, the item named in the Documents shall be furnished. Repetitive submittal of substitutions for the same item will not be considered.

1.11 QUALITY ASSURANCE

A. All Work shall be performed by properly licensed technicians skilled in their respective trades. All materials, equipment and devices shall be installed in accordance with the recommendations of the manufacturer and in the best standard practice to bring about results of a first class condition.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, “Structural Welding Code--Steel.”
C. Steel Pipe Welding: Quality 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 in the systems they are working on and that certification is current.

D. Electrical Characteristics for HVAC Equipment:

1. Equipment having higher electrical characteristics other than those specified should 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.
2. Where variable frequency drives are provided for equipment, whether installed separately or integral to the equipment, the VFDs shall conform to Division 26 Section, “Variable Frequency Motor Controllers”.

E. Wherever a UL standard has been established for a particular type of material, equipment or device, each item of such material, equipment or device provided on this project shall meet the requirements of the UL standard in every way, and shall be UL listed and labeled.

F. Products and materials shall be of the best quality customarily applied in quality commercial practice, and shall be by reputable manufacturers.

G. Each major component shall bear a nameplate giving the name and address of the manufacturer, and the catalog number or designation of the component.

H. Products and materials provided under this Division of the Specifications shall be essentially the standard item, unless otherwise noted, of the specified manufacturer, or where allowed, an alternate manufacturer.

I. Common Requirements for Independent Testing and Inspecting Agency Qualifications: Where this Section and other Sections of this Division call for an Independent Testing and Inspecting Agency (Testing Agency); the Testing Agency shall comply with the following requirements:

1. Have the experience and capability to conduct the testing indicated,
2. Be a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to the AHJ and the Engineer-of-Record.
3. Meet the following:
   a. Be an independent, third party entity which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems being evaluated.
   b. Be regularly engaged in the testing of seismic support of HVAC equipment devices, installations, and systems.
   c. Use technicians who are regularly employed for testing services.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Deliver products and materials with factory-applied end caps or “heat shrink” wrappings to protect openings. Maintain opening protection through shipping, storage, and handling to prevent damage and the entrance of dirt, debris, and moisture.
B. Store light sensitive products and materials away from and protected against direct sunlight.

C. Support products and materials at all times to prevent sagging and bending.

D. The area provided for product and material storage at the jobsite shall be clean, dry and exposure to dust minimized.

E. Responsibility for the protection of products and materials shall extend to existing equipment, systems, and products and materials. Erect temporary sheltering structures, provide temporary bracing and supports, or cover existing equipment, systems, and products and materials to prevent damage and the entrance of dirt, debris, and moisture.

F. Failure on the part of the Contractor to comply with the above to the satisfaction of the Architect, Engineer, or either's authorized representative shall be sufficient cause for the rejection of products and materials in question.

1.13 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.

D. Installation Drawings

1. Prepare special drawings as called for elsewhere herein or directed by the Architect to coordinate this work with the work of other Divisions, to illustrate changes in this work to facilitate its concealment in finished spaces, to avoid obstructions, or to illustrate the installation of a substitute equipment item.

2. Use these drawings in the field for the installation of all systems and components. Unless otherwise directed, do not submit these drawings for review, but provide 3 copies to the Architect for information.

E. ACTION SUBMITTALS

1. Product Data: For the following:
   a. Dielectric fittings.
   b. Mechanical sleeve seals.
   c. Escutcheons.

PART 2 - PRODUCTS

2.1 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.

C. All piping and tubing shall be American manufactured, unless otherwise indicated.

2.2 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. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

E. 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.

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

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

2.3 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.

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

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. 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.

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.

2.4 MECHANICAL SLEEVE SEALS

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

1. Manufacturers:
   a. Innerlynx.
   b. Link-Seal by PSI.
   c. Metraflex Co.

2. Sealing Elements: EPDM for high temperature applications and NBR for all others unless otherwise indicated, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe. Seal shall be same manufacturer as sleeve.

3. Pressure Plates: Stainless steel. Include two (2) for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one (1) for each sealing element.

2.5 SLEEVES

A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 10, galvanized, plain ends.

2.6 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, Cast-Brass Type: With set screw.

   1. Finish: Polished chrome-plated and rough brass, pending approval by Architect.

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

   1. Finish: Polished chrome-plated and rough brass, pending approval by Architect.

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

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

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 SCOPE OF WORK

A. Inspection of Site

1. The accompanying drawings do not indicate existing mechanical installations other than to identify modifications of and extensions thereof. Site visits and installation inspections to ascertain the conditions to be met are included in the scope.
2. Failure to comply with an inspection of the site shall not constitute ground for any additional payments in connection with removing or modifying any part of the existing installations and/or installing any new work under this Division.
3. Review all construction details of the new portion of the building as illustrated on the architectural and structural drawings and be guided thereby.

B. Products and Materials Description

1. Where two (2) or more units of the same kind or class of a specific item are required, these shall be the products of a single manufacturer; however, the component parts of the item need not be the products of one (1) manufacturer.
2. In describing the various products and materials, in general each item will be described singularly, even though there may be a multiplicity of identical items. Also, where the description is only general in nature, exact sizes, duties, space arrangements, horsepower requirements and other data shall be determined by reference to the Documents.

C. Refer to other Divisions of the Specifications for related Work.

D. Install, hang, support, etc. all MEP systems and equipment to satisfy all requirements of the applicable seismic zone using performance requirements and design criteria for project site as indicated by Architect.

E. It is the intent, unless otherwise indicated, that all products and materials described and specified under this Division, shall be provided for a complete working system irrespective of use of the phrases “install”, “furnish”, “furnish and install”, or “provide” as described above has been actually included.

F. The Contractor is responsible for all Work of every description in connection with this Division of the Specifications.

G. The Contractor specifically and distinctly assumes all risk for damage or injury from whatever cause to property or person used or employed on or in connection with this Work and of all damages or injury to any person or property wherever located, resulting from an action or operation under the Contract in connection with the Work, and undertake the promise to defend the Owner against all claims on account of any such damage or injury.

H. The Contractor will be held responsible for the satisfactory execution and completion of the Work in accordance with the true intent of the Documents.
I. Provide without extra charge all incidental items required as part of the Work, even though it may not be specifically indicated. If the Contractor has reason for objecting to the use of any material, equipment, device or method of construction as indicated, he shall make report of such objections to the Owner's Representative, obtain proper approval and adjustment to the Contract, and shall proceed with the Work.

J. Electrical Installation

1. All electric wiring shall be installed under Division 26, except for such equipment items as are prewired at their point of manufacture and so delivered to the project, and except for the following:

   a. Temperature Control Wiring and Power Wiring provided by controls contractor.

2. Prepare and submit for review wiring diagrams for all equipment furnished under this Division. Show on these diagrams all power, interlock, and control circuits. When the Architect takes no exception to these drawings, they shall become installation drawings for the Contractor.

3. All chilled water, condenser water piping, domestic cold and hot water piping, and wet fire protection system shall be heat traced when routed external to the building or in areas susceptible to freezing conditions.

3.2 Schedule And Sequence Of Work

A. The Contractor shall meet and cooperate with the Owner and Owner's Representative to schedule and sequence Work so as to ensure meeting scheduled completion dates and avoid delaying other portions of the Work. Work requiring special sequencing shall be at no additional cost to the Owner and shall have no impact on the schedule.

B. Work schedules and completion dates as established shall be rigidly adhered to. Cooperate in establishing these schedules and perform the work under this Division at such times as directed so as to ensure meeting scheduled dates and avoid delaying any other Contractor.

C. Any work involving a service suspension shall be scheduled in advance with the Owner.

D. Should it be necessary to perform certain operations on an "overtime" basis in order not to interrupt the normal usage of the facility, include the costs of such overtime without change in the Contract amount.

3.3 TEMPORARY HEATING AND COOLING

A. Provide all temporary heating and cooling equipment for spaces that require continued use.

B. Should the work in the designated areas affect any services to areas that are to remain in use, provide temporary services as required to enable those occupied areas to function properly. Additional valves, ductwork, equipment and piping required shall be installed without added cost to the Owner.

3.4 HVAC DEMOLITION

A. 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 Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping 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.

B. 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.

3.5 SALVAGED MATERIALS

A. Reuse no salvaged material except as noted on the Drawings, specified herein, or directed by the Architect. Remove from the premises all present materials falling under this Division, which are removed from the existing building. Upon completion, leave no "dead" line or equipment installed in any portion of the area being remodeled, unless otherwise indicated.

3.6 ACCESS – COMMON REQUIREMENTS

A. Provide an access door in non-lay-in ceilings to maintain and inspect HVAC components. Components include, but are not limited to, the following:

1. Actuators.
2. Control Modules.
3. Filter Boxes.
6. Terminal boxes.
7. Valves.

B. Unless otherwise indicated, access door shall provide a minimum clear opening of 30” x 30”.

3.7 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 Shop 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, after Architect’s final approval of finish, for penetrations of walls, ceilings, and floors according to the following:

1. New piping penetrations shall be one-piece escutcheons.
2. Existing piping penetrations shall be two-piece escutcheons.
3. All sleeved penetrations shall be deep-drawn allow flush installation between escutcheon and finished surface.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board rated partitions, and concrete floor and roof slabs.

2. Cut sleeves to length for mounting flush with both surfaces, unless otherwise indicated.
   a. Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level to prevent water entrance into sleeved hole. Vertical pipe supports must be extended to and be supported by the floor rather than the sleeve.
   b. Provide concrete pipe curb in floors of mechanical equipment areas or other wet areas 4 inches above finished floor level, minimum, in lieu of extended sleeves.
3. Install sleeves in new walls and slabs as new walls and slabs are constructed.
4. 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.

5. 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. 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 for above ground locations.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter for above ground and all underground locations.
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.

Q. Verify final equipment locations for roughing-in.

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

3.8 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.

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

3.9 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.

3.10 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Equipment called for on the plans and not listed herein shall be provided as though it were fully described herein.

B. Equipment called for herein shall be completely provided, whether fully detailed or not on the plans, and/or scheduled.

C. All equipment as indicated on the plans and as described herein shall be installed per manufacturer’s recommendations to allow for proper operation and maintenance of the equipment.

D. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

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

F. 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.
G. Where any piece of equipment is too large for ingress through normal building openings, it shall be placed in its containing space before the enclosing structure is completed.

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

3.11 PAINTING

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

3.12 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 not less than 4 inches larger in both directions than supported unit.
   2. Concrete bases for internally isolated AHU's shall be 6 inches (150 mm) tall above finished floor.
   3. Concrete bases for all other equipment shall be 4 inches (100 mm) tall above finished floor.

3.13 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

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

3.14 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.

3.15 GROUTING

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

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout.

3.16 INSTALLATION INSPECTIONS AND CERTIFICATIONS
A. The Contractor shall obtain timely inspections of the installation by the constituted authorities. Remedy any deficiencies to the satisfaction of the inspecting authority.
B. Upon final completion of the work, obtain certificates of acceptance from the constituted authorities. Deliver the certificates to the Architect for transmission to the Owner.

3.17 OPERATION PRIOR TO COMPLETION
A. When any piece of mechanical or electrical equipment is operable and it is to the advantage of the contractor to operate the equipment, he may do so with permission of Owner, providing that he properly supervises the operation, retains full responsibility for the equipment operated, and protects against dirt accumulations during operation. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner or until final acceptance by the Owner.
B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, and properly adjust the operation of the equipment before final acceptance by the Owner.
C. All equipment is to be maintained per the manufacturer’s instructions until Owner’s maintenance staff is responsible for operation and upkeep.

3.18 INSTRUCTION OF OWNER’S PERSONNEL
A. Provide the services of competent engineers and/or technicians acceptable to the Owner’s Representative to instruct other representatives of the Owner in the complete and detailed operation of each item of equipment or device of all the various electrical systems. These instructions shall be provided for whatever periods may be necessary to accomplish the desired results.
B. Upon completion of these instructions, the Contractor shall obtain a letter of release, acknowledged by the Owner or his authorized representative, stating the dates on which the various kinds of instruction were given, and the personnel to whom the instructions were given.
C. The Contractor shall be fully responsible for proper maintenance of equipment and systems until the instructions have been given the Owner’s personnel and the letter of release acknowledged.
D. In providing the instructions to the Owner’s personnel, the written operating and maintenance manuals shall be followed in all instances, and the Owner’s personnel shall be familiarized with such manuals.
E. Operating and maintenance manuals used for instructions shall include wiring diagrams, manufacturer's operating and maintenance instructions, parts lists (with sources identified), and other data as appropriate for each system.

3.19 SEALANT

A. Apply sealant to penetrations of all floor and wall assemblies to maintain pressure differentials required by AIA for all pressure sensitive rooms.

B. Pressure sensitive rooms include, but are not limited to:
1. Central sterile clean and decontamination rooms.

C. Sealant materials and installation requirements are specified in Division 07 Section “Joint Sealants” and Division 09 Section “Gypsum Board Assemblies.”

END OF SECTION
SECTION 230513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

B. Related Sections include the following:
   1. Division 26 Section "Enclosed Controllers".
   2. Division 26 Section "Variable Frequency Drives".

1.2 COORDINATION
A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

1.3 WARRANTY
A. All inverter-duty motors shall have minimum 5-year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. MagneTek/Century
B. Lincoln
C. Marathon
D. General Electric
E. Gould
F. Toshiba
2.2 GENERAL MOTOR REQUIREMENTS
A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
B. Comply with NEMA MG 1 unless otherwise indicated.
C. Comply with IEEE 841 for severe-duty motors.

2.3 MOTOR CHARACTERISTICS
A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.4 POLYPHASE MOTORS
A. Description: ¾ hp and larger NEMA MG 1, Design B, medium induction motor, unless otherwise indicated.
B. Efficiency: Provide premium efficiency type for all motors 1 HP and greater and conform to the minimum efficiencies as listed in ASHRAE 90.1-2013.
C. Service Factor: 1.15.
D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.
E. Multispeed Motors: Separate winding for each speed.
F. Rotor: Random-wound, squirrel cage.
G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
H. Temperature Rise: Match insulation rating.
I. Insulation: Class F.
J. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

L. Provide shaft grounding rings.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Spike-proof inverter motor such that voltage spikes will not damage motor insulation.
2. No distance restrictions between any inverter and motor.
3. No frequency limitations.
4. Inverter power conditioning equipment shall not be required to protect motor.

C. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

1. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

D. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.6 SINGLE-PHASE MOTORS

A. Motors less than ¾ hp shall be one of the following to suit starting torque and requirements of specific motor application, unless noted otherwise:

B. Permanent-split capacitor.

1. Split phase.
2. Capacitor start, inductor run.
3. Capacitor start, capacitor run.

C. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

D. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

E. Motors 1/20 HP and Smaller: Shaded-pole type.

F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor.
insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.7 MOTOR ENCLOSURES

A. Provide motor enclosures according to the following list as a minimum, unless recommended by the manufacturer for the given application or unless indicated otherwise.

1. Indoor Service: ODP type.
2. Outdoor Service: TEFC type.
3. Inside an Air Stream: For fan motors installed in the air stream by the fan manufacturer the motor enclosure shall be TEAO unless indicated otherwise by the manufacturer.
4. Hazardous Service: For NEC hazardous locations motor enclosures shall be rated for the division, class, and group indicated or required.

PART 3 - EXECUTION

3.1 STARTER AND MOTOR CONTROLS

A. Provide a suitable NEMA rated starter, one per motor, for control of each motor furnished under this Division. All motors 3/4 horsepower and larger require magnetic or electronic starters, no exceptions. All motors of any size that are automatically controlled require "Hand-Auto" or "Hand-off-Auto" magnetic or electronic starters, no exceptions. All magnetic and electronic starters shall have H-O-A switches.

B. Provide each motor that does not require a starter, a manual starting switch with thermal overload protection with identifying nameplate, green pilot light and stainless steel cover plate equal to Westinghouse Type MS. Switches installed on finished walls shall be flush type.

C. Starter shall have overload protection on all phases. This will require three overload relays for three phase motors and one overload relay for one phase/line voltage motor. Provide NEMA 1B control voltage transformer, "on" green pilot light, and 1-normally open and 2-normally closed auxiliary contacts on each starter, unless otherwise noted.

D. Certain starters and motor controls for motors furnished under this Division are scheduled on the Drawings to be elements of motor control centers provided under Division 26. Except for those scheduled starters, provide a suitable starter for control of each motor furnished under this Division.

E. Each starter shall have a capacity rating within the required limits of the motor which it serves; it shall have overload elements selected to provide protection for the motor.

F. Where a combination starter and disconnect switch or starter and circuit breaker in a common enclosure is scheduled, provide auxiliary contacts on the switch or breaker as required to assure that, when the disconnecting means is open, there are no "live" contact points on the starter.

G. Where a holding coil voltage differs from line voltage, install a transformer with secondary fusing in the starter enclosure.

H. Unless otherwise indicated, furnish starters mounted indoors with NEMA Type 1 enclosures; and furnish those exposed to the weather with NEMA Type 3R enclosures.
I. Where starters are not installed in heated and cooled spaces, the heater elements shall be of the ambient temperature-compensated, bimetallic type.

END OF SECTION
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
GMP Documents
July 7, 2017
SECTION 230516
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal-bellows expansion joints.
2. Expansion compensators.
3. Rubber expansion joints.
5. Packed slip expansion joints.
6. Flexible ball joints.
7. Pipe bends and loops.
8. Alignment guides and anchors.

1.2 DEFINITIONS

A. BR: Butyl rubber.

B. Buna-N: Nitrile rubber.

C. CR: Chlorosulfonated polyethylene synthetic rubber.

D. CSM: Chlorosulfonyl-polyethylene rubber.

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

F. NR: Natural rubber.

G. PTFE: Polytetrafluoroethylene plastic.

1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.4 ACTION SUBMITTALS

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

B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.5 INFORMATIONAL SUBMITTALS
A. Welding certificates.

1.6 CLOSEOUT SUBMITTALS
A. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

1.7 QUALITY ASSURANCE
A. Welding Qualifications: Qualify procedures and personnel according to the following:
   2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS
A. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.
   1. Manufacturers:
      a. Adsco Manufacturing, LLC.
      b. Anamet, Inc.
      c. Badger Industries.
      d. Expansion Joint Systems, Inc.
      e. Flex-Hose Co., Inc.
      f. Flexicraft Industries.
      g. Flex-Pression, Ltd.
      h. Flex-Weld, Inc.
      i. Hyspan Precision Products, Inc.
      j. Metraflex, Inc.
      k. Piping Technology & Products, Inc.
      l. Proco Products, Inc.
      m. Senior Flexonics, Inc.; Pathway Division.
      n. Tozen America Corp.
      o. Unaflex Inc.
      p. WahlcoMetroflex.
2. Metal-Bellows Expansion Joints for Copper Piping: Multiple-ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.
5. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
6. Configuration: Double-bellows type with base, unless otherwise indicated.

B. Expansion Compensators: Double-ply corrugated steel, stainless-steel, or copper-alloy bellows in a housing with internal guides, antitorque device, and removable end clip for positioning.

1. Manufacturers:
   a. Adsco Manufacturing, LLC.
   b. Flexicraft Industries.
   c. Flex-Pression, Ltd.
   d. Flex-Weld, Inc.
   e. Hyspan Precision Products, Inc.
   f. Metraflex, Inc.
   g. Senior Flexonics, Inc.; Pathway Division.
   h. Unaflex Inc.

2. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
3. Configuration for Copper Piping: Two-ply phosphor-bronze or stainless-steel bellows and bronze or stainless-steel shroud.
5. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
6. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded.
8. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged or threaded.


1. Manufacturers:
   a. Flex-Hose Co., Inc.
   b. Flexicraft Industries.
   c. Flex-Weld, Inc.
   d. Garlock Sealing Technologies.
   e. General Rubber Corp.
   g. Metraflex, Inc.
   h. MG Piping Products Co.
   i. Proco Products, Inc.
   j. Red Valve Company, Inc.
   k. Senior Flexonics, Inc.; Pathway Division.
   l. Tozen America Corp.
   m. Unaflex Inc.
   n. Vibration Mountings & Controls, Inc.

2. Arch Type: Multiple arches.
3. Spherical Type: Multiple spheres.
a. Minimum Pressure and Temperature Ratings for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
b. Minimum Pressure and Temperature Ratings for NPS 5 and NPS 6: 140 psig at 200 deg F.
c. Minimum Pressure and Temperature Ratings for NPS 8 to NPS 12: 140 psig at 180 deg F.

4. Material: Buna-N or EPDM.

D. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.

1. Manufacturers:
a. Flex-Hose Co., Inc.
b. Flexicraft Industries.
c. Flex-Pression, Ltd.
d. Metraflex, Inc.

2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder- joint end connections.

a. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.

3. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder- joint end connections.

a. NPS 2 and Smaller: Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.

4. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged end connections for NPS 2-1/2 and larger.

a. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
c. NPS 8 to NPS 12: Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.

5. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged end connections for NPS 2-1/2 and larger.

a. NPS 2 and Smaller: Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
c. NPS 8 and Larger: Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

2.2 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

1. Manufacturers:
   a. Adsco Manufacturing, LLC.
   b. Advanced Thermal Systems, Inc.
   c. Flex-Hose Co., Inc.
   d. Flexicraft Industries.
   e. Flex-Weld, Inc.
   f. Hyspan Precision Products, Inc.
   g. Metraflex, Inc.
   h. Piping Technology & Products, Inc.
   i. Senior Flexonics, Inc.; Pathway Division.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

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

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

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.
   2. Expansion Plug: Zinc-coated steel.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.
   1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.

F. Concrete: Portland cement mix, 3000 psi minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, nonmetallic grout; suitable for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE BEND AND LOOP INSTALLATION

A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Attach pipe bends and loops to anchors.
   2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.3 ANCHOR INSTALLATION

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

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

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION
SECTION 230519
METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Thermometers.
   2. Gauges.
   3. Test plugs.

B. Related Sections:
   1. Division 23 Section "Steam and Condensate Heating Piping" for steam and condensate meters.
   2. Division 23 Section "Facility Natural-Gas Piping" for gas meters.

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene propylene diene monomer rubber.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Wiring Diagrams: For power, signal, and control wiring.

C. Shop Drawings: Schedule for thermometers, gauges, and flowmeters indicating manufacturer's number, scale range, and location for each.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of thermometer, gauge, and flowmeters signed by product manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.
1.6 EXTRA MATERIALS

A. Provide a PT measurement kit with thermometers and gauges chosen to indicate system pressures and temperatures at mid-scale. Provide multiple of each as mid-scale measurement dictates.

PART 2 - PRODUCTS

2.1 THERMOMETERS

A. Digital Vari-angle Thermometer, self-powered and within 1% accuracy, Similar to Weiss Model DVU35.

1. Case: Hi-impact ABS
2. Range: -40/300 °F (-40/150 °C)
3. Display: 3/8” LCD digits, wide ambient formula
4. Accuracy: 1% of reading or 1° whichever is greater
5. Resolution: 1/10° between -19.9/199.9 °F (-28/93 °C)
6. Recalibration: Internal potentiometer
7. Lux Rating: 10 Lux (one foot-candle)
8. Update Rate: 10 seconds
9. Ambient Operating Range: -30/140 °F (-35/60 °C)
10. Ambient Temp. Error: Zero
11. Humidity: 100%
12. Sensor: Glass passivated thermistor
13. Connector: Adjustable Angle

2.2 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.

B. Description: Pressure-tight, socket-type 304 Stainless Steel fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAUGES

A. Manufacturers:

1. Ernst Gauge Co.
2. Miljoco Corp.
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.
5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
6. Dwyer Instruments, Inc.

B. Direct-Mounting, Dial-Type Pressure Gauges: Indicating-dial type complying with ASME B40.100.

1. Case: Liquid-filled type, cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Pointer: Red or Black metal.
7. Window: Glass.
9. Accuracy: Grade B, plus or minus 1/2 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 50 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Direct-Mounting, Dial-Type Pressure Gauges: Indicating-dial type complying with ASME B40.100.

1. Case: Dry type, cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Pointer: Red or Black metal.
7. Window: Glass.
9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
10. Vacuum-Pressure Range: 0 to 50 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

D. Pressure-Gauge Fittings:

1. Valves: NPS 1/4 brass or stainless-steel ball type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.4 TEST PLUGS

A. Manufacturers:

1. Flow Design, Inc.
2. MG Piping Products Co.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.
6. Trerice, H. O. Co.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install digital thermometers in the following locations:
   1. Inlet and outlet of each hydronic zone.
   2. Inlet and outlet of each hydronic boiler and chiller.
   3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
   4. Inlet and outlet of each hydronic heat exchanger.

B. Install thermometers in separable sockets at each additional location indicated on the Drawings or specified elsewhere herein, and/or as a standard.

C. Provide the following temperature ranges for thermometers, unless otherwise indicated:
   1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions
   2. Condenser Water: 0 to 160 deg F, with 2-degree scale divisions.
   3. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
   4. Steam and Condensate: 50 to 400 deg F, with 5-degree scale divisions.

3.2 GAUGE COCK APPLICATIONS

A. Install test plugs adjacent to all control sensors (except Insertion Type Flow Meters) installed in piping systems.

B. Valved pressure gauge connections shall be installed in each location indicated on the Drawings and/or specified elsewhere herein.

C. Install each gauge cock on a nipple of sufficient length so that the cock handle will be free of the pipe insulation. Position each cock so that a 4-1/2" diameter dial gauge may be easily read and screwed into and out of the cock.

D. On pumps use a single pressure gauge connected by ball valves and metal tubing to the inlet and discharge flanges as well as the suction diffuser inlet flange, if applicable.

E. Install gauge cocks at each pump as close to pump suction and discharge connections as practicable. Use any gauge connections provided in the pump casing.

3.3 GAUGE APPLICATIONS

A. Install dry-case-type pressure gauges at the following locations:
   1. Discharge of each pressure-reducing valve.
   2. At each steam connection to a heat exchanger in the mechanical equipment rooms.

B. Install liquid-filled-case-type pressure gauges at chilled- and condenser-water inlets and outlets of chillers.
C. On pumps use a single pressure gauge connected by ball valves and metal tubing to the inlet and discharge flanges as well as the suction diffuser inlet flange, if applicable.

D. Furnish and install calibrated pressure gauges at each location indicated on the Drawings, specified elsewhere herein, and/or as a standard.

3.4 INSTALLATIONS
A. Install thermometers and adjust vertical and tilted positions.
B. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated. Install thermowells using thermally conductive grease.
C. Install direct-mounting pressure gauges in piping tees with pressure gauge located on pipe at most readable position.
D. Install ball-valve and snubber or syphon fitting in piping for each pressure gauge for fluids (except steam).
E. Install needle-valve and siphon fitting in piping for each pressure gauge for steam.
F. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.
G. Install flowmeter elements in accessible positions in piping systems.
H. Install flowmeter elements with at least (10) pipe diameters minimum straight lengths of pipe upstream and (5) pipe diameters downstream from element as prescribed by manufacturer's written instructions.
I. Install flowmeters at discharge of hydronic system pumps and at inlet of hydronic air coils, as indicated.
J. Install test plugs adjacent to all gauges and control sensors (except insertion type flow meters) installed in piping systems.

3.5 CONNECTIONS
A. Install meters and gauges adjacent to machines and equipment to allow service and maintenance for meters, gauges, machines, and equipment.
B. Connect flowmeter-system elements to meters.
C. Connect flowmeter transmitters to meters.
D. Install test plugs adjacent to the temperature sensing device used for controls for simultaneous reading with test instrument for calibration purposes.

3.6 ADJUSTING
A. Calibrate meters according to manufacturer's written instructions, after installation.
SECTION 230523
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following general-duty valves:

1. Bronze angle valves.
2. Cast-iron angle valves.
3. Copper-alloy ball valves.
4. Ferrous-alloy ball valves.
5. Ductile-iron butterfly valves.
6. High-pressure butterfly valves.
7. Bronze check valves.
8. Cast-iron swing check valves.
11. Cast-iron gate valves.
13. Cast-iron globe valves.
15. Resilient-seated, cast-iron, eccentric plug valves.

B. Related Sections include the following:

1. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
2. Division 23 Sections for specialty valves applicable to specific services only.
3. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and charts.
4. Division 23 Section "Instrumentation and Control for HVAC" for actuators in control valve applications.
5. Division 23 Section "Hydronic Piping" for additional valves and fittings.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

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

C. HPS: High-pressure Steam. Any system pressure above 15 psig is HPS.

D. LPS: Low-pressure Steam. Any system pressure less than or equal to 15 psig is LPS.

E. NRS: Nonrising stem.

F. OS&Y: Outside screw and yoke.
G. PTFE: Polytetrafluoroethylene plastic.

H. Single Flange: Any valve design where lugs are evenly spaced around the circumference of the valve face and attach to adjoining piping using full length bolts.

I. Spring-loaded, Lift-disc Check Valve: Non-slam check valve.

J. SWP: Steam working pressure.

K. TFE: Tetrafluoroethylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated. Include body the following:
   1. Seating, and trim materials
   2. Valve design
   3. Pressure and temperature classifications
   4. End connections
   5. Arrangement
   6. Dimensions
   7. Required clearances.
   8. Include list indicating valve and its application by system and size.
   9. Include rated capacities
   10. Shipping, installed, and operating weights
   11. Furnished specialties
   12. Accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each valve include operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.1 for power piping valves and ASME B31.9 for building services piping valves.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

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 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Copper-alloy Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated. All valves shall comply with recognized industry standards such as MSS SP-80 and SP-110.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

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

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:
   1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
   2. Gear Drive: Enclosed worm gear.
   3. Handwheel: For valves other than quarter-turn types.
   4. Lever Handle: Clamp lock.
   5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

G. Valves in Insulated Piping: Valves shall have 3-inch stem extensions and the following features:
   1. Gate Valves: Shall be rising-stem type.
   2. Ball Valves: Shall have extended operating handle of non-thermal-conductive material, protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation, and memory stops that are fully adjustable after insulation is applied.
      b. Jamesbury, Inc.
      c. Kitz Insulated Stem Extension Model #ISE 1 thru 4
      d. NIBCO Nib-seal handle extension
   3. Butterfly Valves: Shall have extended necks.

I. Valve Grooved Ends: AWWA C606.

J. Solder Joint: With sockets according to ASME B16.18.
   1. Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.

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

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

2.2 BRONZE ANGLE VALVES

A. Bronze Angle Valves, General: MSS SP-80, with silicon bronze stem, non-asbestos packing and malleable-iron handwheel.

B. Class 150, Bronze Angle Valves: ASTM B 62 bronze body with TFE disc, union-ring bonnet, threaded ends, and having 300-psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. NIBCO Model T-335-Y

C. Class 300, Bronze Angle Valves with Stainless-Steel Disc: ASTM B 61 bronze body with stainless-steel plug and renewable seat, union-ring bonnet, threaded ends, and having 600-psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. NIBCO Model T-376-AP

2.3 CAST-IRON ANGLE VALVES

A. Cast-Iron Angle Valves, General: MSS SP-85, Type II; having ASTM A 126, Class B cast-iron body and bolted bonnet; bronze mounted, non-asbestos packing and gaskets; and flanged-end connections.

B. Class 125, Cast-Iron, Standard Angle Valves: 200-psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. NIBCO Model F-818-B

C. Class 250, Cast-Iron, Stop-Check Angle Valves: Stop-check design with non-asbestos packing and gaskets, and having 500-psig (3450-kPa) CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. NIBCO Model NIBCO Model F-869-B
2.4 COPPER ALLOY BALL VALVES

A. Brass Ball Valves, General: MSS SP-110 and have a brass body complying with ASTM B 283.

B. Bronze Ball Valves, General: MSS SP-110 and have a copper alloy body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.

C. Two-Piece, Full-Port, Copper Alloy Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, reinforced TFE seats, threaded body packnut design, blow-out proof stems, with adjustable stem packing, soldered or threaded ends; 150 psig SWP and 600-psig CWP ratings.
   2. Jamesbury, Inc.
   3. Kitz Model #68M or #69M
   4. NIBCO Model S-585-70-66 or T-585-70-66

D. Two-Piece, Full-Port, 250 psig SWP, Copper Alloy Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, carbon-filled TFE seats, threaded body packnut design, blow-out proof stems, with adjustable stem packing, threaded ends; 250 psig SWP and 600-psig CWP ratings.
   2. Jamesbury, Inc.
   3. Kitz Model #68PM
   4. NIBCO Model T-585-70-66-ST

E. Three-Piece, Full Port, Copper Alloy Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, threaded body packnut, blow-out proof stems, with adjustable stem packing, stainless nuts and bolts on valve body, soldered or threaded ends; 150 psig SWP and 600-psig CWP rating.
   2. Jamesbury, Inc.
   3. Kitz Model #62M or #63M

2.5 FERROUS-ALLOY BALL VALVES

A. Ferrous-Alloy Ball Valves, General: MSS SP-72, with ASTM A-216 Type WCB, carbon-steel body; ASTM A-351, Type CF8M vented stainless-steel ball; and ASTM A-276, Type 316 stainless-steel stem; fire rated according to API 607 (4th edition); and having flanged ends and blowout-proof stem.

B. Class 150, Full-Port, Ferrous-Alloy Ball Valves: Split-body construction, carbon-filled TFE seats; 285 psig CWP rating.
   2. Jamesbury, Inc.
   3. Kitz 150SCTDZM-FS BZM-FS(C)
   4. NIBCO Model F-515-CS-F-66-FS
2.6 FERROUS-ALLOY BUTTERFLY VALVES

A. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:

1. Full lug, grooved and flanged valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange. Valves NPS 12 and smaller shall not have exposed stem to disc fasteners and no exterior mounted fasteners to hold the liner.
2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.

B. Single-Flange, 150-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece Type 416 stainless-steel stem, bronze bushing, aluminum-bronze disc, and phenolic-backed EPDM seat (liner) attached to the body.

1. Cooper Cameron Corp.; Cooper Cameron Valves Div.
2. DeZURIK; SPX Corporation
3. Kitz Model #6123EG
4. NIBCO Model LD-1000-5

C. Single-Flange, 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece, Type 410 or 416 stainless-steel stem, copper bushing, fasteners and pins shall not be used to attach stem to disc, no pins or fasteners in waterway, aluminum-bronze disc, and molded-in EPDM seat (liner).

1. Cooper Cameron Corp.; Cooper Cameron Valves Div.
2. DeZURIK; SPX Corporation
3. Kitz Model #6123EL or #6123EG
4. NIBCO Model LD-2000-3/5

D. Grooved-End, Ferrous-Alloy Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc: Ductile-iron with grooved or shouldered ends, polyamide coating inside and outside, two-piece Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, fasteners and pins shall not be used to attach stem to disc, no pins or fasteners in waterway, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.

1. Anvil International, Inc.
2. Grinnell Mechanical Products.
3. NIBCO Model GD-4765-3/5
4. Victaulic Co. of America.
2.7 HIGH-PRESSURE BUTTERFLY VALVES

A. High-Pressure Butterfly Valves, General: MSS SP-68 API 609 seat pressure and temperature ratings, ANSI B1634A body pressure and temperature ratings, ANSI B16.5 flange dimensions, ISO 5211, EN 12116 actuator mounting top works, capable of bi-directional dead-end service at full-rated pressure without use of downstream flange, carbon-steel body, offset design, extended-neck for insulation, permanently lubricated 300-series stainless-steel bushings with graphite and modified PTFE seats, graphite packing and gasket, one-piece duplex stainless-steel stem, and stainless-steel disc. Maximum steam rating of 50 psig. Valves NPS 6 and smaller shall have lever-lock operator; valves NPS 8 and larger shall have weatherproof gear operator.

B. Single-Flange, Full-Lug, 285 psig CWP Rating, High-Pressure Butterfly Valves:
   1. Jamesbury, Inc.
   2. NIBCO Model LCS6822-3/5
   3. Xomox Corporation.

C. Single-Flange, Full-Lug, 720 psig CWP Rating, High-Pressure Butterfly Valves:
   1. Jamesbury, Inc.
   2. NIBCO Model LCS7822-3/5
   3. Xomox Corporation.

2.8 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 125, Bronze, Lift Check Valves with TFE Disc: ASTM B-584 bronze body and integral seat with soldered or threaded end connections, and having 250-psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. Kitz Model #26 or #36
   3. NIBCO Model S-480-Y or T-480-Y
   4. Powell, Wm. Co.

C. Class 125, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. Kitz #30T or #29T
   3. NIBCO Model S-413-Y or T-413-Y
   4. Powell, Wm. Co.

D. Class 150, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 300 psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. Kitz #30T or #29T
   3. NIBCO Model S-433-Y or T-433-Y
   4. Powell, Wm. Co.
E. Class 300, Bronze, Swing Check Valves with Bronze Disc: ASTM B-61 bronze body and seat with regrinding-type bronze disc, Y-pattern design, threaded end connections, and having 600 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Kitz Model #19
3. NIBCO Model T-473-B
4. Powell, Wm. Co.

2.9 IRON SWING CHECK VALVES


B. Class 125, Gray-Iron, Standard Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; bronze disc and seat; and having 200 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Kitz Model #78
3. NIBCO Model F-918-B
4. Powell, Wm. Co.

C. Class 250, Gray-Iron, Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; and bronze disc and seat; and having 500 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. NIBCO Model F-968-B

D. Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends; nonasbestos, synthetic-fiber gaskets; rubber seats; and having 250-psig CWP Rating.

1. Anvil International, Inc.
2. Grinnell Mechanical Products
3. NIBCO Model G-917-W
4. Victaulic Co. of America

2.10 SPRING-LOADED, CENTER-GUIDED LIFT-DISC, IRON CHECK VALVES

A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.

B. Class 125, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 200 psig CWP rating.

1. NIBCO Model F-910-B
2. Kitz #7022 (wafer)
3. Metraflex Co.

C. Class 250, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 400 psig CWP rating.
1. NIBCO Model F-960-B
2. Metraflex Co.

2.11 BRONZE GATE VALVES

A. Bronze Gate Valves, General: MSS SP-80, with malleable-iron handwheel.

B. Class 150, Rising-Stem, Union-Ring Bonnet, Bronze Gate Valves: ASTM B-62 bronze body, bonnet, and wedge, copper-silicone bronze stem, union-ring bonnet, soldered or threaded end connections; and having 300 psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. Kitz Model #43 or #42T
   3. NIBCO Model S-134 or T-134
   4. Powell, Wm. Co.

C. Class 300, Rising-Stem, Stainless-Steel Wedge, Bronze Gate Valves: ASTM B-61 bronze body, bonnet and seat, stainless-steel wedge and seat, copper-silicone bronze stem, union-ring bonnet, and threaded end connections; and having 600 psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. NIBCO Model T-174-SS

2.12 CAST-IRON GATE VALVES

A. Cast-Iron Gate Valves, General: MSS SP-70, Type I with bolted bonnet, flanged end connections, and non-asbestos packing and gasket.

B. Class 125, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim, and solid-wedge disc; and having 200 psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. Kitz Model #72
   3. NIBCO Model F-617-O
   4. Powell, Wm. Co.

C. Class 250, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim, and solid-wedge disc; and having 500 psig CWP rating.
   1. Crane Co.; Crane Valve Group; Crane Valves.
   2. NIBCO Model F-667-O

2.13 BRONZE GLOBE VALVES

A. Bronze Globe Valves, General: MSS SP-80, with malleable-iron handwheel.

B. Class 150, TFE Disc, Bronze Globe Valves: ASTM B-62 bronze body, bonnet, and seat, TFE disc, copper-silicone bronze stem, union-ring bonnet, soldered or threaded end connections; and having 300 psig CWP rating.
1. Crane Co.; Crane Valve Group; Crane Valves.
2. Kitz Model #10 or #9
3. NIBCO Model S-235-Y or T-235-Y
4. Powell, Wm. Co.

C. Class 300, Stainless-Steel Disc, Bronze Globe Valves: ASTM B-61 bronze body and bonnet, stainless-steel disc and seat, copper-silicone bronze stem, union-ring bonnet, threaded end connections; and having 600 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Kitz Model #17S
3. NIBCO Model T-276-AP
4. Powell, Wm. Co.

2.14 CAST-IRON GLOBE VALVES

A. Cast-Iron Globe Valves, General: MSS SP-85 with bolted bonnet, flanged end connections, and non-asbestos packing and gasket.

B. Class 125, Metal Seat, Cast-Iron Globe Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim and having 200 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Kitz Model #76
3. NIBCO Model F-718-B
4. Powell, Wm. Co.

C. Class 250, Metal Seat, Cast-Iron Globe Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim and having 500 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. NIBCO Model F-768-B

2.15 CAST-IRON PLUG VALVES

A. Available Manufacturers:

1. Lubricated-Type, Cast-Iron Plug Valves:
   a. Milliken Valve Co., Inc.
   b. Nordstrom Valves, Inc.
   c. Olson Technologies; Homestead Div.
   e. Walworth Co.

2. Nonlubricated-Type, Cast-Iron Plug Valves:
   a. General Signal; DeZurik Unit.
   b. Grinnell Corporation.
   e. Wheatley Gaso, Inc.
2.16 RESILIENT-SEATED, CAST-IRON, ECCENTRIC PLUG VALVES

A. Available Manufacturers:

1. General Signal; DeZurik Unit.
3. Olson Technologies; Homestead Div.
4. Pratt, Henry Company.

B. Resilient-Seated, Cast-Iron, Eccentric Plug Valves, NPS 2-1/2 and Smaller: Design similar to MSS SP-108, and rated for 175-psig minimum CWP.

C. Resilient-Seated, Cast-Iron, Eccentric Plug Valves, NPS 3 and Larger: MSS SP-108, and rated for 175-psig minimum CWP.

2.17 CHAINWHEEL ACTUATORS

A. Manufacturers:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries, Inc.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Sprocket Rim with Chain Guides: Ductile iron of type and size required for valve
2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
3. Chain: Hot-dip, galvanized steel of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.
B. 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.

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

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

E. 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.

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

3.2 VALVE APPLICATIONS

A. Chilled-Water Piping:
   1. Ball Valves, NPS 2 and Smaller: Two-piece, full port, stainless-steel trim, copper alloy.
   2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full-port, ferrous alloy.
   5. Gate Valves, NPS 2 and Smaller: bronze body with extended stem, Class 200.
   6. Gate Valves, NPS 2-1/2 and Larger: bronze body with extended stem, Class 200.
   10. Lift Check Valves, NPS 2 and Smaller: Class 125, non-slam type, bronze with TFE disc.
   11. Swing Check Valves, NPS 2 and Smaller: Class 150, bronze with TFE disc.
   12. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, non-slam type, cast-iron, standard.
   14. Spring-Loaded, Center-Guided Lift-Disc Check Valves, NPS 2-1/2 and Larger: Class 125, flanged end, iron.
   15. Plug Valves, NPS 2 and Larger: Class 125 or 150, nonlubricated-type, cast iron.

B. Heating Water Piping:
   1. Gate Valves, NPS 2 and Smaller: bronze body with extended stem, Class 150.
   2. Gate Valves, NPS 2-1/2 and Larger: bronze body with extended stem, Class 150.
8. Lift Check Valves, NPS 2 and Smaller: Class 125, bronze with TFE disc.
9. Swing Check Valves, NPS 2 and Smaller: Class 150, bronze with TFE disc.
10. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, cast iron, standard.
12. Spring-Loaded, Center-Guided, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Class 125, flanged end, iron.

C. Steam Piping, 0 - 125 psig Operating Pressure:

1. Angle Valves, NPS 2 and Smaller: Class 150, with TFE disc, bronze.
2. Angle Valves, NPS 2-1/2 and Larger: Class 125, cast iron.
4. Ball Valves, NPS 2-1/2 and Larger: Class 150, full-port, ferrous alloy.
6. Swing Check Valves, NPS 2 and Smaller: Class 125, bronze with TFE disc.
7. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, cast-iron, standard.
8. Gate Valves, NPS 2 and Smaller: Class 150, bronze.
9. Gate Valves, NPS 2-1/2 and Larger: Class 125, cast iron.
10. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, TFE disc, bronze.
11. Globe Valves, NPS 2-1/2 and Larger: Class 125; cast iron.

D. Steam Condensate Piping:

1. Angle Valves, NPS 2 and Smaller: Class 150, TFE disc, bronze.
2. Angle Valves, NPS 2-1/2 and Larger: Class 250, cast iron.
3. Ball Valves, NPS 2 and Smaller: Class 250, Two-piece, full port, stainless-steel trim, copper alloy.
4. Ball Valves, NPS 2-1/2 and Larger: Class 300, full-port, ferrous alloy.
6. Swing Check Valves, NPS 2 and Smaller: Class 300, bronze with bronze disc.
7. Swing Check Valves, NPS 2-1/2 and Larger: Class 250, gray iron, standard.
8. Gate Valves, NPS 2 and Smaller: Class 300, bronze.
9. Gate Valves, NPS 2-1/2 and Larger: Class 250, cast iron.

E. Select valves, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, for chilled or condenser water piping systems only.
2. For Copper Tubing, NPS 2-1/2 and Larger: Flanged ends.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 and Larger: Flanged ends.
5. For Grooved-End, Copper Tubing and Steel Piping: Valve ends may be grooved. Do not use for steam or steam condensate piping.
3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. For shut-off service of hydronic systems, use

   1. Up to NPS 2: Gate type.
   2. NPS 2-1/2 and greater: Gate or Butterfly type.

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

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

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

G. Provide clamp lock lever handle for all valves, other than plug type, NPS 4 or smaller.

H. Provide hand wheel for all valves, other than plug type, NPS 6 and greater.

I. Install chainwheel operators on valves NPS 4 and larger and more than 78 inches above floor. Extend chains to 60 inches above finished floor elevation.

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

   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. 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.

3.5 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.

END OF SECTION
SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 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. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. 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 Sections "Metal Ducts" and "Nonmetal Ducts" for duct hangers and supports.
6. Division 23 Section "HVAC Insulation" for pipe saddles at pipe hangers.

1.2 DEFINITIONS

A. MFMA: Metal Framing Manufacturers Association.

B. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

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

1.3 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.
1.4 ACTION 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: Signed and sealed by a qualified professional engineer. 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. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE


B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   5. ASME Boiler and Pressure Vessel Code: Section IX.

C. Pipe hangers and supports shall conform to the recommendations of ASHRAE, ASPE, ANSI, and MSS, unless otherwise indicated.

D. Ensure anchors are acceptable per ICC for use in cracked concrete.

E. Furnish and install hangers and supports that conform to the requirements of the following codes and standards:
   1. Metal Framing Manufacturers Association
 PART 2 - PRODUCTS

2.1 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. Anvil.
   5. Carpenter & Paterson, Inc.
   6. Empire Industries, Inc.
   7. ERICO/Michigan Hanger Co.
   8. Globe Pipe Hanger Products, Inc.
   9. Grinnell Corp.
   10. GS Metals Corp.
   12. PHD Manufacturing, Inc.
   13. PHS Industries, Inc.
   15. 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.

2.2 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.

2.3 METAL FRAMING SYSTEMS

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

B. Available Manufacturers:
   2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
   3. GS Metals Corp.
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.

2.4 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type or threaded-anchor-type zinc-coated or stainless 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:
   b. Empire Industries, Inc.
   c. Hilti, Inc.
   d. ITW Ramset/Red Head.
   e. MKT Fastening, LLC.
   f. Powers Fasteners.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

5. Toggle Bolts: All-steel springhead type.


2.5 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. Manufacturers:
   a. ERICO/Michigan Hanger Co.
   b. MIRO Industries.

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

1. Manufacturers:
   a. MIRO Industries.
   b. Portable Pipe Hangers.
D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:
   a. ERICO/Michigan Hanger Co.
   b. MIRO Industries.
   c. Portable Pipe Hangers.

2. Base: Plastic or 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. 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.

1. Available Manufacturers:
   a. Curb Technologies.
   b. Pate.
   c. Thy Curb.

   1) Models:
      a) TC-1 for insulated roof decks.
      b) TC-2 for un-insulated and existing roof decks.
      c) TC-3 for Bulb-T roof decks.

d. United Air

2. Pipe curbs and rails with covers shall be all welded 18 gauge galvanized steel shell and baseplate, wood nailer, and TP-1 Duro EPDM cover or TP-2 pipe cover, as detailed on the drawings, for pipe penetration(s).

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.
1. Available Manufacturers:
   a. Curb Technologies.
   b. Pate.
   c. Thy Curb.

   1) Models:
      a) TEMS-1 for insulated roof decks.
      b) TEMS-2 for un-insulated and existing roof decks.
      c) TEMS-3 for single-ply roof systems.

d. United Air

2. Equipment supports shall be all welded 18 gauge galvanized steel shell, baseplate and counterflashing with internal bulkhead reinforcement and wood nailer.

2.7 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.

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

PART 3 - EXECUTION

3.1 PREPARATION

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to proper placement of inserts, anchors and other building structural attachments.

3.2 HANGER AND SUPPORT APPLICATIONS

A. Use only one type hangers and supports, by one manufacturer, for each piping service.

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

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

D. Use galvanized steel, painted, or cadmium plated components in hangers and supports unless otherwise indicated.
E. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing or provide copper-plated hangers and supports for copper piping systems where hangers are in contact with bare pipe.

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

G. Horizontal-Piping Hangers and Supports: Select size of hangers and supports to exactly fit pipe size for bare piping, and around piping insulation with saddle or shield for insulated piping. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F 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 non-insulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Slide and Slide Plate (MSS Type 35): For support of piping where horizontal movement due to expansion and contraction may occur, and where a low coefficient of friction is desired. Support system shall include guided plate mounted on a concrete pedestal or structural steel support.
15. 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.
16. 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.
17. 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.
18. 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.
19. 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.
20. 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.
21. 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.

22. 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.

H. Vertical-Piping Clamps: Select size of vertical piping clamps to exactly fit pipe size of bare pipe. 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.

I. Hanger-Rod Attachments: Select size of hanger rod attachments to suit hanger rods. 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.

J. Building Attachments: Select size of building attachments to suit hanger rods. 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-joint 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.

K. 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.

L. Spring Hangers and Supports: Select spring hangers and supports to suit pipe size and loading. 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.

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

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

O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
3.3 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-58 and MSS SP-69 for construction standards and applications. Install hangers, supports, clamps, and attachments as required by the following table to properly support piping from building structure.

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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 fabricated from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
3. Neither wire nor perforated metal shall be used to support piping, unless otherwise indicated or approved.
4. Do not support piping from other piping, unless otherwise indicated.

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

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

E. Fastener System Installation:

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

F. 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.

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


I. 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.

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

K. 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.

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

M. 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.

N. Insulated Piping: Comply with Division 23 Section “HVAC Insulation” and 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.
   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.
   b. Shield Dimensions for Pipe: Not less than the following:
      1) Pipes NPS 8 and Larger: Include wood inserts.
      2) Insert Material: Length at least as long as protective shield.
   c. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
3.4 EQUIPMENT SUPPORTS

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

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

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

3.5 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports, as required, unless otherwise indicated.

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.

3.6 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1 inch.

3.7 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.
3.8 TUNNEL SUPPORTS

A. The tunnel piping shall be supported. Supports shall be a delegated design. The Mechanical Contractor shall coordinate with the General Contractor to insure that the proper steel supports are provided.

B. Where systems leave a tunnel and enter grade, provide a coordinated, delegated design to ensure soil-borne forces and adequate cover are provided for direct buried systems.

3.9 THRUST BLOCKS

A. Concrete thrust blocks as a part of a delegated design shall be installed at underground mechanical piping connections to prevent separation under pressure at the following locations:

1. Changes in direction 22-1/2 deg. And greater (both horizontal and vertical).
2. Terminal ends.
3. All valves, so as to support the body weight and prevent excessive torque on pipe connections.

B. Each thrust block shall be sized to accommodate the piping and soil conditions.

C. Thrust blocks:

1. Provide concrete thrust blocks at all changes in direction of piping of non-restrained mechanical jointed pressure systems and other systems as required.

   a. Provide thrust blocks for restrained mechanical jointed piping systems where indicated.

2. Provide 3,000 psi minimum concrete mix.
3. Provide thrust blocks of the required size and shape necessary for the specific system pressure and soil bearing capacity at the particular location.
4. Exercise Care to avoid encasing fittings, bends, valves, etc., in concrete to the extent that it will hamper maintenance.

3.10 SECURING UNDERGROUND LINES

A. Install pipe clamps and braces using poured in place concrete blocks, or other anchors and supports required to insure stability of all underground lines to prevent joint separation either during tests or thereafter when lines are in service. Provide a delegated design for this application.

B. Pipe Braces and nuts installed in the ground shall be fabricated of stainless steel to resist corrosion.
SECTION 230548
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Delegated Design requirements for system design.
   2. Requirements for Manufacturer Seismic Certification.
   3. Isolation pads.
   4. Freestanding and restrained spring isolators.
   5. Elastomeric hangers.
   7. Spring hangers with vertical-limit stops.
   8. Pipe riser resilient supports.
   9. Resilient pipe guides.
  11. Seismic snubbers.
  12. Restraining braces and cables.
  13. Steel and inertia, vibration isolation equipment bases.

B. Related Sections:
   1. Division 23 Section "Common Work Results" for description of concrete bases used as vibration isolation.
   2. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for installation locations of pipe saddles at pipe hangers.

1.2 DEFINITIONS


C. Seismic Certification: Seismic certification refers to a manufacturer's certification for architectural, mechanical, and electrical components, supports, and attachments pursuant to ASCE/SEI 7-05 Section 13.2.1.2.

D. Seismic Qualification: Same as Special Seismic Certification

E. Special Seismic Certification: Seismic certification of mechanical and electrical equipment based on ASCE/SEI 7-05 Section 13.2.2. Special Seismic Certification is required for active mechanical and electrical equipment that must remain operable following the design earthquake.
1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for vibration and seismic controls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Do not use more than one pre-approved seismic-force resistance system on any single run of pipe, duct or conduit. Mixing of multiple pre-approved systems is not acceptable.

B. Seismic-Restraint Loading: In preparation of Delegated Design, utilize seismic forces as described in ASCE 7-02 “Minimum Design Loads for Buildings and Other Structures” as published by the American Society of Civil Engineers, unless requirements in this Section are more stringent.

1. Site Class as Defined in the IBC: D.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
   a. Component Importance Factor: As defined by ASCE 7-10 Section 13.1.3.
   b. Assign component factors based on ASCE-7 Table 13.6-1 for the following:
      1) Component Response Modification Factor.
      2) Component Amplification Factor.
3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.138g.
4. Design Spectral Response Acceleration at 1-Second Period: 0.088g.

C. Wind-Restraint Loading:

1. Basic Wind Speed: 120 mph.
2. Building Classification Category: III.
3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

D. Submittal Review Conference: At time of Delegated Design Shop Drawing submission, schedule a submittal review conference with the Architect and Structural Engineer-of-Record for the project. The purpose of this conference is to review attachment locations and insure supplementary framing that is needed to resist the loads, maintain stability or to meet other installation requirements of a pre-approved system have been accounted for in the Structural Engineer-of-Record’s design.

1.4 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 23 Section “Common Work Results for HVAC” for products specified under PART 2 – PRODUCTS.

B. General Submittal Requirements:

1. Submittals shall be reviewed by Architect and the Structural Engineer-of-Record prior to submitting them to authorities having jurisdiction.
C. Contractor Statement of Responsibility:
   1. Submit a written statement in accordance with IBC Chapter 17.
   2. Statement shall be submitted on company letterhead.
   3. In instances where trade sub-contractors are responsible for construction and implementation of seismic-force resisting systems, the representatives of these various trade sub-contractors shall sign the Contractor Statement of Responsibility.

D. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.

E. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
      a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
   2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
   3. Vibration Isolation Base Details: 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. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
   5. Field-fabricated supports.
   6. Seismic- and Wind-Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic and 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 seismic events. Indicate association with vibration isolation devices.

c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

2. Submit approval from Structural Engineer where supports are directly connected to structure.

B. Welding certificates.

C. Common Requirements For Qualification Data:

1. Manufacturer Seismic Qualification Certification: Where this Section and other Sections of this Division require products to meet seismic requirements; Submit certification that equipment, devices, accessories, and components will withstand seismic forces defined in this Section. Include the following:

   a. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

2. Manufacturer Special Seismic Certification: Where this Section and other Sections of this Division require products to meet seismic requirements; Submit certification that equipment, devices, accessories, and components will withstand seismic forces defined in this Section. Include the following:

   a. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

      1) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For professional engineer and testing agency.

E. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

F. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For seismic-force restraint systems and components 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. Copy of the Delegated Design Shop Drawings, including AHJ approval stamp.
2. Copy of the Delegated Design Submittal, including AHJ approval stamp.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC, unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Special Seismic Certification: Unless otherwise allowed by OSHPD, mechanical components, supports, and attachments shall be certified pursuant to ASCE/SEI 7-05 Section 13.2.2. Items requiring certification are as follows, but not limited to:

1. Components with hazardous contents, excluding pipes and ducts.
2. Smoke control fans.
3. Built-up or field assembled equipment.
4. Air handling and air conditioning units.
5. HVAC chillers.
7. Control panels.

F. Rugged Equipment: Factory assembled, discrete components are considered rugged and deemed to comply with ASCE/SEI 7-05 Section 13.2.6, and do not require Special Seismic Certification, unless otherwise indicated by OSHPD. Items considered exempt are as follows:

1. Equipment and components weighing not more than 20 lbs. supported directly on structures (and not mounted on other equipment or components) with supports and attachments in accordance with Chapter 13, ASCE/SEI 7-05, as modified by Section 1614A, 2007 CBC.

G. Comply with NFPA 70.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Vibration Isolation and Control

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. ISAT
5. Korfund Company.
7. Vibro-Acoustics

B. Seismic Restraint

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.
4. Hyspan.
5. ISAT
8. Mason Industries.
9. TOLCO Incorporated.
10. Unistrut; Tyco International, Ltd.
11. Vibro-Acoustics
2.2 VIBRATION ISOLATORS

A. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a non-slip pattern and galvanized-steel base plates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

B. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Minimum Lateral Stiffness: $K_x/K_y = 1.0$.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Base plates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to base plate underside. Base plates shall limit floor load to 100 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled base plate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to base plate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Minimum Lateral Stiffness: $K_x/K_y = 1.0$.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

D. 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.

E. 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. Minimum Lateral Stiffness: $K_x/K_y = 1.0$.
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.

F. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

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. Minimum Lateral Stiffness: Kx/Ky = 1.0.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

G. 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.

H. 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.

2.3 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

A. General Requirements for Restrained Vibration Isolation Roof-Curb Rails: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

B. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

C. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or wind restraint.
   a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
   b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Minimum Lateral Stiffness: $K_x/K_y = 1.0$.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2. Pads: Oil and water resistant neoprene arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel base plates, and factory cut to sizes that match requirements of supported equipment.

D. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.4 VIBRATION ISOLATION EQUIPMENT BASES

A. Housekeeping Pads: Reinforced concrete 4" or 6" tall with 1" chamfer on all top edges.

B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.


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. The weight of each inertial block shall not be less than 150% of supported equipment.
   c. Extend block minimum 4" beyond equipment base.
   d. Chamfer edges minimum 1".
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Channels shall be minimum 6” deep. 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.

2.5 SEISMIC-RESTRAINT DEVICES

A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.

2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A603 galvanized or ASTM A492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener:

1. Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

2. Reinforcing steel angle clamped to hanger rod.

F. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
1. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

2.6 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 seismic- and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- 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. Base: None.

1. Suspended Equipment:
   a. Fan Coil Units.
   b. Piping in Mechanical Rooms, up to 3” NPS.

2. Isolator: Spring hanger with 1” deflection.

B. Base: None.

1. Suspended Equipment:
   a. Fan Systems:
      1) Axial Fans.
      2) Centrifugal, in-line Fans.
      3) Factory Fabricated AHUs.
a) Provide structural steel channel to support unit and suspend frame from structure.

b) Piping in Mechanical Rooms, greater than 3” NPS.

2. Isolator: Spring hanger with 2” deflection.

C. Base: Roof Curbs or Rails.

1. Equipment:

   a. Roof Exhaust Fans.
   b. Air Cooled Condensing Units.
   c. Factory Fabricated AHUs without internal isolation.

2. Isolator:

   a. Pad integral with curb.
   b. Restrained, open spring type with 1” deflection.

D. Base: Reinforced Concrete Inertia Block

1. Equipment: Pumping Systems

   a. Fire.
   b. Heating water.

2. Isolator: Freestanding, open spring type with 1.5” deflection.

E. Base: 4” Housekeeping Pad

1. Equipment:

   a. Floor mounted Fan Systems.

      1) Cabinet fans.
      2) Centrifugal fans:

         a) DWDI.
         b) In-line.
         c) Utility vent sets.

      3) Factory Fabricated AHUs.

   b. Floor mounted Reciprocating Air Compressors.

2. Isolator: Restrained, open spring type with 2” deflection.

F. Miscellaneous Systems

1. Factory Fabricated, Internally Isolated, AHUs.

   a. Base:

      1) 6” Housekeeping pad.
      2) Factory fabricated, sound attenuating curb.
b. Isolator: Pad.

2. Jockey Pump
   b. Isolator: None.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

C. Install seismic isolators and restraints as required by delegate design calculations.

D. Install hanger rod stiffeners to prevent buckling of hanger rods due to seismic forces.

E. Install spring isolators for the closest three hangers for all piping attached to rotating equipment.

F. Equipment Restraints:
   1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

G. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
   3. Brace a change of direction longer than 12 feet.

H. Install cables so they do not bend across edges of adjacent equipment or building structure.

I. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.
M. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

N. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer's recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION
A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.5 IDENTIFICATION
A. Install brass identification tags at all seismic brace locations. Tags to include the following information:
   1. Unique keyed identification number that corresponds to nomenclature used to mark location on shop drawings and calculations.
   2. Specific G-force the system at that location is designed to resist.
   3. Maximum brace reaction to the structure.
   4. For Individually suspended items: Maximum conduit size.
   5. For Trapeze or Multiple pipe hangers: Maximum pounds-per-lineal-foot.
   6. For Suspended Equipment: Maximum weight of equipment.

3.6 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days’ advance notice.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

F. Prepare a report that identifies unit components and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.

3.7 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT
GMP Documents
July 7, 2017
SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification material and device.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
D. Valve numbering scheme.
E. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 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. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, laminated phenolic with a black surface and white substrate for mechanical engraving, 1/16 inch minimum thickness, beveled edges, and having predrilled holes for attachment hardware.
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.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number as directed by owner. Secondary lettering shall indicate date of installation.

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.

D. Punched plastic tape for labels is not acceptable.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch minimum thickness, and having predrilled holes for attachment hardware.


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 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1 inch for name of units. 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. Labels shall conform to ANSI A13.1 and the following table:
### Outside Diameter of Pipe or of Covering

<table>
<thead>
<tr>
<th>Outside Diameter of Pipe or of Covering</th>
<th>Height of Letters</th>
</tr>
</thead>
<tbody>
<tr>
<td>¾&quot; to 1 1/4&quot;</td>
<td>½&quot;</td>
</tr>
<tr>
<td>1-1/2&quot; to 2&quot;</td>
<td>¾&quot;</td>
</tr>
<tr>
<td>2-1/2&quot; to 6&quot;</td>
<td>1-1/4&quot;</td>
</tr>
<tr>
<td>8&quot; to 10&quot;</td>
<td>2-1/2&quot;</td>
</tr>
<tr>
<td>Over 10&quot;</td>
<td>3-1/2&quot;</td>
</tr>
</tbody>
</table>

### GMP Documents

**IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

- **B.** Available Manufacturers: Seton, Brady, or Westline.

- **C.** Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or cover full circumference of pipe.

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

- **E.** Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction. For steam systems, also include line pressure on label.
  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.

### DUCT LABELS

- **A.** Material and Thickness: Multicolor, plastic labels having adhesive for attachment.

- **B.** Service:
  1. Non-hazardous
    a. Supply
    b. Return
    c. Outside air
    d. Relief
    e. General Exhaust
  2. Hazardous
    a. Isolation Exhaust
    b. Nuclear Medicine Exhaust
    c. Laboratory Exhaust
    d. Pharmacy Exhaust
    e. Other air streams as indicated

- **C.** Letter Color:
  1. Non-hazardous Service: Black
  2. Hazardous Service: Black

- **D.** Background Color:
  1. Non-hazardous Service: White
  2. Hazardous Service: Orange
E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content.

G. Minimum Letter Size: 2-1/2 inch for name of service.

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 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.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with minimum 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 chain and S-hook or beaded chain.

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

2.6 FIRE DAMPERS AND SMOKE DAMPERS

A. Provide identification for all fire damper or smoke damper access openings.

B. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss, acrylic enamel red unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

C. Labels
   1. A. Material and Thickness: Multilayer, multicolor, laminated phenolic with a red surface and white substrate for mechanical engraving, 1/16 inch (1.6 mm) minimum thickness, beveled edges, and having predrilled holes for attachment hardware.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

6. Minimum Letter Size: 1 inch (25.4 mm) for name of units. 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.

D. Fire Damper and Smoke Damper Stencil and Labels Contents

1. "FIRE DAMPER" or "SMOKE DAMPER" as appropriate for each device.

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 using fasteners or adhesives.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding:

1. Painting of piping is specified in Division 09 Section "High-Performance Coatings."

2. Provide color coding of all pipe services, either paint or PVC wrap, in the following:

   a. Boiler Rooms
   b. Central Plants / Power Houses
   c. Mechanical Rooms

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. Reduce intervals to 10 feet in areas of congested piping and equipment.

7. In no case shall a line enter or leave a room without being identified.
8. Secure identification markers to piping by firmly pressing markers in place, following removal of protective covering. Additionally secure by banding ends of markers in place using 1/2 inch wide aluminum bands of the type normally used to secure insulation in place.

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on the outermost surface of an installed air ducts system.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems except:

1. Check valves
2. Valves within factory-fabricated equipment.
3. Shutoff valves directly adjacent to equipment
4. Faucets
5. Convenience and lawn-watering hose connections
6. HVAC terminal devices

B. Emergency shut-off valves: Provide permanent equipment label with minimum 1” high lettering. These valves include valves 2” and larger for the following services:

1. Domestic cold water.
2. Domestic hot water.
3. Chilled water.
4. Heating water.
5. Steam.
6. Steam condensate.
7. Natural gas.

C. Mark ceiling grid with colored marker in style and material as required by Owner indicating valve locations above ceiling.

D. List tagged valves in a valve schedule and provide to Owner with floor plans indicating location.

3.6 FIRE DAMPER AND SMOKE DAMPER LABEL INSTALLATION

A. Stencil the words "FIRE DAMPER", "FIRE-SMOKE DAMPER" or "SMOKE DAMPER" on access doors that are in sheet metal ducts. Ensure overspray of stencil medium is cleaned, removed, or covered from adjacent piping, walls, and as otherwise indicated.

B. Install tags on access doors that are in walls or ceilings where such doors conceal fire damper access plates, or on the T-bars of removable ceilings immediately below the location of fire damper access openings above.

END OF SECTION
SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.

2. Hydronic Piping Systems:
   a. Constant-flow systems.
   b. Variable-flow systems.

3. Steam systems.
4. HVAC equipment quantitative-performance settings.
5. Space pressurization testing and adjusting.
6. Smoke-control systems testing and adjusting.
7. Verifying that automatic control devices are functioning properly.
8. Reporting results of activities and procedures specified in this Section.

1.2 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.
I. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.

J. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

K. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.

L. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

M. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

N. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

O. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

P. TAB: Testing, adjusting, and balancing.

Q. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

R. Test: A procedure to determine quantitative performance of systems or equipment.

S. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 6 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.


D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review based on system readiness reports and pre-functional check lists.

F. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
G. Sample Report Forms: Submit two sets of sample TAB report forms.

H. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

I. Warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. The TAB firm shall be organized to provide independent professional testing and balancing services. The firm shall have a minimum of one (1) Professional Engineer licensed in the project’s state, in good standing with the board and have a current registration.

B. All personnel used on the job site shall be either TAB engineers or TAB technicians, who shall have been permanent, full-time employees of the Tab firm for a minimum of six (6) months prior to working on the project.

C. Upon request, the TAB Firm shall submit the following to the Architect/Engineer and/or Owner for approval prior to commencing services:
   1. Name and biographical data of the Professional Engineer and all personnel to be assigned to this project.
   2. Proof of company operation for minimum of five (5) years.

D. TAB Firm Qualifications: Engage a TAB firm certified by AABC.

E. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers’ authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
   1. Agenda Items: As a minimum, include the following:
      a. Submittal distribution requirements.
      c. TAB plan.
      d. Work schedule and Project-site access requirements.
      e. Coordination and cooperation of trades and subcontractors.
      f. Coordination of documentation and communication flow.
      g. Coordinate submission of FMS sequence and schematics for review by TAB firm.

F. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
G. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems."

H. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems."

I. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.5 COORDINATION

A. Notice: Provide minimum 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.

C. The Contractor shall start up and test all materials and equipment which normally require testing. All piping, etc., shall be tested to meet code requirements or the specification requirements, whichever is the more stringent. All equipment shall operate a sufficient length of time at the Contractor's expense to prove to the Architect/Engineer and/or Owner that the equipment is free from mechanical defects, runs smoothly and quietly and performs satisfactorily to meet the requirements set forth in the mechanical plans and specifications.

D. In order that all HVAC systems can be properly tested, adjusted and balanced, the Contractor shall operate the HVAC systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB, and shall further operate and pay all costs of operation during the TAB period. Operating expenses to be paid for by the Contractor will include, but not necessarily be limited to, the following:
   1. Utility costs; electrical, water, gas, etc.
   2. Personnel costs to start, operate and stop all HVAC equipment.
   3. All start-up labor and material costs.
   4. All maintenance costs.

E. The plans and specifications have indicated valves, dampers and miscellaneous adjustment devices for the purpose of testing and balancing the HVAC systems to obtain optimum operating conditions. The Contractor shall install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as required.

F. The Contractor shall provide and coordinate services to repair or replace any and all deficient items or conditions found before and during the TAB period.

G. As a part of this Project Contract, the Contractor shall make any changes in the sheaves, belts, motors, dampers and valves or the addition of dampers and/or valves as required to correctly balance the HVAC systems as required at no additional cost.

H. Provide sufficient time in Project Contract completion schedule to permit the completion of TAB services prior to Owner occupancy of the Project.
I. The Contractor shall furnish without charge to the TAB Firm:

1. One set of mechanical specifications and all addenda.
2. All pertinent change orders.
3. Complete set of mechanical plans with latest revisions.
4. “As-installed” drawings.
5. Approved control diagrams and submittals.
6. Approved manufacturer's submittals for all HVAC equipment.

1.6 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's “National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems” forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
3. Based on examination of the Contract Documents, to recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 01 Section "Project Record Documents.”

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
E. Examine equipment performance data including fan and pump curves. 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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA’s "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine system pumps to ensure absence of entrained air in the suction piping.

M. Examine equipment for installation and for properly operating safety interlocks and controls.

N. Examine control system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

O. 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. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Prepare a TAB plan that includes strategies and step-by-step procedures.

C. The Contractor shall complete system readiness checks, prepare system readiness reports, and prefunctional tests including the following:
   1. Permanent electrical power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. 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. TAB firm shall coordinate with Contractor to gather all required system points and data without voiding manufacturers’ warranties. Facility personnel and factory-authorized service representatives may also be required.

B. Perform testing and balancing procedures on each system according to the procedures contained in AABC’s “National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems” and this Section.

C. Cut insulation, penetrate pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

D. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

E. 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. Provide a marked-up set of mechanical plans or "as-built" duct layouts of systems that includes numbering of each HVAC device that corresponds to the respective item in the TAB report.

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. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
F. Verify that motor starters are equipped with properly sized thermal protection.
G. Check dampers for proper position to achieve desired airflow path.
H. Check for airflow blockages.
I. Check condensate drains for proper connections and functioning.
J. Check for proper sealing of air-handling unit components.
K. Check for proper sealing of air duct system.

3.5 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS
A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
B. Prepare schematic diagrams of systems’ "as-built" piping layouts.
C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
   1. Check liquid level in expansion tank.
   2. Check highest vent for adequate pressure.
   3. Check flow-control valves for proper position.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
   5. Verify that motor starters are equipped with properly sized thermal protection.
   6. Check that air has been purged from the system.

3.6 GENERAL PROCEDURES FOR DOMESTIC HOT WATER SYSTEMS
A. Balance domestic hot water recirculation, to ensure proper flow through all mains and branches. Tune system until hot water is delivered to the most remote fixture within the allowable time as required by the AHJ.

3.7 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS
A. Pressure testing shall be limited to the following room types:
   1. Soiled / Decontamination.
B. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable sating, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.
C. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.

D. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
   1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
   2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
   3. Test room pressurization first, then zones, and finish with building pressurization.

E. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.

F. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.
   1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
   2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test overpressurization and underpressurization, and observe and report on the system’s ability to revert to the set point.
   3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.

G. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.

H. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.8 PROCEDURES FOR SMOKE-CONTROL SYSTEM TESTING

A. Before testing smoke-control systems, verify that construction is complete and verify the integrity of each smoke-control zone boundary. Verify that windows and doors are closed and that applicable saiving, gasket, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

B. Measure and record wind speed and direction, outside-air temperature, and relative humidity on each test day.

C. Measure, adjust, and record airflow of each smoke-control system with all fans that are a part of the system operating as intended by the design.

D. Measure, adjust, and record the airflow of each fan. For ducted systems, measure the fan airflow by duct Pitot-tube traverse.

E. After air balancing is complete, perform the following pressurization testing for each smoke-control zone in the system:
1. Verify the boundaries of each smoke-control zone.

2. With the HVAC systems in their normal mode of operation and smoke control not operating, measure and record the pressure difference across each smoke-control zone. Make measurements after closing doors that separate the zones. Make one measurement across each door. Clearly indicate the high and low pressure side of each door.

3. With the system operating in the smoke-control mode and with each zone in the smoke-control system activated, perform the following:

   a. Measure and record the pressure difference across each door that separates the smoke zone from adjacent zones. Make measurements with doors that separate the smoke zone from the other zones closed. Clearly indicate the high and low pressure side of the door. Doors that have a tendency to open slightly due to the pressure difference should have one pressure measurement made while held closed and another measurement made with the door open.

   b. Continue to activate each separate zoned smoke-control system and make pressure difference measurements.

   c. After testing a smoke zone’s smoke-control system, deactivate the HVAC systems involved and return them to their normal operating mode before activating another zone’s smoke-control system.

   d. Verify that controls necessary to prevent excessive pressure differences are functional.

F. Operational Tests:

1. Check the proper activation of each zoned smoke-control system in response to all means of activation, both automatic and manual.

2. Check automatic activation in response to fire alarm signals received from the building’s fire alarm and detection system. Initiate a separate alarm for each means of activation to ensure that the proper operation of the correct zoned smoke-control system occurs.

3. TAB firm involvement shall provide air flow and pressure measurements and verification of HVAC equipment and EMS control activation when Smoke-Control system is activated by others.

4. Check and record the proper operation of fans, dampers, and related equipment as outlined below for each separate zone of the smoke-control system.

   a. Fire zone in which a smoke-control system automatically activates.

   b. Type of signal that activates a smoke-control system, such as pull station, sprinkler water flow, or smoke detector.

   c. Smoke zone(s) where maximum mechanical exhaust to the outside is implemented and no supply air is provided.

   d. Positive pressure smoke-control zone(s) where maximum air supply is implemented and no exhaust to the outside is provided.

   e. Fan(s) "ON" as required to implement the smoke-control system. Multiple- or variable-speed fans should be further noted as "MAX. VOLUME" to verify that the intended control configuration is achieved.

   f. Fan(s) "OFF" as required to implement the smoke-control system.

   g. Damper(s) "OPEN" where maximum airflow must be achieved.

   h. Damper(s) "CLOSED" where no airflow should take place.

   i. Auxiliary functions to achieve the smoke-control system configuration such as changes or override of normal operating pressure and temperature-control set points.

   j. If standby power is provided for the smoke-control system, test to verify that the system functions while operating under both normal and standby power.
G. Conduct additional tests required by authorities having jurisdiction. Unless required by authorities having jurisdiction, perform testing without the use of smoke or products that simulate smoke.

H. Using the air flow and pressure measurements taken by the TAB firm, the Contractor shall prepare a complete report of observations, measurements, and deficiencies.

3.9 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures for systems with pneumatic components and device positions and correlate with airflow and water flow measurements.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. For pneumatic systems, check main control supply-air pressure and observe compressor and dryer operations.

J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.10 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans:
   a. Up to 5000 cfm: 0 to plus 10 percent.
   b. Larger than 5000 cfm: 0 to plus 5 percent.

2. Air Devices
   a. Exhaust: 0 to -10 percent.
   b. Return: +/-5 percent.
   c. Supply: 0 to +10 percent.

3. Hydronic Flow Rates
   a. Pumps: 0 to +10 percent.
   b. Equipment: 0 to +5 percent.
3.11 REPORTING

A. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.12 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems. A single PDF document with navigational bookmarks by section may be substituted for a manual binder.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures, along with proof of calibration.

C. 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, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB firm.
   3. Project name.
   4. Project location.
   5. Architect’s name and address.
   6. Engineer’s name and address.
   7. Contractor’s name and address.
   9. Signature of TAB firm 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, type size, and fittings.
   14. Notes to explain why certain final data in the body of reports varies from indicated values.

E. Provide a marked-up set of mechanical plans or “as-built” layouts of systems that include numbering of each HVAC device that corresponds to the respective item in the TAB report.
1. Quantities of outside, 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.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:
   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. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Filter condition.
   g. Preheat coil static-pressure differential in inches wg.
   h. Cooling coil static-pressure differential in inches wg.
   i. Heating coil static-pressure differential in inches wg.
   j. Outside airflow in cfm.
   k. Return airflow in cfm.
   l. Relief airflow in cfm (L/s).
   m. Outside-air damper position.
   n. Return-air damper position.
   o. Relief-air damper position.
   p. Fan drive settings including VFD settings and percentage of maximum pitch diameter.
   q. Settings for supply-air static-pressure controller.

G. Apparatus-Coil Test Reports:
1. **Coil Data:**
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch o.c.
   f. Make and model number.
   g. Face area in sq. ft.
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.

2. **Test Data (Indicated and Actual Values):**
   a. Airflow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outside-air, wet- and dry-bulb temperatures in deg F.
   e. Return-air, wet- and dry-bulb temperatures in deg F.
   f. Entering-air, wet- and dry-bulb temperatures in deg F.
   g. Leaving-air, wet- and dry-bulb temperatures in deg F.
   h. Water flow rate in gpm.
   i. Water pressure differential in feet of head or psig.
   j. Entering-water temperature in deg F.
   k. Leaving-water temperature in deg F.
   l. Refrigerant expansion valve and refrigerant types.
   m. Refrigerant suction pressure in psig.
   n. Refrigerant suction temperature in deg F.
   o. Inlet steam pressure in psig.

**H. 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 Btuh.
   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. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. **Test Data (Indicated and Actual Values):**
   a. Total airflow rate in cfm.
   b. Entering-air temperature in deg F.
   c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btuh.
i. High-fire fuel input in Btuh.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btuh.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btuh.

I. 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 Btuh.
   e. Number of stages.
   f. Connected volts, phase, and hertz.
   g. Rated amperage.
   h. Airflow 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 Btuh.
   b. Airflow rate in cfm.
   c. Air velocity in fpm.
   d. Entering-air temperature in deg F.
   e. Leaving-air temperature in deg F.
   f. Voltage at each connection.
   g. Amperage for each phase.

J. 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. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:
   a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
g. Number of belts, make, and size.

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.

K. 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 deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft. 
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

L. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device make.
f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.
i. Air-terminal-device effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
M. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Entering-water temperature in deg F.
   c. Leaving-water temperature in deg F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in deg F.
   f. Leaving-air temperature in deg F.

N. Compressor and Condenser Reports: Utilize chiller data display for some of the information below. Indicate which items are not available on the display panel and rely on data provided by manufacturer instead. For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Unit make and model number.
   d. Compressor make.
   e. Compressor model and serial numbers.
   f. Refrigerant weight in lb.
   g. Low ambient temperature cutoff in deg F.

2. Test Data (Indicated and Actual Values):
   a. Inlet-duct static pressure in inches wg.
   b. Outlet-duct static pressure in inches wg.
   c. Entering-air, dry-bulb temperature in deg F.
   d. Leaving-air, dry-bulb temperature in deg F.
   e. Condenser entering-water temperature in deg F.
   f. Condenser leaving-water temperature in deg F.
   g. Condenser-water temperature differential in deg F.
   h. Condenser entering-water pressure in feet of head or psig.
   i. Condenser leaving-water pressure in feet of head or psig.
   j. Condenser-water pressure differential in feet of head or psig.
   k. Low-pressure-cutout set point in psig.
   l. High-pressure-cutout set point in psig.
   m. Suction pressure in psig.
   n. Suction temperature in deg F.
   o. Condenser refrigerant pressure in psig.
   p. Condenser refrigerant temperature in deg F.
   q. Oil pressure in psig.
   r. Oil temperature in deg F.
s. Voltage at each connection.
t. Amperage for each phase.
u. Kilowatt input.
v. Crankcase heater kilowatt.
w. Number of fans.
x. Condenser fan rpm.
y. Condenser fan motor make, frame size, rpm, and horsepower.
z. Condenser fan motor voltage at each connection.
aa. Condenser fan motor amperage for each phase.

O. Heat-Exchanger/Converter Test Reports: For steam and hot-water heat exchangers, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and type.
   e. Model and serial numbers.
   f. Ratings.

2. Steam Test Data (Indicated and Actual Values):
   a. Inlet pressure in psig.

3. Primary Water Test Data (Indicated and Actual Values):
   a. Entering-water temperature in deg F.
   b. Leaving-water temperature in deg F.
   c. Entering-water pressure in feet of head or psig.
   d. Water pressure differential in feet of head or psig.
   e. Water flow rate in gpm.

4. Secondary Water Test Data (Indicated and Actual Values):
   a. Entering-water temperature in deg F.
   b. Leaving-water temperature in deg F.
   c. Entering-water pressure in feet of head or psig.
   d. Water pressure differential in feet of head or psig.
   e. Water flow rate in gpm.

P. Pump Test Reports:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and size.
   e. Model and serial numbers.
   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.
   l. Impeller size.

Q. Boiler Test Reports:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and type.
   e. Model and serial numbers.
   f. Fuel type and input in Btuh.
   g. Number of passes.
   h. Ignition type.
   i. Burner-control types.
   j. Voltage at each connection.
   k. Amperage for each phase.

2. Test Data (Indicated and Actual Values):
   a. Operating pressure in psig.
   b. Operating temperature in deg F.
   c. Entering-water temperature in deg F.
   d. Leaving-water temperature in deg F.
   e. Number of safety valves and sizes in NPS.
   f. Safety valve settings in psig.
   g. High-limit setting in psig.
   h. Operating-control setting.
   i. High-fire set point.
   j. Low-fire set point.
   k. Voltage at each connection.
   l. Amperage for each phase.
   m. Draft fan voltage at each connection.
   n. Draft fan amperage for each phase.
   o. Manifold pressure in psig.
R. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.13 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. Randomly 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. Measure sound levels at two locations.
   e. Measure space pressure of at least 10 percent of locations.
   f. Verify that balancing devices are marked with final balance position.
   g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
3. Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.
3.14 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing 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 testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION
SECTION 230700
HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
   a. Calcium silicate.
   b. Cellular glass.
   c. Fiberglass.
   d. Flexible elastomeric.
   e. Mineral or glass fiber.
   f. Phenolic.
   g. Polyolefin.

2. Fire-rated insulation systems.
3. Factory-applied jackets.
4. Field-applied cloths.
5. Field-applied jackets.
6. Adhesives.
7. Mastics.
8. Lagging adhesives.
10. Tapes.
11. Securements.

B. Related Sections:

1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 22 Section "Plumbing Insulation."
3. Division 23 Section "Metal Ducts" for duct liners.
4. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for installation locations of pipe saddles at pipe hangers.
5. Division 33 Section "Underground Hydronic Energy Distribution" for loose-fill pipe insulation in underground piping outside the building.
6. Division 33 Section "Underground Steam and Condensate Distribution Piping" for loose-fill pipe insulation in underground piping outside the building.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Calculations: For insulation submitted outside of the conductivity range per the "Minimum Pipe Insulation Thickness" Table for the application listed, submit thickness calculations.
C. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the United States Department of Labor, Employment and Training Registered Apprenticeship Program.

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.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fiberglass
   2. K-Flex.
   4. Manson (Certain Teed).
   5. Owens-Corning.

B. Flexible Elastomeric
   1. Aeroflex / Aerocel EPDM
   2. Armacell / Armaflex
   3. RBX Industries / Rubatex

C. Phenolic
   1. Polyguard Products
   2. Resolco / Insul-Phen

D. Polyisocyanurate
   1. Dow / Trymer

E. Polyolefin
   1. Nomaco/ IMCOA Imcolock
2.2 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. Calcium Silicate:
   1. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   3. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Cellular Glass: Inorganic, incombustible, cellular 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.

H. Fiberglass
   1. Flexible glass fiber; ASTM C553 and ASTM C1290; commercial grade; 'k' value of 0.25 at 75 degrees F; 1.5 lb/cu ft minimum density; 0.002 inch foil scrim kraft facing for air ducts.
   2. Rigid glass fiber; ASTM C612, Class 1; 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density.
   3. Duct liner, flexible glass fiber; ASTM C1071; Type II, 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; coating air side to be black, unless otherwise indicated, and rated for 4,000 feet per minute air velocity. The airstream surface must be protected with a durable polyacrylate copolymer emulsion, or approved equal, specifically formulated to:
      a. Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM D 5590 with "0" growth rating.
      b. Act as a fungicidal protective coating: water based, VOC < 50 g/l. Fungicidal coating must be EPA registered for use in HVAC duct systems.
I. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials with a built-in vapor barrier. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.


K. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

L. Mineral Wool: ASTM C 547; preformed, high temperature insulation; 'k' value of 0.35 at 300 degrees F.

M. Phenolic:
   1. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
   2. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
   3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

N. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

2.3 FIRE-RATED INSULATION SYSTEMS

A. 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, provide one of the following:
      a. CertainTeed Corp.; FlameChek.
      b. Johns Manville; Firetemp Wrap.
      c. 3M; Fire Barrier Wrap Products.
      d. Unifrax Corporation; FyreWrap.

2.4 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.
   4. Pipe Shields, Inc.
   5. Rilco Manufacturing Company, Inc.
   6. Value Engineered Products, Inc.
C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

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

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

F. For Clevis or Band Hangers: Insert and shield shall cover lower 360 degrees of pipe.

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

2.5 ADHESIVES

A. Products: Subject to compliance with requirements, insulation manufacturer shall provide insulation adhesive and jacket manufacturer shall provide jacket adhesive.

B. 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.

C. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

D. Cellular-Glass and Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

E. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

2.6 MASTICS

A. Products: Subject to compliance with requirements, insulation manufacturer shall provide mastics.

B. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

C. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 360 deg F.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 200 deg F.
3. Solids Content: 63 percent by volume and 73 percent by weight.

2.7 LAGGING ADHESIVES

A. Products: Subject to compliance with requirements, insulation manufacturer shall provide lagging adhesives

B. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
   2. Service Temperature Range: Minus 50 to plus 360 deg F.

2.8 SEALANTS

A. Products: Subject to compliance with requirements, insulation manufacturer shall provide sealants

B. Joint Sealants for Cellular-Glass, and Phenolic Products:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Permanently flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 100 to plus 300 deg F.

C. FSK and Metal Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.

D. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.

2.9 INSULATING CEMENT

A. ASTM C 195; hydraulic setting mineral fiber thermal insulating cement with dry density of no more than 38 lb/ft3 thermal conductivity of 0.96 at 400°F mean temperature, and service temperature to 1200°F.

B. Acceptable manufacturers: RAMCO or approved equal.
2.10 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jackets
   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) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
   b. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   c. for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
6. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.11 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

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

2.12 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. 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.
   c. Proto PVC Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.


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, and mechanical joints.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

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, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.

   a. Factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
   a. Factory cut and rolled to size.
   b. Material, finish, and thickness are indicated in field-applied jacket schedules.
   c. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. PVDC Jackets:

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. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.

2. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

3. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.


2.13 TAPES

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. Avery Dennison Corporation, Specialty Tapes Division.
2. Compac Corp.
4. Venture Tape.
5. Dow Chemical Company (The).

B. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

C. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
D. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   1. Width: 2 inches.
   2. Thickness: 6 mils.
   3. Adhesion: 64 ounces force/inch in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch in width.

E. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Width: 2 inches.
   2. Thickness: 3.7 mils.
   3. Adhesion: 100 ounces force/inch in width.
   4. Elongation: 5 percent.
   5. Tensile Strength: 34 lbf/inch in width.

F. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   1. Width: 3 inches.
   2. Film Thickness: 4 mils.
   3. Adhesive Thickness: 1.5 mils.
   4. Elongation at Break: 145 percent.
   5. Tensile Strength: 55 lbf/inch in width.

G. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   1. Width: 3 inches.
   2. Film Thickness: 6 mils.
   3. Adhesive Thickness: 1.5 mils.
   4. Elongation at Break: 145 percent.
   5. Tensile Strength: 55 lbf/inch in width.

2.14 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. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.
   3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.

B. Insulation Pins and Hangers:
   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.
2) GEMCO.
3) Midwest Fasteners, Inc.

2. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, minimum 0.106-inch-diameter shank, length to suit depth of insulation indicated.

3. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, minimum 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

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. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Match ductwork material, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. 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. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Match ductwork material, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. Adhesive: Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers 0.016-inch-thick, Match pin material, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

2.15 PIPE INSULATION HANGER SHIELDS

A. Where hangers are placed outside the jackets of pipe insulation, provide shields or equivalent by Elin Metal Products Company.

B. Insulation and shields shall consist of a 360 degree insert of high-density, 100 psi, waterproof calcium silicate, encased in a 360 degree galvanized sheet steel shield. Insert shall be same thickness as adjoining pipe insulation, and shall extend 1-inch beyond sheet metal shield in each direction. Shield lengths and minimum sheet metal gauges shall be as directed below:

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>SHIELD LENGTH</th>
<th>MINIMUM GAUGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; to 8&quot;</td>
<td>12&quot;</td>
<td>16</td>
</tr>
<tr>
<td>10&quot; &amp; Larger</td>
<td>22&quot;</td>
<td>16</td>
</tr>
</tbody>
</table>
C. Insulation and shields for Phenolic type insulation shall consist of a 360 degree insert of high-density (minimum 5 lbs/cu. ft.) phenolic insulation by the same manufacturer, encased in a 360 degree galvanized sheet steel shield. Insert shall be same thickness as adjoining pipe insulation, and shall extend 1-inch beyond sheet metal shield in each direction. Shield length and gauge per above table.

D. Shields shall be Model A1000 – A9000, except for pipe roller applications and where pipe hanger spacing exceeds 10 feet, then provide Model CSX-CW.

E. At the Contractor's option, shop-fabricated galvanized metal shields may be provided based on approved shop drawings. Length and gauge of sheet metal shall be as specified above.

2.16 PREMANUFACTURED COVERS

A. Preformed manufactured PVC fitting covers with rigid one piece (half-shell) preformed rigid insulation.

PART 3 - EXECUTION

3.1 GENERAL

A. Materials shall be applied by a qualified insulation applicator/workman skilled in this trade. Insulation shall be installed in accordance with the manufacturers written instructions and in accordance with recognized industry standards. Mechanical fasteners shall be used whenever possible to assure permanent construction. Unsightly work shall be cause for rejection.

B. Prior to installation of any insulation materials to ferrous piping systems, the piping surfaces shall be thoroughly cleaned of all mill scale, grease and dirt and passed pressure testing.

C. Non-compressible insulation material shall be installed at hanger supports on cold piping to prevent damage to insulation and vapor barrier. All wet duct and pipe insulation shall be replaced.

D. Insulation of cold surfaces shall be vapor-sealed to prevent condensation.

E. Minimum thickness of insulation shall be as scheduled unless alternate thicknesses can be shown to meet energy performance and approved by the Engineer.

F. Where piping system insulation is specified, cover valves, strainers, unions, flanges, and fittings with pre-manufactured valve and fitting covers.

G. Install pipe insulation hanger shields.

H. Extend piping insulation without interruption through walls, floors and similar piping penetrations, there shall be no exceptions.

I. Duct insulation shall terminate at fire/smoke damper sleeves. A separate strip of insulation shall be provided around the sleeve and sealed at the wall.

J. Miscellaneous Applications

   1. Refrigerant suction lines within air cooled condensing units, heat pumps and chillers.
K. Unless indicated otherwise, insulate pipe and equipment that operates:
   1. 10 degrees or lower than ambient space temperature.
   2. 10 degrees of higher than ambient space temperature.

L. All steam valves and regulators at and below an elevation of 7' - 0" A.F.F. shall be insulated with removable asbestos free insulation jackets with Velcro fasteners to allow easy installation and removal.

3.2 APPLICATION TYPES

A. Equipment

   E1: Cut insulation to fit contour of equipment, and secure by means of bands, stick-clips, weld-pins and lugs or adhesives as required for each individual piece of equipment. Provide vapor barrier and finish as required for each specific application. Provide new cold surfaces of pumps with accessible boxes that easily separate coincidental with parting line of evaporator heads and pump casings. Resulting insulation joints shall be covered with a self-sealing, vapor-barrier mastic. Seal all laps and penetrations in vapor barrier jacket with an approved vapor barrier mastic.

B. Piping


   P2: Butt insulation together and securely tape. Install factory-furnished laps at the butt joints. Neatly bevel and finish insulation where it terminates. Seal all laps and penetrations in vapor barrier jacket with an approved vapor barrier mastic.

   P3: Same as P2, except install insulation over heat trace tape. Finish with metal jacket.

C. Ductwork

   D1: Apply fiberglass board insulation to ducts with mechanical fasteners such as stick-clips or weld-pins (with tape and mastic) spaced as required to install full pieces of board insulation. Space on 12" centers (maximum) on the bottom of each duct and plenum. Cover joints and seams in vapor barrier facings with 3" wide matching tape, or with vapor-barrier mastic reinforced with 3" glass mesh reinforcement. Provide an additional layer of insulation board where duct-standing seams exceed the insulation thickness. Seal all laps and penetrations in vapor barrier jacket with an approved vapor barrier mastic.

   D2: Wrap flexible fiberglass insulation around ducts and secure. Additionally, ducts 24 inches wide and larger shall secure insulation with stick clips on 18" centers. Lap insulation a minimum of four (4) inches and seal with an approved vapor barrier mastic. Reinforce lap with a three (3) inch wide band of either glass mesh reinforcement or foil/vapor-barrier tape. Seal raw glass to duct where insulation terminates. Seal all laps and penetrations in vapor barrier jacket with an approved vapor barrier mastic.
### 3.3 INSULATION SCHEDULE KEYS

#### Insulation Types Key

<table>
<thead>
<tr>
<th>Type</th>
<th>Maximum K Factor @ 75°F</th>
<th>Temp. Limit °F</th>
<th>Density Lb. Per Cubic Foot</th>
<th>Federal Spec. Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Calcium Silicate</td>
<td>0.38</td>
<td>1200</td>
<td>14</td>
<td>HH-I-523C</td>
</tr>
<tr>
<td>2. Fiberglass (Rigid)</td>
<td>0.23</td>
<td>450</td>
<td>3</td>
<td>ASTM C 547 Type 1</td>
</tr>
<tr>
<td>3. Fiberglass Flexible Duct Wrap</td>
<td>0.25</td>
<td>250</td>
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<td>4. Foamed Glass (Cellular)</td>
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<td>5. Foamed Plastic (Flexible)</td>
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<td>5</td>
<td>HH-I-573</td>
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<td>6. High Temperature Fiberglass</td>
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<td>7. Insulating Cement</td>
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<td>ASTM C 1126</td>
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<td>8. Phenolic</td>
<td>0.13</td>
<td>250</td>
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<td>ASTM C 177 or C518</td>
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<td>9. Flexible Elastomeric</td>
<td>0.27</td>
<td>220</td>
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<tr>
<td>10. Polyolefin</td>
<td>0.25</td>
<td>200</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

#### Finishes Key

- **F1.** 8-ounce glass cloth
- **F2.** Insulation cement
- **F3.** 0.016 aluminum, plain, up through 12” pipe size; 0.016 aluminum, corrugated, for pipe sizes 14” and larger
- **F4.** 15-mil PVC
- **F5.** Foil/reinforced/kraft jacket (vapor barrier)
- **F6.** 1/4-inch weatherproof mastic with glass mesh reinforcement
- **F7.** 1/16” vapor barrier mastic (0.05 perm rating) with glass mesh reinforcement
- **F8.** White all-service jacket (vapor barrier) with self-sealing lap, or taped joints
- **F9.** Two coats vinyl lacquer type white paint
- **F10.** Canvas jacketing of 6 oz. Minimum, 100% cotton woven fabric with 25/50 flame/smoke rating and equal to Fattal’s Thermocanvas Recovery Jacket.

### 3.4 DUCT AND PLENUM INSULATION

#### A. Outside Air Ducts and Plenums in Concealed or Exposed Locations

2. Insulation Materials:
   - a. Rigid Fiberglass.
   - b. Cellular Glass
   - c. Phenolic
3. Application Type: D1.
5. Outdoor Finish: F1 and F2.

#### B. Supply Air Ducts and Plenums in Concealed Locations

3. Application Type: D2.
5. Outdoor Finish: F1 and F2.

C. Supply Air Ducts and Plenums in Exposed Locations

2. Insulation Materials:
   a. Rigid Fiberglass.
   b. Cellular Glass
   c. Phenolic

3. Application Type: D1.
5. Outdoor Finish: F1 and F2.

D. Relief, Return, Exhaust Ducts, and Plenums, and Air Devices in Concealed Locations Under an Exposed Roof.

3. Application Type: D2.
5. Outdoor Finish: F1 and F2.

E. Relief, Return, Exhaust Ducts, and Plenums, and Air Devices in Exposed Locations Under an Exposed Roof.

2. Insulation Materials:
   a. Rigid Fiberglass.
   b. Cellular Glass
   c. Phenolic

3. Application Type: D1.
5. Outdoor Finish: F1 and F2.

F. Additional Duct Installations

1. Where Noted on the Plans, Relief Air Ducts, Recirculated Air Ducts, Mixed Air Ducts and Return Air Duct shall be Internally Lined.
2. Items Not Insulated:
   a. Fibrous-glass ducts.
   b. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
   c. Factory-insulated flexible ducts.
   d. Factory-insulated plenums and casings.
   e. Flexible connectors.
   f. Vibration-control devices.
   g. Factory-insulated access panels and doors.

3. Where duct is exposed outdoors, protect the ductwork with one of the following:
3.5 EQUIPMENT INSULATION

A. Equipment above ambient temperature, excluding factory insulated assemblies.

1. Equipment includes, unless otherwise indicated:

   a. Hot Water:
      1) Water-to-Water Heat Exchangers.
      2) Expansion tanks.
      3) Air Separators.
      4) Pumps.
      5) Laundry Exhaust Assemblies.
      6) Humidifiers.

   b. Steam:
      1) Blowdown Heat Recovery Unit.
      2) Blowdown Separator Flash Tanks.
      3) Boiler Breeching.
      4) Dearator.
      5) Flash Tanks.
      6) Steam Condensate Pumps.
      7) Steam-to-water Heat Exchanger.
      8) Steam Surge Tank.

   c. Exhaust services:
      1) Medical gas equipment

2. Insulation Materials:

   a. Laundry exhaust and humidifiers: High Temperature Fiberglass.
   b. All others: Rigid Fiberglass.

3. Application Types:

   a. Laundry exhaust and humidifiers: D1.
   b. All others: E1.

4. Indoor Finish:

   a. Laundry exhaust: F6 and F3.
   c. All others: F2 and F1.

5. Outdoor Finish:

   a. Laundry exhaust: F6 and F3.
   b. Humidifiers: no application.
   c. All others: F8 and F3.
B. Equipment Below Ambient Temperature, excluding factory insulated assemblies.
   1. Equipment includes, unless otherwise indicated:
      a. Chilled and Condenser Water:
         1) Water-to-Water Heat Exchangers.
         2) Expansion tanks.
         3) Air Separators.
         4) Pumps.
         5) Chillers.
   2. Insulation Materials:
      a. Chillers and pumps:
         1) Rigid Insulation.
         2) Foam Glass.
         3) Foam Plastic.
      b. All others: Rigid Fiberglass.
   3. Application Type: E1.
   4. Indoor Finish:
      a. Chillers and pumps (to be used with Insulation Material above, respectively):
         1) F2 and F1.
         2) F2 and F3.
         3) F9.
      b. All others: F2 and F1.
   5. Outdoor Finish:
      a. Chillers and pumps (to be used with Insulation Material above, respectively):
         1) F3.
      b. All others: F8 and F3.
   C. Equipment insulation thicknesses and performance shall be based on Minimum Pipe Insulation Thickness schedule.

3.6 PIPING INSULATION

A. Minimum insulation thicknesses are scheduled below.
B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor’s option.
C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following unless there is a potential for personnel injury.
1. Drainage piping located in crawl spaces.
2. Underground piping.

D. Fitting and Valve Covers:
   1. Fitting covers shall be of preformed PVC for indoor service and metal for outdoor service.
   2. Insulation material shall be rigid and of the same or greater material type and thickness, density and conductivity as the adjoining pipe. Blanket inserts will not be allowed.
   3. Fittings on fiberglass pipe insulation shall be mitered insulation up to 2" diameter and molded fittings for 2½" and larger.
   4. Insulation on steam control valves, pressure reducing valves, calibrated balance valves and triple duty valves shall be provided with a manufactured removable insulation cover. Insulated covers shall be heavy canvas type, filled with insulating material and leather laces or straps to secure cover around valve or fitting.

E. Chilled Water, Cooling Condensate, and Refrigerant Piping Indoors, Concealed or Exposed.
   1. Insulation Materials:
      a. Cellular Glass, with mitered section fittings only.
      b. Phenolic.
   2. Application Type: P2.
   3. Finish:
      b. For Foam Glass only:
         1) No finish required for concealed installations above ceilings and within shafts.
         2) Only field applied ASJ shall be used.

F. Cryogen piping, Indoor or Outdoor, Concealed or Exposed.
   1. Insulation Material: Flexible Elastomeric.
   2. Application Type: P2.
   3. Finish:

G. Hot Water, Steam, and Steam Condensate, Indoors, Concealed or Exposed.
   1. Insulation Material: Rigid Fiberglass.
   2. Application Type: P2.

H. Chilled Water, Heating Hot Water, Cooling Condensate, Domestic Water, and Refrigerant Piping Outdoors, Concealed or Exposed. Note that piping in the airstream of AHUs is considered “outdoors” for this application.
   1. Insulation Material: Cellular Glass, with mitered section fittings only and field applied ASJ.
   2. Application Type: P2.
4. Provide heat trace under insulation for hydronic services subject to freezing.

I. Engine Generators

1. Between engine generator and muffler:
   a. Insulation material: Calcium silicate.
   c. Finish: F3.

2. Engine generator muffler:
   a. Insulation material: Calcium silicate.
   c. Finish: F3.

<table>
<thead>
<tr>
<th>MINIMUM PIPE INSULATION THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLUID TEMP. (°F)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>&gt;350 (Includes HPS)</td>
</tr>
<tr>
<td>251-350 (Includes HPR, BF)</td>
</tr>
<tr>
<td>201-250 (Includes LPS, LPR)</td>
</tr>
<tr>
<td>141-200 (Includes HS, HR)</td>
</tr>
<tr>
<td>105-140</td>
</tr>
</tbody>
</table>

Notes:

1. The above table is applicable to insulations in the conductivity ranges stated only. For insulation outside these conductivity ranges, the minimum thickness (T) shall be determined by the following calculation and the calculation submitted for acceptance:
   \[ T = r(1 + t/r)^{K/k} - 1 \]
   - T = Thickness
   - r = Actual outside radius of pipe (in.)
   - t = Insulation thickness per the above table
   - K = Conductivity of alternate material
   - k = Upper value of the Conductivity Range per the above table
SECTION 230900

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:

1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
2. Division 23 Section "Modular Central Station AHUs" for additional requirements.

1.2 DEFINITIONS

A. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

B. BACnet Specific Definitions:

2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.

C. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

D. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.

E. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

F. DDC: Direct digital control.
G. **EPO**: Emergency power off. An emergency push-button used to de-energize connected power equipment. EPOs are typically installed at room egresses and have a guard to prevent accidental activation.

H. **Gateway**: Bidirectional protocol translator that connects control systems that use different communication protocols.

I. **I/O**: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

J. **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.

K. **MS/TP**: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

L. **MTBF**: Mean time between failures.

M. **Network Controller**: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicate on peer-to-peer network for transmission of global data.

N. **Network Repeater**: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

O. **PC**: Personal computer.

P. **Peer to Peer**: Networking architecture that treats all network stations as equal partners.

Q. **PID**: Proportional plus integral plus derivative.

R. **RTD**: Resistance temperature detector.

S. **UPS**: Uninterruptible power supply.

T. **USB**: Universal Serial Bus.

1.3 **SYSTEM PERFORMANCE**

A. Comply with the following performance requirements:

1. **Graphic Display**: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. **Graphic Refresh**: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. **Object Command**: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. **Object Scan**: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
   a. Water Temperature: Plus or minus 1 deg F.
   b. Water Flow: Plus or minus 5 percent of full scale.
   c. Water Pressure: Plus or minus 2 percent of full scale.
   d. Space Temperature: Plus or minus 1 deg F.
   e. Ducted Air Temperature: Plus or minus 1 deg F.
   f. Outside Air Temperature: Plus or minus 2 deg F.
   g. Dew Point Temperature: Plus or minus 3 deg F.
   h. Temperature Differential: Plus or minus 0.25 deg F.
   i. Relative Humidity: Plus or minus 5 percent.
   j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
   k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
   l. Airflow (Terminal): Plus or minus 10 percent of full scale.
   m. Air Pressure (Space): Plus or minus 0.01-inch wg.
   n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
   o. Carbon Monoxide: Plus or minus 5 percent of reading.
   p. Carbon Dioxide: Plus or minus 50 ppm.
   q. Electrical: Plus or minus 5 percent of reading.

1.4 ACTION SUBMITTALS

A. Multiple Submissions:
   1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
   2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
   3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

B. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
   2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
   3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

C. LEED Submittals:
1. Include supporting data showing energy, flow, gas, moisture, motion, pressure, <Insert other> and temperature instruments, where and if used in Project; and associated application for monitoring and control to satisfy requirements of Project LEED credits.
   a. Indicate applicable locations and area coverage, control set points, description of control operation and other required information to satisfy submission requirements for award of LEED credit.

2. Organize and identify standalone, supporting data for each LEED credit.

D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:
   a. Wiring diagrams for control units with termination numbers.
   b. Schematic diagrams and floor plans for field sensors and control hardware.
   c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:
   a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
   b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
   c. Written description of sequence of operation including schematic diagram.
   d. Points list.

E. Data Communications Protocol Certificates: Certify that each proposed DDC system component, including workstations, diagnostic units, unitary and assembled controllers, and all informational and signal processes, complies with [ASHRAE 135][LonWorks].

F. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.
G. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.
B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

   a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
   b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
   c. As-built versions of submittal Product Data.
   d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
   e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
   f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
   g. Engineering, installation, and maintenance manuals that explain how to:

      1) Design and install new points, panels, and other hardware.
      2) Perform preventive maintenance and calibration.
      3) Debug hardware problems.
      4) Repair or replace hardware.

   h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
   i. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
   j. List of recommended spare parts with part numbers and suppliers.
   k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
   l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
   m. Licenses, guarantees, and warranty documents.
   n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
   o. Owner training materials.
1.7 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.

C. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

E. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

F. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

G. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

H. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

I. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor, controller, and thermostat.
2. Maintenance Materials: One thermostat adjusting key(s) per floor or 50,000 sqft of total conditioned space, whichever is greater.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Andover.

2.2 GENERAL REQUIREMENTS

A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the provision, installation and extension of the existing building automation and Control System (FMS) including all related systems and accessories.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems.

C. System points lists included in the Documents are intended to show the desired alarm, monitoring and control points. Add any control points necessary and as required to accomplish the sequence of operations.

D. The FMS/DDC shall use BACNet/IP protocol capable of communicating over an Ethernet system. It shall be capable of residing on the corporate enterprise WAN/LAN by having an assigned IP address.

E. Provide a UPS with minimum 15 minutes backup for:
   1. All building controllers where the loss of memory or program content would result in the event of power loss.
   2. Supply and return AHU damper actuators.
   3. All smoke control components.

F. For AHUs, each individual operating state shall have an individual PID control loop for that state.

G. Controls color graphic displays. Match existing functionality and the following:
   1. Color graphic floor plan displays, and system schematics for each piece of mechanical equipment (including air handling units, variable air volume boxes, fan coils, unit ventilators, cabinet heaters, exhaust fans, fin tube radiation, chilled water systems, hot water boiler systems, and so forth) shall be provided, as specified in the point lists of the Documents, in order to optimize system performance analysis, speed alarm recognition, and simplify user interaction. Configure the color graphics and plot all associated control/monitoring points on the screen. Copies of all color graphics screens shall be provided as color printouts to the engineer for approval.
   2. System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu
selection, or test-based commands. Floor plans shall display room numbers and each zone shall be color-coded. The operator shall be able to point and click on a room or zone of rooms (in the case of an air handler that serves more than one zone). The room or zone will display an animated flow diagram of the mechanical equipment that serves that zone, with all control and monitoring points associated with that piece of equipment, including setpoints. Setpoints shall be overridden or modified from this screen.

3. Dynamic Animated Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention. Damper and valve positions, air and water flow shall be animated and shall represent actual, current conditions.

4. System Performance Analysis Screens: System performance analysis screens shall be provided for the major mechanical systems (such as air handlers, chillers, boilers, and so forth.). For each of these systems, the screen shall be split into quadrants, simultaneously displaying the following data:

   a. Quadrant 1. – Dynamic animated flow diagrams.
   b. Quadrant 2. – All analog values associated with the mechanical system shall be graphed on an X-Y axis graph. Five-minute samples for the last twenty-four hour period shall plotted. Scaling shall be automatic.
   c. Quadrant 3. – Text sequence of operations from engineering as-built submittals.
   d. Quadrant 4. – Space temperature summaries from each zone being served by mechanical system.

5. Windowing: The windowing environment of the PC Operator Workstation shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, or to allow the display of a graphic associated with an alarm to be viewed without interrupting Work in progress.

6. Alarm Annunciation: Any point in a state of alarm shall change the color of its symbol to red until it is no longer in alarm.

7. AHU Summary Graphic Screen: An AHU summary graphic screen shall be provided for economizer and non economizer AHU’s as follows:

   a. AHU’s without economizer cycles shall include a summary graphic screen including the following information:

      1) Air Handling Unit

         a) AHU number
         b) Supply air temperature
         c) Supply air temperature setpoint
         d) Supply air cfm setpoint
         e) Total terminal box airflow
         f) Chilled water valve position in %
         g) Return air temperature
         h) Return air humidity in %
         i) Outside air temperature
         j) Outside air humidity

      2) Chilled Water Secondary System

         a) Chilled water supply temperature
         b) Chilled water return temperature
         c) Chilled water flow in gpm
         d) Building load in tons
         e) Chilled water system differential pressure
INSTRUMENTATION AND CONTROL FOR HVAC

f) Chilled water system differential pressure setpoint

g) Each chilled water pump speed in %

3) Chillers

a) Each chillers chilled water supply temperature.

b. AHU’s with economizer cycles shall include a summary graphic screen including the following information:

1) Air Handling Unit

   a) AHU number
   b) Supply air temperature
   c) Supply air temperature setpoint
   d) Return air temperature
   e) Outside air temperature
   f) Outside air humidity
   g) Mixed air temperature

2) Outside Air

   a) Outside air cfm setpoint
   b) Outside air cfm measured
   c) Return fan speed %
   d) Supply Fan speed %
   e) Supply static pressure setpoint
   f) Supply static pressure actual

3) Dampers

   a) Economizer damper open position %

H. Systems integration/FMS specific requirements

1. Open Systems Integration: VFD Integrator Interface

   a. The FMS shall include appropriate hardware equipment and software to allow two-way data communications between the FMS and the VFD manufacturer’s control panel.
   b. Coordinate with the VFD manufacturer to provide a functional data communications connection.
   c. All data supported by the VFD communication protocol shall be mapped into the supervisory DDC controller’s database and shall be displayed on data screens at the Operator Workstation and shall be transparent to the operator.
   d. Furnish a BACnet communications interface as required by the VFD manufacturer.
   e. Provide all communications and power wiring and gateway panel installation for the DDC system. The VFD manufacturer shall provide all hardware for connection of the manufacturer’s processor.
   f. Provide all hardware and software required for the VFD manufacturer’s gateway interface.

2. Open Systems Integration: Boiler Integrator Interface
a. The FMS shall include appropriate hardware equipment and software to allow two-way data communications between the FMS and the boiler manufacturer’s Master Boiler Controller Control Panel.

b. Coordinate with the boiler manufacturer to provide a functional data communications connection.

c. Furnish BACnet communications interface.

d. Provide all communications and power wiring and gateway panel installation for the DDC system. The boiler manufacturer shall provide all hardware for connection of the manufacturer’s processor.

e. Provide all hardware and software required for the boiler manufacturer’s gateway interface.

I. Alarm management

1. Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, to minimize network traffic, and to prevent alarms from being lost. At no time shall the DDC panel’s ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network.

2. Point Change Report Description: All alarm or point change reports shall include the point’s English language description, and the time and date of occurrence.

3. Prioritization:

   a. Set up all system analog points with high and low alarm limits. All digital system points shall be associated with a status feedback point and all exceptions shall be reported as alarms. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized and filtered to minimize nuisance reporting and to speed operator response to critical alarms.

   b. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

4. Critical and Non-Critical Alarm Routing:

   a. Critical alarms shall be defined as chiller, boiler, generator, critical space temperature or humidity, and kilowatt demand approaching threshold. Critical alarms shall be displayed at the workstation, printed at the alarm printer, and alpha paged to the on-duty maintenance person over the Owners alphanumeric paging system. Alpha pages shall provide sufficient information to identify the equipment and the point in alarm and the time and date of occurrence.

   b. All other alarms shall be considered non-critical and shall be displayed and acknowledged before being sent to the alarm log.

5. Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PCs used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.

6. Alarm Messages:

   a. In addition to the point’s descriptor and the time and date, the user shall be able to print, display, or store a 65-character alarm message to more fully describe the alarm condition or direct operator response.
b. Each stand-alone DDC panel shall be capable of storing a minimum library of 250 Alarm Messages. Each message may be assignable to any number of points in the panel.

7. Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request is made, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.

2.3 DDC EQUIPMENT

A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

   a. Global communications.
   b. Discrete/digital, analog, and pulse I/O.
   c. Monitoring, controlling, or addressing data points.
   d. Software applications, scheduling, and alarm processing.
   e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

   a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
   b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
   c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
   d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
   e. Remote communications.
   f. Maintenance management.
   g. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
   a. Global communications.
   b. Discrete/digital, analog, and pulse I/O.
   c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

C. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
   1. Binary Inputs: Allow monitoring of on-off signals without external power.
   2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
   3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
   4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
   5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
   7. Universal I/Os: Provide software selectable binary or analog outputs.

D. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
   1. Output ripple of 5.0 mV maximum peak to peak.
   2. Combined 1 percent line and load regulation with 100-mic. second response time for 50 percent load changes.
   3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

E. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
   1. Minimum dielectric strength of 1000 V.
   3. Minimum transverse-mode noise attenuation of 65 dB.
   4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.4 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
   1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.

3. Enclosures:
   a. For Conditioned Space: Dustproof rated for operation at 32 to 120 deg F.
   b. For Outdoor and Non-conditioned Space: Waterproof rated for operation at -10 to 150 deg F.

2.5 ALARM PANELS

A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch-thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.

B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
   1. Alarm Condition: Indicating light flashes and horn sounds.
   2. Acknowledge Switch: Horn is silent and indicating light is steady.
   3. Second Alarm: Horn sounds and indicating light is steady.
   4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
   5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.6 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
   1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
   1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
2. Proportional band shall extend from 2 to 20 percent for 5 psig.
3. Authority shall be 20 to 200 percent.
4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal of zero to supply pressure.
5. Gauges: 1-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.7 INPUT DEVICES

A. General Requirements: Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors

1. General Requirements:

   a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
   b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
   c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

      1) 0.5 deg F:
         a) Chilled Water.
         b) Room Temperature.
         c) Duct Temperature.

      2) 0.75 deg F: All others

2. Room Temperature Sensors

   a. Room sensors shall be constructed for either surface or wallbox mounting.
   b. Room sensors shall have the following options:

      1) Setpoint reset slide switch providing a +5 degree (adjustable) range.
      2) Individual heating/cooling setpoint slide switches.

3. Room Temperature Sensors with Integral Display:

   a. Room sensors shall be constructed for either surface or wallbox mounting.
   b. Room sensors shall have an integral LCD display and four button keypad with the following capabilities:

      1) Display room temperature.
      2) Display and adjust room comfort setpoint.
      3) Display and adjust fan operation status.
      4) Timed override request push button with LED status for activation of after-hours operation.
      5) Display controller mode.
      6) Password selectable adjustment of setpoint and override modes.
4. Thermowells:
   a. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
   b. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
   c. Thermowells and sensors shall be mounted in a threadolet or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.
   d. Thermowells shall be constructed of 316 stainless steel.

5. Outside Air Sensors:
   a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
   b. Sensors shall be shielded by a perforated plate that surrounds the sensor element.
   c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

6. Duct Mount Sensors:
   a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
   b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
   c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

7. Averaging Sensors:
   a. Similar to JCI TE6300.
   b. For ductwork greater in any dimension than 48 inches, inside air handling units, and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
   c. A 20 foot averaging continuous sensor shall be serpentine across the cross section with minimum 1 foot of length for every square foot of cross sectional area. Capillary supports at the sides of the duct shall be provided to support the sensing string.

C. Current Sensing Relays
   1. Current sensor shall induce power from the monitored load and shall have an adjustable operating range from 2.5 - 135 A.
   2. Visual indicators (LED’s) shall indicate output status and sensor power.
   3. Adjustable trip set point to +/- 1%.
   4. Current sensor output shall be normally open, solid state, 0.1A @ 30 VAC/DC.

D. Humidity Sensors:
   1. The sensor shall be a solid state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
   2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
   3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion.
      a. Indoor locations and sensors mounted in air handling units or ducts; +/- 3%.
b. Outdoor locations: Humidity Sensor shall be HyCal +/- 2 %.

4. Outside air relative humidity sensors shall include a rain proof, perforated cover. The transmitter shall be include in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.

5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.

6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

E. Differential Pressure Transmitters:

1. Air and Water Pressure Transmitter Requirements:
   a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
   b. Differential pressure transducers shall be piped to permit equalizing pressure prior to disconnecting.
   c. Differential pressure sensors used to control equipment such as fans and pumps, shall be connected directly to the same controller that controls the equipment to insure the continued proper operation of the controlled equipment without dependence on the control network.

F. Flow measuring devices:

1. Air Flow Measuring:
   a. General:
      1) Airflow measuring sensors shall be installed at fan inlet whenever possible and shall be capable of continuously measuring the air handling capacity (air volume) of the respective centrifugal, plug, or vane-axial fan(s).
   b. Manufacturers:
      1) Paragon Controls Incorporated (PCI), MicroTrans EQ.
   c. Fan Inlet Piezometer Rings
      1) Factory tap fan inlet with sensor ports.
      2) Accuracy: +/-3% of Full Scale.
   d. Duct mounted:
      1) Manufacturers:
         a) Ebtron.
      2) Description: Thermal dispersion type. Units shall be provided complete with differential pressure transducers, temperature compensation, square root extraction. Unit shall perform all internal calculations to output to the FMS the CFM readings.
      3) Location: Provide straight duct before and after device according to the sensor manufacturer’s recommendations. Provide access door in ductwork adjacent to sensors.
4) Accuracy: Sensor accuracy shall be +/- 2% of the airflow reading over the entire range of airflow measured.

e. Transmitter / Transducer

1) Each sensor shall be provided complete with transmitter.
2) Manufacturers:
   a) Paragon.
3) Full Scale Accuracy:
   a) Accuracy: +/- 0.25% of Full Scale.
   b) Terminal Point Non-linearity: +/- 0.2%.
   c) Hysteresis: +/- 0.2%.
   d) Non-repeatability: +/- 0.3%.
   e) Temperature Effect: +/- 0.15% Full Scale / °F.

4) The transmitter-controller shall be capable of receiving flow signals (total and static pressure) from an airflow station or probe array and produce an output linear and scaled for air volume, velocity, differential pressure, etc. The internal P, I, three-mode controller shall be capable of controlling at a user selectable internal or external setpoint, and output a 0-5VDC, 0-10VDC, or 4-20mA control signal.

5) The transmitter-controller shall contain an integral multi-line digital display for use during the configuration and calibration process, and to display one transmitter output plus controller setpoint during normal operating mode. All transmitter configuration, parameter setting, zero and span calibration, plus display formatting and scaling will be performed digitally in the on-board microprocessor via input pushbuttons.

6) The transmitter-controller will be available in multiple natural spans covering the range of 0.05" w.c. to 10.0" w.c. The transmitter-controller shall be furnished with a transducer automatic zeroing circuit, and be capable of maintaining linear output signals on applications requiring 10 to 1 velocity or pressure turndown.

7) The transmitter-controller shall be capable of having its operating span electronically selected without having to perform recalibration involving an external pressure source. The transmitter-controller will provide the means of managing a system for automatic high pressure purge of the airflow station or probe array, with user selectable purge frequency and duration, while maintaining the last transmitter output during the purge cycle. Using a second transmitter as an input, the internal microprocessor can perform a summed flow, flow differential, low signal select, high signal select or percent deviation calculation, with the result being displayed and provided as an analog output signal.

2. Water Flow Measuring:

a. General:

1) Sensors shall operate in line pressures up to 400 psi and liquid temperatures up to 220° F.
2) A certificate of calibration shall be provided with each flow meter.
3) Each flow meter shall be covered by the manufacturer’s two-year warranty.
b. Turbine:
   1) Manufacturer:
      a) Onicon, F-1100 or F-1200 Series.
   2) Accuracy:
      a) Less than 2 ft/sec: ± 0.02%.
      b) 2 to 30 ft/sec: ± 1%.
   3) Provide complete sensor assembly with all installation hardware necessary to enable insertion and removal of the meter without system shutdown.
   4) Materials of construction for wetted metal components shall be 316 SS.
   5) Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1%.
   6) Output signals shall be completely isolated and shall consist of the following:
      a) (1) analog output; 4-20mA, 0-10V, or 0-5V jumper selectable
      b) (1) scalable dry contact output for totalization
      c) (1) high resolution frequency output for use with peripheral devices such as an ONICON display module or Btu meter.

c. Transmitter / Transducer
   1) Each sensor shall be provided complete with transmitter.
   2) Water meter: The analog transmitter shall be Data Industrial Model 310-00, or equivalent.
   3) The analog flow transmitter shall be a loop powered device capable of transmitting a linear 4 - 20 mA signal proportional to frequency. The unit shall be microprocessor controlled with no switches or potentiometers to set.
   4) The transmitter shall meet ISA Class L, H and U non-isolated requirements. All circuitry shall be encapsulated in a low profile epoxy body to meet MIL spec M.1-146058C type AR, for humidity, moisture and fungus resistance. Operating range shall be 35°F to 150°F.
   5) All programming, including flow sensor selection, pipe size, flow range setting, response time and filtering shall be set digitally via a computer using Windows-based software with programming kit (disk and cable). The transmitter shall be easily programmed in the field using a standard computer.
   6) The transmitter shall have a ground lug to maximize EMI protection when necessary. The transmitter shall be mounted directly near the insertion flow sensor on a DIN Rail, as a panel mount or in a weather proof or NEMA 4X enclosure.

G. Power Monitoring Devices:
   1. Current Measurement (Amps):
      a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.
      b. Current Transformer – A split core current transformer shall be provided to monitor motor amps.
1) Operating frequency – 50 - 400 Hz.
2) Insulation – 0.6 Kv class 10Kv BIL.
3) UL recognized.
4) Five amp secondary.
5) Select current ration as appropriate for application.

c. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:

1) 6X input over amp rating for AC inrushes of up to 120 amps.
2) Manufactured to UL 1244.
3) Accuracy: +.5%, Ripple +1%.
4) Minimum load resistance 30kOhm.
5) Input 0-20 Amps.
6) Output 4-20 mA.
7) Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).

H. Smoke Detectors:

1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. All wiring for air duct detectors shall be as specified in Division 28 - Fire Alarm System.

I. Status and Safety Switches:

1. General Requirements:
   a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the FMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2. Current Sensing Switches:
   a. The current sensing switch shall be self-powered with solid state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
   b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
   c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

3. Air Filter Status Switches:
   a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
   b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
   c. Provide appropriate scale range and differential adjustment for intended service.

4. Air Flow Switches:
a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

5. Air Pressure Safety Switches:
   a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
   b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

7. Low Temperature Limit Switches: Equal to Johnson Controls A70.
   a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
   b. The sensing element shall be one foot long for each square foot of coil area and be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
   c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

J. EPO Switches
   1. General Description: All products listed shall meet the following requirements:
      a. Operators shall be heavy duty type and comply with UL Type 13/NEMA Type 13 and UL Type 6/NEMA Type 6.
      b. Contact blocks shall be rated 10 amperes continuous.
   2. EPO Design:
      a. Mushroom type: Flush mounted, two position, maintained push - maintained pull mushroom head type push button operator with 2.25 inch diameter mushroom top, red, with one normally open and one normally closed (1NO - 1NC) contact. Provide with aluminum extended mushroom guard.

2.8 OUTPUT DEVICES
A. Actuators:
   1. General Requirements:
      a. Damper and valve actuators shall be electronic, as specified in the System Description section.
   2. Electronic Damper Actuators:
      a. Electronic damper actuators shall be direct shaft mount as manufactured by Belimo.
      b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized based on actuator
manufacturer’s recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, or a gear release to allow manual positioning.

c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, proportional control.

d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as “quick acting,” shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.

3. Electronic Valve Actuators:

a. Electronic valve actuators shall be manufactured by the valve manufacturer or Belimo Air Controls. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.

b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close off against the system pressure for the required application. The valve actuator shall be sized based on valve manufacturer’s recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.

c. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, proportional control.

d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.

B. Control Dampers:

1. Furnish all automatic dampers that are not furnished with air handling units. Coordinate exact damper requirements with the air handling unit manufacturer. All automatic dampers shall be sized for the application or as specifically indicated on the Drawings.

2. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.

3. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.

4. All dampers used for smoke control applications shall be UL 555 listed.

5. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 48”. Damper blades shall be 16-gauge minimum and shall not exceed six (6) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. Additional stiffening or bracing shall be
provided for any section exceeding 48” in height. All damper bearings shall be made of stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomeric seals on the blade edges and flexible stainless steel side seals. Dampers of 48”x48” size shall not leak in excess of 8.5 cfm per square foot when closed against 4” w.g. static pressure when tested in accordance with AMCA Std. 500.

6. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5” w.g., but no more than 4000 FPM or 6” w.g.

7. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below.

8. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

C. Control Relays:

1. Control Pilot Relays:
   a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
   b. Mounting bases shall be snap-mount.
   c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
   d. Contacts shall be rated for 10 amps at 120VAC.
   e. Relays shall have an optional indicator light and check button.

D. Control Valves:

1. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Section.

2. Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer’s recommendations for the given application. In general, valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no more than 5 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no more than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no more than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.

3. Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all hot and chilled water applications, except those described hereinafter. The valve discs shall be composition type. Valve stems shall be stainless steel.

4. Ball valves shall be acceptable for water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units.

5. Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless
steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.

6. Control valves for ball valves shall not use pulse of tri-mode controllers or actuators. Controllers installed shall be capable of being spanned for the two stem travel ranges of 0-20% open and 85-100% open.

E. Electronic Signal Isolation Transducers:

1. A signal isolation transducer shall be provided whenever an analog output signal from the Facility Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.
2. The signal isolation transducer shall provide ground plane isolation between systems.
3. Signals shall provide optical isolation between systems.

F. Motor starters: an integral HAND/OFF/AUTO switch shall override the controlled device pilot relay.

1. A status input to the Facility Management System shall indicate whenever the switch is not in the automatic position.
2. A Status LED shall illuminate whenever the output is ON.
3. An Override LED shall illuminate whenever the HAND/OFF/AUTO switch is in either the HAND or OFF position.
4. Contacts shall be rated for a minimum of 1 amp at 24 VAC.

G. Variable frequency motor controllers: an integral HAND/AUTO pushbutton shall override the controlled device pilot relay.

1. A status input to the Facility Management System shall indicate whenever the controller is in the hand or bypass position.
2. A Status LED shall illuminate whenever the output is ON.
3. An Override LED shall illuminate whenever the HAND/AUTO pushbutton is in either the HAND or OFF position.
4. Contacts shall be rated for a minimum of 1 amp at 24 VAC.

2.9 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

3.2 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
1. Connect and configure equipment and software to achieve sequence of operation

B. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and architectural room details before installation. Install devices 48 inches above the floor.

C. Install manual reset switches, such as high and low static resets, no higher than 6'-0" above nearest adjacent finished floor.

D. Install averaging elements in ducts, plenums, and coil faces in crossing or zigzag pattern. Provide one linear foot of sensor per square foot of coil in a pattern that will create an even distribution of sensor over the entire cross sectional area of duct or air handling unit.

E. Install freezestats to provide one linear foot of sensor per square foot of coil.

F. Install temperature sensor on the leaving side of all cooling and heating coils in AHUs.

G. Install outdoor air temperature sensors on a north facing wall and away from direct sunlight as well as 20 feet (minimum) from exhaust or relief air fans.

H. Install outdoor air humidity sensors on a north facing wall and away from direct sunlight as well as 20 feet (minimum) from exhaust or relief air fans. Do not install within 20 feet of cooling tower discharge, steam vents, or downstream of similar services in the direction of typical wind patterns.

I. Install temperature and flow meters to calculate building BTUH use for the following systems:
   1. Chilled Water.

J. Flow Station Locations:
   1. Air side
      a. Provide piezometer ring type at fan inlet for all fans located in AHUs and as indicated on drawings.
      b. Fans external to AHU are to be piezometer type.
      c. Fans external to AHU to be thermal dispersion type installed at the fan inlet.
      d. Duct mounted flow stations shall be thermal dispersion type.
   2. Water side
      a. Water flow stations shall be turbine type.
      b. Flow meters shall be installed in the following locations as a minimum:
         1) chilled water loops
         2) heating water loops
      c. Adequate straight pipe shall be installed before (10 pipe diameters) and after (5 pipe diameters) device according to the manufacturer’s recommendations.

K. Install pressure monitors across walls dividing a spaces with monitored pressure requirements, including the following applications:
   1. Soiled.
   2. Decontamination.
L. Coordinate EPO switch location and type with Division 26. Install EPOs as follows:
   1. Mushroom:
      a. Boilers

M. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

N. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

O. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

P. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

Q. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping."

R. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."

S. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

T. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

U. Unit Heaters: Unit heaters shall each be provided with a low voltage electric wall-mounted room thermostat, which shall cause the heater to be cycled "on" or "off" as required to satisfy the thermostat setting. Control circuit voltage shall not exceed 120 volts to ground.

3.3 EQUIPMENT STATUS MONITORS

A. Current sensing relays are to be installed across motors and must be sensitive enough to detect and alarm when driven equipment, such as a fan motor is operating without a belt or a pump motor is operating without flow.

B. Where a current sensing relay is not sensitive as described above, provide differential pressure transducers/switches to monitor equipment status.

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
   1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable bundled, labeled for service, and well supported to prevent contact with other systems.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches or hand/auto push buttons to override automatic interlock controls when switch or pushbutton is in hand position.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check DDC system as follows:

   a. Verify that DDC controller power supply is from emergency power supply, if applicable.
b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
c. Verify that spare I/O capacity has been provided.
d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.6 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
   a. Check analog inputs at 0, 50, and 100 percent of span.
   b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
   c. Check digital inputs using jumper wire, including:
      1) Status indicators for fans shall be tested to indicate an alarm upon belt loss or dead-head pump condition. Adjust current sensing relays appropriately.
      2) Status indicators for preheat circulating pumps shall be tested to indicate an alarm upon dead-head condition. Adjust current sensing relay appropriately.
   d. Check digital outputs using ohmmeter to test for contact making or breaking.
   e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:
   a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
   b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:
   a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
   b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:
   a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
   b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide for visits to Project during other than normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 231123

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

B. Related Sections include the following:

1. Division 23 Section “Common Work Results” for escutcheons and grout.
2. Division 23 Section “Hangers and Supports” for hangers.

1.2 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.
3. Minimum Operating Pressure of Service Meter: 5 psig.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig but not more than 5 psig, and is reduced to secondary pressure of more than 0.5 psig but not more than 2 psig.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.3 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.
4. Dielectric fittings.
5. 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: 1/8 inch per foot.

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. Welding certificates.

F. Field quality-control reports.

G. Operation and Maintenance Data: For motorized gas valves, pressure regulators and service
meters to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Quality 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.

1.5 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 Construction Manager and Owner no fewer than ten 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.

1.6 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.

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:
   b. End Connections: Threaded or butt welding to match pipe.
   c. Lapped Face: Not permitted underground.
   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. Available Manufacturers:
      1) Dresser Piping Specialties; Division of Dresser, Inc.
      2) Smith-Blair, Inc.
   b. Stainless-steel flanges and tube with epoxy finish.
   c. Buna-nitrile seals.
   d. Stainless-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.
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.

   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. Available Manufacturers:
      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. Available Manufacturers:
      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. Available Manufacturers:
1) Dresser Piping Specialties; Division of Dresser, Inc.
2) Smith-Blair, Inc.

b. Stainless-steel flanges and tube with epoxy finish.
c. Buna-nitrile seals.
d. Stainless-steel bolts, washers, and nuts.
e. Factory-installed anode for steel-body couplings installed underground.

2.2 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: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

B. 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: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

C. 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: 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
   4. CWP Rating: 750 psig.

D. 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.


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. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 100 psig.
   3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   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.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
   1. CWP Rating: 100 psig.
   2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
   1. Available Manufacturers:
      a. BrassCraft Manufacturing Company; a Masco company.
      c. Lyall, R. W. & Company, Inc.
      e. Perfection Corporation; a subsidiary of American Meter Company.
   3. Ball: Chrome-plated brass.
   4. Stem: Bronze; blowout proof.
   5. Seats: Reinforced TFE; blowout proof.
   6. Packing: Separate packnut with adjustable-stem packing threaded ends.
   8. CWP Rating: 600 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.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   1. Available Manufacturers:
      a. BrassCraft Manufacturing Company; a Masco company.
      c. Lyall, R. W. & Company, Inc.
      e. Perfection Corporation; a subsidiary of American Meter Company.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
8. CWP Rating: 600 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. Bronze Plug Valves: MSS SP-78.

1. Available Manufacturers:
   a. Lee Brass Company.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

1. Available Manufacturers:
   c. Xomox Corporation; a Crane company.
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.
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.

G. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Available Manufacturers:
   a. Flowserve.
   b. Homestead Valve; a division of Olson Technologies, Inc.
d. Milliken Valve Company.
e. Mueller Co.; Gas Products Div.

2. Body: Cast iron, complying with ASTM A126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
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.

H. PE Ball Valves: Comply with ASME B16.40.

1. Available Manufacturers:
   a. Kerotest Manufacturing Corp.
   b. Lyall, R. W. & Company, Inc.
   c. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: PE.
3. Ball: PE.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: 80 psig.
8. Operating Temperature: Minus 20 to plus 140 deg F.
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

I. 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 MOTORIZED GAS VALVES


1. Available Manufacturers:
   a. ASCO Power Technologies, LP; Division of Emerson.
   b. Dungs, Karl, Inc.
   c. Eaton Corporation; Controls Div.
   d. Eclipse Combustion, Inc.
e. Honeywell International Inc.
f. Johnson Controls.

2. Body: Brass or aluminum.
5. Normally closed.
7. Electrical operator for actuation by appliance automatic shutoff device.

B. Electrically Operated Valves: Comply with UL 429.

1. Available Manufacturers:
   a. ASCO Power Technologies, LP; Division of Emerson.
   b. Dungs, Karl, Inc.
   c. Eclipse Combustion, Inc.
   d. Goyen Valve Corp.; Tyco Environmental Systems.
   e. Magnatrol Valve Corporation.
   f. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
   g. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

2. Pilot operated.
3. Body: Brass or aluminum.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.

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.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Available Manufacturers:
   a. Actaris.
   b. American Meter Company.
   c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   d. Invensys.
   e. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
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.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

1. Available Manufacturers:
   a. Actaris.
   b. American Meter Company.
   c. Eclipse Combustion, Inc.
   d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   e. Invensys.
   f. Maxitrol Company.
   g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
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.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: [2 psig] [5 psig].

1. Available Manufacturers:
   a. Canadian Meter Company Inc.
   b. Eaton Corporation; Controls Div.
   c. Harper Wyman Co.
   d. Maxitrol Company.
   e. SCP, Inc.

5. Seat Disc: Nitrile rubber.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: \[1 \text{ psig}] [2 \text{ psig}] [5 \text{ psig}].

### 2.7 DIELECTRIC FITTINGS

#### A. Dielectric Unions:

1. Available Manufacturers:
   b. Central Plastics Company.
   e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
   f. Wilkins; Zurn Plumbing Products Group.

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. Available Manufacturers:
   b. Central Plastics Company.
   c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
   d. Wilkins; Zurn Plumbing Products Group.

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. Available Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

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 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. For renovations and additions close equipment shutoff valves before turning off natural gas to premises or piping section.
B. Inspect natural-gas piping according to NFPA 54 and all applicable codes to determine that natural-gas utilization devices are turned off in piping section affected.
C. Comply with NFPA 54 and all applicable code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION
A. Comply with NFPA 54 and all applicable codes 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. 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. 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 and all applicable codes 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, after Architect’s final approval of finish, for penetrations of walls, ceilings, and floors according to the following:

   1. New piping penetrations shall be one-piece escutcheons.
   2. Existing piping penetrations shall be two-piece escutcheons.
   3. All sleeved penetrations shall be deep-drawn to allow flush installation between escutcheon and finished surface.

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 pipe spaces, utility spaces, above ceilings, 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 Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.

3. 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 23Section "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 regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

C.  Install earthquake valves aboveground outside buildings according to listing.

D.  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:


   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.  Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

F.  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.

G.  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  CONNECTIONS

A.  Install piping adjacent to appliances to allow service and maintenance of appliances.
B. 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.

C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 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.

3.9 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to NFPA 54 and all applicable codes 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.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.12 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 malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.13 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping NPS 2 and smaller shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping NPS 2-1/2 and larger shall be one of the following:
   1. Steel pipe with wrought-steel fittings and welded joints.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

D. 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.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, full-port, bronze ball valves with bronze trim.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.
   3. Cast-iron, nonlubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, full-port, bronze ball valves with bronze trim.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.
   3. Cast-iron, nonlubricated or lubricated plug valve.

E. Valves in branch piping for single appliance shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, full-port, bronze ball valves with bronze trim.
SECTION 232113
HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, and joining methods for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Makeup-water piping.
4. Condensate-drain piping.
5. Blowdown-drain piping.
6. Air-vent piping.
7. Safety-valve-inlet and -outlet piping.
8. Pre-insulated piping systems.

B. Related Sections include the following:

1. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for expansion fittings.
2. Division 23 Section “General-Duty Valves for HVAC Piping” for valves and accessories for piping.
3. Division 23 Section "Heat Tracing for HVAC Piping" for heat tracing system requirements and applications.
4. Division 23 Section "HVAC Insulation" for pipe saddles at pipe hangers.
5. Division 23 Section "HVAC Water Treatment" for water-treatment chemicals, equipment, and controls.
6. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
7. Division 23 Section “Steam and Condensate Heating Piping”.
8. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding 150 psig at the corresponding temperature as the minimum working pressure and temperature, unless otherwise indicated:

1. Hot-Water Heating Piping: 200 deg F.
2. Chilled-Water Piping: 200 deg F.
3. Makeup-Water Piping: 200 deg F.
4. Condensate-Drain Piping: 200 deg F.
5. Blowdown-Drain Piping: 200 deg F.
6. Air-Vent Piping: 200 deg F.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.
8. Pre-insulated Piping Systems: Same as the piping system to which it is attached.
1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air control devices.
   3. Hydronic specialties.

B. Shop Drawings: Detail, at 1/4 scale, 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.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Qualification Data: For Installer.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

E. All underground distribution systems shall be designed in strict conformance to the latest edition of ANSI B31.1 or local requirements, whichever is more stringent, and sealed by a Registered Professional Engineer in good standing with state and local authorities. The system shall be designed to compensate for stresses and movement of the service pipe.

1.5 QUALITY ASSURANCE

A. All piping shall be American manufactured, unless otherwise indicated.

B. Installer Qualifications:

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

D. 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.

E. 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.
1.6 EXTRA MATERIALS

A. 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 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
C. DWV Copper Tubing: ASTM B 306, Type DWV.
D. Wrought-Copper Fittings: ASME B16.22.
   1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
   2. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

E. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
G. 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:
   2. End Connections: Butt welding.
   3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:
1. Manufacturers:
   a. Anvil International, Inc.
   b. Grinnell, Inc.
   c. Victaulic Company of America.

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

3. 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.

I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 PRE-INSULATED PIPE AND FITTINGS

A. Pipe And Insulation Materials:
1. Manufacturers:
   a. Perma-Pipe. (Basis-of-design: Terra-Gard)
   b. Thermacore.

2. Internal service pipe shall be A53/A106 seamless carbon steel pipe. Pipe thickness / schedule shall be as described for fluid service.

3. The system design shall be in strict conformance with ANSI B31.1, latest edition.

4. End seals, gland seals and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system.

5. Outer conduit shall be smooth wall, welded steel:
   a. For sizes up to 26 NPS, 10 ga.
   b. For sizes 28 NPS to 36 NPS, 6 ga.
   c. For sizes 38 NPS to 42 NPS, 4 ga.

6. Insulated service pipe shall be supported minimum 10 ft on center. From outer conduit. Supports shall not directly contact service pipe.

7. Internal service pipe shall be insulated per Division 23 "HVAC Insulation".

8. All pre-insulated sections shall be have a factory applied PVC outer covering 60mils minimum thickness. All fittings, bellows, and anchors of the insulated piping system shall be prefabricated to job dimensions.

9. Provide x-ray inspection of the entire length to ensure there are no insulation voids.

B. Accessories:
1. Leak detection: Provide complete system including sensors, control panel, and interface with FMS to continuously monitor and locate moisture intrusion within the casing.
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 B32, 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. Manufacturers:
      b. Central Plastics Company.
      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. Manufacturers:
      b. Central Plastics Company.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:

1. Manufacturers:
   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- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings:

1. Manufacturers:
   a. Calpico, Inc.
   b. Lochinvar Corporation.

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

G. Dielectric Nipples:

1. Manufacturers:
   a. Grinnell Mechanical Products.
   b. Perfection Corporation; a subsidiary of American Meter Company.
   c. Precision Plumbing Products, Inc.
   d. Sioux Chief Manufacturing Company, Inc.
   e. Victaulic Company of America.

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

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 4 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
2. Standard weight steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 5 and larger, shall be any of the following:
1. Standard weight steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
2. Standard weight steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. Chilled-water piping, aboveground, NPS 4 and smaller, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
   2. Standard weight steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

D. Chilled-water piping, aboveground, NPS 5 and larger, shall be any of the following:
   1. Standard weight steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   2. Standard weight steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

E. Chilled-water piping installed belowground shall be any of the following:

F. Makeup-water piping installed aboveground shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

G. Makeup-Water Piping Installed Belowground: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

H. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

I. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

J. Air-Vent Piping:
   1. Inlet: Same as service where installed according to the piping manufacturer's written instructions.
   2. Outlet: Type L, annealed-temper copper tubing with soldered or flared joints.

K. 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 according to the piping manufacturer's written instructions.

3.2 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. Cut pipe to measurements established at site and work into place with forcing or springing.
C. Piping shall be installed by skilled mechanics using designated basic materials plus any required supplementary materials.

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

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

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

G. Install piping to permit valve servicing.

H. Install piping at indicated slopes.

I. Install piping straight and true, free of sags and bends.

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

K. Install piping to allow application of insulation.

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

M. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

N. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

P. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

T. Welder shall stamp each weld in order to identify the individual who completed the work.

3.3 PIPE GRADING

A. General: Grade each system in accordance with good established practice to avoid air pockets, to relieve liquids and vent gases. Grade uniformly between indicated elevations or at indicated slope. Slopes shown on plans shall take precedence over any listed herein.
B. Steam and Condensate Return Lines: Grade to insure steam delivery to and discharge of condensate from utilizing devices. Minimally grade steam and condensate return lines down 1" in 40 feet when graded down in the direction of flow. Grade steam lines down 1" in 20 feet when back graded. Do not back grade steam piping without permission of Architect. Where horizontal mains change size, keeps the bottom of the coupled pipes on the same level using eccentric couplings. Grade steam relief and vent lines back to receiver or other device installed to eliminate tapping float trap. Terminate an atmospheric vent piping in a cast iron exhaust head as detailed.

C. Heating and Chilled Water Circulating Lines: Lay on an even slope; grade to drain at a valve at the circulating pump whenever possible; where other low points are unavoidable, provide service drains. Where horizontal mains change size, keep the tops of the coupled pipes on the same level using eccentric couplings.

D. Equipment Drains: Each line from a relief valve, air vent valve, separator or a boiler, drip pan elbow, exhaust head, heat exchanger, compression tank, receiver, pump base, air conditioning unit pan, air washer overflow and drain, evaporator pan, and similar drain shall grade down to a point of open sight discharge and/or as indicated on the drawings.

3.4 HANGERS AND SUPPORTS

A. Piping support must account for expansion and contraction, vibration, dead load of piping and its contents, and seismic-bracing requirements.

B. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

C. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Use manufacturer’s recommended methods and follow all applicable codes for joining each piping system.

C. Make square cuts on all pipes using proper tools and alignment devices. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

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

E. 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.

1. Use solder joint fittings in copper tubing lines.
2. Do not anneal copper tubing and fittings.
3. Tubing shall be cut square, and burrs shall be removed. Insides of fittings and outsides of tubing shall be well cleaned with steel wool, steel brushes, and/or emery cloth before assembly.
4. Installation shall be made by skilled mechanics in accordance with the material manufacturer's recommendations.
5. Mitering of joints for elbows and notching of straight runs for tees will not be permitted.
6. All joints shall be made with solid string or wire solder. Fluxes shall be non-corrosive pastes of the proper type. Solder shall be lead free. No cored solder will be permitted.


G. 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.

   1. All joints shall be fusion welded by a metallic arc or gas welding process. Pipe ends shall be beveled 37½°. All welding operations shall conform to the latest recommendations of the American Welding Society or to the applicable provisions of the Code for Pressure Piping, ANSI B31.1, latest edition, amended to date.
   2. Weld rods shall be of the proper type for each application to match the line materials.
   3. If the Engineer so requests, the Contractor shall have each of his welders prepare test coupons which shall be tested in an approved independent testing laboratory and any defects found shall be cause for dismissal of the welder from the project. All cost of such tests shall be borne by the Contractor.
   4. Branch takeoffs not larger than 2/3 of the main may be made using shaped nipples, weldolets, or threadolets to match branch line fabrication methods.

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

J. Copper Fittings
   1. Use wrought copper solder joint type in all patterns and sizes available. Use long radius copper elbows wherever available and space will permit.

K. Welding Fittings
   1. All fittings in welded lines shall be factory-fabricated welding fittings of the same material and the same weight or Schedule as the piping attached.
   2. All elbow tees, caps and special fittings including connections into headers shall be standard butt welding fittings, conforming to ANSI B16.9, with the following exception: Branch take-offs from lines 2½" and larger and where the size of the takeoff does not exceed 2/3 of the normal diameter of the mains to which connected, may be made with shaped nipples or with Bonney Weldolets or Threadolets as required by the class of fabrication.
   3. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.

L. Flanges
1. At connections to flanged valves and equipment outlets in steel piping systems using welding neck, slip on welding flanges, screwed steel, or cast iron companion flanges.
   a. It will be permissible to use cast iron flanged fittings at connections to equipment items.

2. In grooved end piping systems use matching flanged adapter nipples.
3. In copper lines use brass flanges.
4. Connecting flanges shall have matching flat or raised faces. Faces shall be free of imperfections that would prevent proper seating.
5. Tighten bolts uniformly all around to prevent any stress.

M. Gaskets
   1. Manufactured from proper materials as with performance and materials described in Division 23 “Common Work Results for HVAC”, unless otherwise indicated. Full-faced type for flat-faced flanges and ring type for raised-faced flanges.
      b. Steam and Condensate Return Lines: Non-asbestos sheeting.
      c. Dielectric Flanges: As provided with the flanges.
      d. Other Lines: As recommended for the duty.

N. Securing Underground Lines
   1. Install pipe clamps and braces using poured in place concrete blocks, or other anchors and supports required to ensure stability of all underground lines to prevent joint separation either during tests or thereafter when lines are in service.
      a. Pipe Braces and nuts installed in the ground shall be fabricated of stainless steel to resist corrosion.

O. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

3.6 TERMINAL EQUIPMENT CONNECTIONS
   A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
   B. Install control valves in accessible locations close to connected equipment.
   C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
   D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."
   E. For hydronic connections less than NPS 2-1/2", provide one of the following, but not both:
      1. Flexible connectors.
3.7 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. Procedures in subparagraphs below are paraphrased from ASME B31.9.
2. Test piping prior to backfilling, concealing, insulating or painting; isolate pressure sensitive equipment from tests.
   a. Test portions as required by construction schedule. When previously tested sections are expanded, retest at connections.
   b. Test new portions as required by construction schedule; test new connections into existing lines.
3. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Air may be substituted as a testing medium instead of water. Refrigerant lines shall be leak tested with air unless otherwise indicated.
4. 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.
5. Isolate expansion tanks and determine that hydronic system is full of water.
6. 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."
7. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
8. Prepare written report of testing. All test results shall be submitted to the Owner and Architect. Provide all tests required by acceptable codes.
9. Furnish all compressed air, vacuum and water pumps; tanks of compressed air, nitrogen, carbon dioxide, refrigerant, gauges, plugs, seals, etc., as required to obtain, maintain and measure pressures during tests.
10. Pressure test all systems per governing codes, to a minimum of 1.5 times the working pressure, or the following table, whichever is greater:
<table>
<thead>
<tr>
<th>Piping System</th>
<th>Test Pressure (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Pressure Steam (above 15 psig)</td>
<td>200</td>
</tr>
<tr>
<td>Low Pressure Steam (15 psig and less)</td>
<td>100</td>
</tr>
<tr>
<td>Gravity Steam Condensate Returns</td>
<td>100</td>
</tr>
<tr>
<td>Pumped Steam Condensate Return</td>
<td>200</td>
</tr>
<tr>
<td>Heating, Chilled, and Condenser Water</td>
<td>150</td>
</tr>
<tr>
<td>Refrigerant</td>
<td>450</td>
</tr>
</tbody>
</table>

11. 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.

D. Perform the following prior to operating the heat trace system:

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Manufacturer’s Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
3. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   a. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
   b. Test cables for electrical continuity and insulation integrity before energizing.
   c. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
4. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
5. Cables will be considered defective if they do not pass tests and inspections.
6. Prepare test and inspection reports.

3.8 REPAIRS

A. Effect repairs as recommended by the manufacturer of the pipe and fittings materials; replace any defective materials. When procedures involve additional work on a joint and they fail, remake the joint. Repair operations shall include:

1. Screwed Joints: Additionally tighten.
2. Caulked Joints: Additionally caulk.
3. Welded Joints: Chip out old weld metal and re-weld.
4. Compression Joints: Re-clean; replace seal, compression rings, couplings, etc.
5. Mechanical Joints: Re-clean; additionally tighten.
6. Soldered or Brazed Joints: Remake joint, no additional soldering or brazing allowed.
3.9 CLEANING

A. Clean all new piping systems and components prior to putting into service.

B. Hydronic Service Procedure:
   1. Cleaning water lines are to be cleaned by placing one 2” connection each end of new run of supply and return pipe and piping with circulating pump to move chemicals through pipe for period of 2 days. Then dump & drain after approval by City of Wichita Falls. Should City not approve dumping, then it shall be the responsibility of the mechanical contractor to arrange disposal of chemical as well as two refills for flushing.
   2. Cleaning of CHS and CHR shall be done using solvent or chemical compound acceptable to the City of Wichita Falls and shall contain no phosphates in any form. (Organic Citrus based cleaners have in the past been acceptable). The final cleaning shall meet the latest City of Wichita Falls Water Quality Sample requirements.
   3. Refill cleaned system with fresh water to which adequate amounts of suitable chemicals have been added.

C. Steam and Condensate Return System: Clean all fittings and pipes before installation. After installation, blow out all steam lines with steam and repeat as necessary to insure all foreign particles are removed.

D. Blow off all strainers.

E. Waste and Drain Lines: Swab out lines; flush with fresh water.

F. Repetition: Repeat the above procedures until all parts of each piping system are thoroughly cleaned of all foreign materials.

END OF SECTION
1.1 SUMMARY

A. Section includes special-duty valves and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Makeup-water piping.
4. Condensate-drain piping.
5. Blowdown-drain piping.
6. Air-vent piping.
7. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:

1. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for expansion fittings.
2. Division 23 Section "General-Duty Valves for HVAC Piping" for valves and accessories for piping.
3. Division 23 Section "Heat Tracing for HVAC Piping" for heat tracing system requirements and applications.
4. Division 23 Section "HVAC Insulation" for pipe saddles at pipe hangers.
5. Division 23 Section "HVAC Water Treatment" for water-treatment chemicals, equipment, and controls.
6. Division 23 Section "Steam and Condensate Piping".
7. Division 23 Section "Steam and Condensate Specialties".
8. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air-control devices.
3. Hydronic specialties.

B. Shop Drawings: Detail, at 1/4 scale, 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.
1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
      a. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding 150 psig minimum working pressure at the temperature listed below, unless otherwise indicated:

1. Hot-Water Heating Piping: 200 deg F.
2. Chilled-Water Piping: 200 deg F.
3. Makeup-Water Piping: 200 deg F.
4. Condensate-Drain Piping: 200 deg F.
5. Blowdown-Drain Piping: 200 deg F.
6. Air-Vent Piping: 200 deg F.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.
8. Pre-insulated Piping Systems: Same as the piping system to which it is attached.

2.2 VALVES

A. Gate, Globe, Check, 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:
   a. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump; a division of ITT Industries.
c. Flow Design Inc.
d. Griswold Controls.
e. Taco.

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
8. Handle Style: Lever, with memory stop to retain set position.
10. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Flow Design Inc.
   d. Grinnell Mechanical Products.
   e. Griswold Controls.
   f. Taco.
   g. Tour & Andersson; available through Victaulic Company of America.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
5. Seat: PTFE.
6. End Connections: Flanged or grooved.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

E. Diaphragm-Operated, Pressure-Reducing Valves:

1. Manufacturers:
   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.
5. Diaphragm: EPT.
6. Low inlet-pressure check valve.
7. Inlet Strainer: Stainless steel, removable without system shutdown.
9. 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: ASME labeled.

1. Manufacturers:
   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.
5. Diaphragm: EPT.
7. Inlet Strainer: Stainless steel, removable without system shutdown.
9. 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.

G. Automatic Flow-Control Valves:

1. Manufacturers:
   a. Flow Design Inc.
   b. Griswold Controls.
   c. Nexus.
   d. NuTech.

2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
9. Minimum Operating Temperature: 200 deg F.
B. Manual Air Vents:
1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 (DN 15).
6. Minimum Simultaneous Operating Point: 150 psig at 225 deg F.

C. Automatic Air Vents:
1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/4 (DN 8).
6. Minimum Simultaneous Operating Point: 150 psig at 240 deg F.

D. Expansion Tanks, Bladder Type:
1. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Bladder shall be sized for full acceptance without failure of the membrane.

E. Tangential-Type Air Separators:
1. Tank: Welded steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 375 deg F (191 deg C) 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 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.
5. Size: Match system flow capacity, unless otherwise indicated.

F. In-Line Air Separators:
1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Minimum Simultaneous Operating Point: 175 psig at 300 deg F.

G. Air Purgers:
1. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
2. Minimum Simultaneous Operating Point: 150 psig at 250 deg F.
2.4 HYDRONIC PIPING SPECIALTIES

A. Strainer Perforations: All strainers shall be stainless steel and sized based on the service and installed pipe size as indicated by the table below, unless indicated otherwise.

<table>
<thead>
<tr>
<th>SERVICE DUTY</th>
<th>PIPE SIZE (NPS)</th>
<th>STRAINER PERFORATION SIZE (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled and Hot Water</td>
<td>1/4” to 2”</td>
<td>0.033</td>
</tr>
<tr>
<td></td>
<td>2-1/2” to 4”</td>
<td>0.057</td>
</tr>
<tr>
<td></td>
<td>6” and Larger</td>
<td>0.125</td>
</tr>
<tr>
<td>Condenser Water</td>
<td>1/4” to 2”</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>2-1/2” to 4”</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>6” and Larger</td>
<td>0.100</td>
</tr>
</tbody>
</table>

B. 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. Grooved connections are also acceptable.

C. 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. Grooved connections are also acceptable.

D. 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. CWP Rating: 750 psig.

E. Stainless-Steel Bellow, Flexible Connectors:
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

F. Spherical, Rubber, Flexible Connectors:
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
B. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
C. Install calibrated-orifice, balancing valves at each branch connection to return main.
D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.
G. All valves shall be installed with stems in vertical position, unless otherwise indicated. If not possible, stems may be installed 45° off vertical position where allowed by manufacturer.
H. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
I. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
J. 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.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Select system components with pressure rating equal to or greater than system operating pressure.
B. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
C. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
D. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
E. Install air separators on chilled and heating water systems.

F. Install tangential air separator for system on suction side of pump header prior to first pump. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

G. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.
2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

H. Install expansion tanks on the floor or suspended as indicated. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION
SECTION 232123
HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   2. Close-coupled, end-suction centrifugal pumps.
   4. Automatic condensate pump units.

1.2 DEFINITIONS

A. Buna-N: Nitrile rubber.
B. EPT: Ethylene propylene terpolymer.
C. OPD: Open Drip-proof
D. TEFC: Totally Enclosed Fan Cooled

1.3 ACTION SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.
1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.

B. PACO Pumps.

C. Taco, Inc. Basis of Design.
2.2 GENERAL HYDRONIC PUMP REQUIREMENTS

A. Provide hydronic pumps of the type, rotational speed and arrangement indicated and scheduled; each rated to deliver the capacity indicated in the tabulation on the Drawings against the head of the system in which it operates.

B. Provide each centrifugal pump with an impeller whose diameter is 90% or less of the maximum impeller which the manufacturer shows in his published curves for that pump. Pump selection shall be such that variation of plus or minus 15% of head estimated can be accomplished by "trimming" impellers by the manufacturer.

C. Impellers shall only be trimmed by manufacturer or an authorized manufacturer’s representative.

D. Efficiencies for the pumps selected for submittal shall be equal to or greater than the efficiency of the scheduled pumps at the scheduled design conditions.

E. Provide each pump with a constant speed or variable speed (as scheduled), premium efficiency, with minimum efficiencies as listed in Division 23 Common Motor Requirements for HVAC Equipment, ODP motor, unless noted to be a TEFC, wound for operation on the current characteristics indicated in the tabulation on the Drawings. Size each motor with relation to the pump impeller so that the required brake horsepower will not exceed the rated motor horsepower at any point on the pump curve.

F. Provide pump rated for a continuous water temperature of 225 deg F (107 deg C), unless otherwise indicated.

G. Provide pump rated for 125 psig (860 kPa) or 250 psig (1720 kPa) as required by its service, unless otherwise indicated. Provide class 125 or 250 flanges to match pump rated service pressure.

H. Match rating of overcurrent protective device serving the pump assembly. Provide equipment with the available short-circuit current as indicated on the Drawings. Refer to Division 26 Section “Overcurrent Protective Device Coordination Study” for additional requirements.

2.3 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

B. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange or union end connections, unless otherwise indicated.

2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.


4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

5. Pump Bearings: Permanently lubricated ball bearings.
2.4 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

B. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and threaded companion-flange or flanged connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.
6. Motor: Single speed, with permanently lubricated or grease-lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with integral pump support. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.5 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

B. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange or flanged connections unless otherwise indicated.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

C. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor for single speed or an EPDM coupling sleeve for variable-speed applications.

D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
E. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

F. Motor: Single speed, with permanently lubricated or grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.6 AUTOMATIC CONDENSATE PUMP UNITS

A. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch-minimum, electrical power cord with plug.

2.7 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 150-psig (1034-kPa) pressure rating, ductile-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support. Unit shall be drilled and tapped for gauge connections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23Section "Common Work Results for HVAC."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.
3.3 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Pump impellers shall be trimmed when 15% out of scheduled duty.

C. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

E. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

F. Set base-mounted pumps on concrete foundation with anchor-bolt inserts cast into bases. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

   1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.

   2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

G. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.5 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 machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
E. Install check valve and throttling or triple-duty valve on discharge side of pumps as indicated on drawings. For VFD pumps, a balancing or combination valve is not required.
F. Install Y-type strainer or suction diffuser and shutoff valve on suction side of pumps as indicated on drawings.
G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves. Piping disassembly shall not be required to service pump.
H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
I. Install suction diffusers for end suction pumps, except condenser water service.
J. Install check valve and gate or ball valve on each condensate pump unit discharge.
K. Install electrical connections for power, controls, and devices.
L. Install each VFD scheduled according to Division 26 Section "Variable Frequency Motor Controllers"
M. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
N. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:
   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Open discharge valve slowly.
3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 232213
STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following for LP and HP steam and condensate piping:

1. Pipe and fittings.

B. Related Sections include the following:

1. Division 23 Section "Steam Condensate Pumps" for pumps and accessories for steam piping.
2. Division 23 Section “General-Duty Valves for HVAC Piping” for valves and accessories for piping.
3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for expansion fittings.
4. Division 23 Section “Hydronic Piping” for near atmospheric pressure condensate piping.
5. Division 23 Section "HVAC Insulation" for insulation and pipe saddles at pipe hangers.
6. Division 23 Section “Steam and Condensate Piping Specialties” for steam valves, flash tanks, traps, and other accessories.
7. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 DEFINITIONS

A. FMS: Facility Management System.

B. HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.

C. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.3 ACTION SUBMITTALS

A. Product Data. Include data on pipe materials, pipe fittings, and applications.

B. Shop Drawings: Detail, 1/4 inch equals 1 foot scale, flash tank assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.
C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

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

B. Pipe Welding: Qualify procedures and operators according to the following:

1. ASME Compliance:
   b. Comply with ASME B31.9, "Building Services Piping" for LP systems for materials, products, and installation.
   c. Safety valves and pressure vessels shall bear the appropriate ASME label.
   d. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

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

C. All underground distribution systems shall be designed in strict conformance to the latest edition of ANSI B31.1 or local requirements, whichever is more stringent, and sealed by a Registered Professional Engineer in good standing with state and local authorities. The system shall be designed to compensate for stresses and movement of the service pipe.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. Wrought-Copper Fittings and Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.
E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   2. End Connections: Butt welding.
   3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

I. Stainless-Steel Bellows, Flexible Connectors:
   2. End Connections: Threaded or flanged to match equipment connected.
   5. Maximum Operating Temperature: 250 deg F.

2.3 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 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
2.4 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:
      c. Watts Water Technologies, Inc.
      d. Zurn Plumbing Products Group.
   2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:
   1. Available Manufacturers:
      b. Watts Water Technologies, Inc.
   2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:
   1. Available Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. 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- or 300-psig minimum working pressure as required to suit system pressures.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, aboveground, NPS 2 and Smaller: Standard weight, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, aboveground, NPS 2-1/2 and Larger: Standard weight, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
C. LP Steam Piping, aboveground, NPS 14 and larger: Standard weight, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.2 CONDENSATE PIPING APPLICATIONS

A. Condensate piping, aboveground, NPS 2 and smaller, shall be the following: Extra-strong, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. Condensate piping, aboveground, NPS 2-1/2 and larger, shall be the following: Extra-strong, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate Piping, belowground: Pre-insulated piping system with service pipe as described above.

3.3 ANCILLARY PIPING APPLICATIONS

A. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

B. Air-Vent Piping:
   1. Inlet: Same as service where installed.
   2. Outlet: Type K annealed-temper copper tubing with soldered or flared joints.

C. Vacuum-Breaker Piping: Outlet, same as service where installed.

D. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.4 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.5 PIPING INSTALLATION

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

B. 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 free of sags and bends.

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

H. Install piping to allow application of insulation.

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

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

Q. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

R. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

S. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 100 feet.
2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.
3.6 HANGERS AND SUPPORTS
A. Install hangers and supports according to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.7 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 ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
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.

3.8 TERMINAL EQUIPMENT CONNECTIONS
A. Size for supply and return piping connections shall be the same as or larger than equipment connections.
B. Install traps and control valves in accessible locations close to connected equipment.
C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
D. Install vacuum breakers downstream from control valve, close to coil inlet connection.
E. Install a drip leg at coil outlet.
3.9 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping," 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 system with clean water. Clean strainers.
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.

B. Perform the following tests on steam and condensate 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. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the 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.
3. 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.

C. Prepare written report of testing.

END OF SECTION
SECTION 232216

STEAM AND CONDENSATE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following piping specialties for [low (LP)] [and] [high (HP)] pressure steam and condensate piping:

1. Strainers.
2. Flash tanks.
4. Pressure-reducing valves.
5. Steam traps.
6. Thermostatic air vents and vacuum breakers.
7. Steam and condensate meters.

1.2 DEFINITIONS

A. FMS: Facility Management System.

B. HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.

C. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following, noting the service for each:

1. Air vent and vacuum breaker.
2. Drip Trap
3. Flash tank.
4. Meter.
5. Pressure-reducing and safety valve.
6. Steam trap.

B. Shop Drawings: Detail, 1/4 inch equals 1 foot scale, flash tank assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.
1.5 QUALITY ASSURANCE

A. [Provide valves, fittings, and related products as listed on Drawings and described herein. All products to be purchased from Ferguson Enterprises.]

B. Pipe Welding: Qualify procedures and operators according to the following:

1. ASME Compliance:
   b. Comply with ASME B31.9, "Building Services Piping" for LP systems for materials, products, and installation.
   c. Safety valves and pressure vessels shall bear the appropriate ASME label.
   d. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. HP Steam Piping: <Insert psig>.
2. LP Steam Piping: 15.0 psig or less.
5. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
6. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Stop-Check Valves:

1. Manufacturers:
   a. A.Y. McDonald Mfg. Co.
   b. Crane; Crane Energy Flow Solutions.
   c. Jenkins Valves.
   d. Lunkenheimer Valves.

2. Body and Bonnet: Malleable iron.
4. Disc: Cylindrical with removable liner and machined seat.
5. Stem: Brass alloy.
6. Operator: Outside screw and yoke with cast-iron handwheel.
8. Pressure Class: 250.

2.3 STRAINERS

A. Strainer Perforations: All strainer baskets shall be stainless steel and sized based on the service and installed pipe size as indicated by the table below, unless indicated otherwise.

<table>
<thead>
<tr>
<th>B. SERVICE DUTY</th>
<th>C. PIPE SIZE (NPS)</th>
<th>D. STRAINER PERFORATION SIZE (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F. 1/4&quot; TO 2&quot;</td>
<td>G. 0.020</td>
<td></td>
</tr>
<tr>
<td>H. 2-1/2&quot; TO 4&quot;</td>
<td>I. 0.031</td>
<td></td>
</tr>
<tr>
<td>J. 6&quot; AND GREATER</td>
<td>K. 0.250</td>
<td></td>
</tr>
</tbody>
</table>

L. 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 strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Tapped blowoff plug.
4. CWP Rating: 250-psig working steam pressure.

M. Basket Strainers:
1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. CWP Rating: 250-psig working steam pressure.

2.4 FLASH TANKS

A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

2.5 SAFETY VALVES

A. Bronze or Brass Safety Valves, NPS 2-1/2 inches and smaller: ASME labeled.
1. Manufacturers:
b. Kunkle Valve.
c. Spirax Sarco, Inc.
d. Watts; a Watts Water Technologies company.

2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves, NPS 1-1/2 inches through NPS 6 inches: ASME labeled.

1. Manufacturers:
   b. Kunkle Valve.
   c. Spirax Sarco, Inc.
   d. Watts; a Watts Water Technologies company.

2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.

2.6 PRESSURE-REDUCING VALVES

A. Available Manufacturers:

2. Hoffman Specialty; Division of ITT Industries.
3. Leslie Controls, Inc.
5. Spirax Sarco, Inc.

B. ASME labeled.

C. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

D. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.

E. Body: Cast iron.
F. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.

G. Trim: Hardened stainless steel.

H. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.


J. Sound attenuators: As required for a maximum 85 dBA measured 3 feet above finished floor and 3 feet away, in any direction, from assembly.

2.7 STEAM TRAPS

A. Thermostatic Traps:
   1. Available Manufacturers:
      b. Dunham-Bush, Inc.
      c. Hoffman Specialty; Division of ITT Industries.
      d. Spirax Sarco, Inc.
      e. Sterling.

   2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
   3. Trap Type: Balanced-pressure.
   4. Bellows: Stainless steel or monel.
   5. Head and Seat: Replaceable, hardened stainless steel.
   6. Pressure Class: 125.

B. Thermodynamic Traps:
   1. Available Manufacturers:
      b. Dunham-Bush, Inc.
      c. Hoffman Specialty; Division of ITT Industries.
      d. Spirax Sarco, Inc.

   4. Disc and Seat: Stainless steel.
   5. Maximum Operating Pressure: 600 psig.

C. Float and Thermostatic Traps:
   1. Available Manufacturers:
      b. Dunham-Bush, Inc.
      c. Hoffman Specialty; Division of ITT Industries.
      d. Spirax Sarco, Inc.
      e. Sterling.
2. Body and Bolted Cap: ASTM A 126, cast iron.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.

D. Inverted Bucket Traps:
1. Available Manufacturers:
   b. Dunham-Bush, Inc.
   c. Hoffman Specialty; Division of ITT Industries.
   d. Spirax Sarco, Inc.
   e. Sterling.

2. Body and Cap: Cast iron.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.

2.8 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:
1. Available Manufacturers:
   b. Dunham-Bush, Inc.
   c. Hoffman Specialty; Division of ITT Industries.
   d. Spirax Sarco, Inc.
   e. Sterling.

2. Body: Cast iron, bronze, or stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: \[1.5x \text{the system to which it is attached}[125 \text{ psig}][300 \text{ psig}]\]
7. Maximum Temperature Rating: \[1.5x \text{the system to which it is attached}[350 \text{ deg F}]\]

B. Vacuum Breakers:
1. Available Manufacturers:
b. Dunham-Bush, Inc.
c. Hoffman Specialty; Division of ITT Industries.
d. Johnson Corporation (The).
e. Spirax Sarco, Inc.

2. Body: Cast iron, bronze, or stainless steel.
5. O-Ring Seal: EPR.
6. Pressure Rating: \[ 1.5x \text{the system to which it is attached}] [125 \text{ psig}][300 \text{ psig}].
7. Maximum Temperature Rating: \[ 1.5x \text{the system to which it is attached}] [350 \text{ deg F}].

2.9 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellows, Flexible Connectors:

1. Manufacturers:
   a. Duraflex, Inc.
   b. Flexicraft Industries.
   c. Hyspan Precision Products, Inc.
   d. Mason Industries, Inc.
   e. Metraflex Company (The).

3. End Connections: Threaded or flanged to match equipment connected.
5. Pressure Rating: \[ 1.5x \text{the system to which it is attached}] [150 \text{ psig}].
6. Maximum Temperature Rating: \[ 1.5x \text{the system to which it is attached}] [250 \text{ deg F}].

2.10 STEAM METERS

A. Available Manufacturers:

1. EMCO Flow Systems; Division of Advanced Energy Company.
2. ISTECS Corp.
3. Preso Meters; a division of Racine Federated Inc.
4. Spirax Sarco, Inc.

B. Meters shall have a microprocessor to display totalizer flow, flow rate, temperature, pressure, time, and date; alarms for high and low flow rate and temperature.

1. Computer shall have 4- to 20-mA or 2- to 10-V output for temperature, pressure, and contact closure for flow increments.
2. Independent timers to store four peak flow rates and total flow.
3. Interface compatible with central workstation described in Section 230923 "Direct Digital Control (DDC) System for HVAC."

C. Sensor:
1. Venturi, of stainless-steel construction, for insertion in pipeline between flanges. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
2. Vortex type with stainless-steel wetted parts and flange connections; and with a piezoelectric sensor removable and serviceable without shutting down the process. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.

2.11 CONDENSATE METERS

A. Available Manufacturers:

1. Central Station Steam Co.
2. Lincoln Meter Company.

B. Body: Cast iron, bronze, or brass.

C. Turbine: Copper, brass, or stainless steel.

D. Connections: Threaded for NPS 2 and smaller and flanged for NPS 2-1/2.

E. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.

1. Computer shall have 4- to 20-mA or 2- to 10-V output for temperature, pressure, and contact closure for flow increments.
2. Independent timers to store four peak flow rates and total flow.
3. Interface compatible with central workstation specified in Division 23 Section "Instrumentation and Control for HVAC."

F. Pressure Rating: Atmospheric.

G. Maximum Temperature Rating: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code.

C. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.2 PIPING INSTALLATION

A. Select system components with pressure rating equal to or greater than system operating pressure.
B. Install piping to permit valve servicing.

C. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

D. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

E. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

F. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

G. Install shutoff valve immediately upstream of each dielectric fitting.

H. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

I. Flash Tank:
   1. Pitch condensate piping down toward flash tank.
   2. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
   3. Install thermostatic air vent at tank top.
   4. Install safety valve at tank top.
   5. Install full-port ball valve, and swing check valve on condensate outlet.
   6. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for three times the calculated heat load.
   7. Install pressure gage on low-pressure steam outlet according to Division 23 Section "Meters and Gages for HVAC Piping."

3.3 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install isolation valve, strainer, and union upstream from trap; install union, check valve, and isolation valve downstream from trap unless otherwise indicated.

C. Isolation valve sizes:
   1. Pipe sizes up to NPS 2": full-port ball valve.
   2. Pipe sizes greater than NPS 2": gate valve.

3.4 PRESSURE-REDUCING VALVE INSTALLATION

A. Install pressure-reducing valves in accessible location for maintenance and inspection.

B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.

C. Install gate valves on both sides of pressure-reducing valves.
D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections, respectively.

E. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 23 Section "Meters and Gages for HVAC Piping."

F. Install strainers upstream for pressure-reducing valve.

G. Install safety valve downstream from pressure-reducing valve station.

3.5 STEAM OR CONDENSATE METER INSTALLATION

A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's written instructions.

B. Provide data acquisition wiring. Refer to Division 23 Section "Instrumentation and Control for HVAC."

3.6 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.1, "Power Piping" or ASME B31.9, "Building Services Piping," based on the service installed.

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.7 HANGERS AND SUPPORTS

A. Install hangers and supports according to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.8 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.
SECTION 232300

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerant piping valves and specialties.
3. Refrigerants.

B. Related Sections:

1. Division 23 Section "Common Work Results" for description of concrete bases used as vibration isolation.
2. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for installation locations of pipe saddles at pipe hangers.
3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for expansion fittings.
4. Division 23 Section "HVAC Insulation" for pipe saddles at pipe hangers.
5. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty.

1. Include pressure drop, based on manufacturer's test data, for the following:
   a. Thermostatic expansion valves.
   b. Solenoid valves.
   c. Hot-gas bypass valves.
   d. Filter dryers.
   e. Strainers.
   f. Pressure-regulating valves.

B. Shop Drawings:

1. Delegated-Design Submittal: As a 1/8 inch equals 1 foot scale drawing, show:
   a. Layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, as well as slopes of horizontal runs.
   b. Valve arrangements and locations.
   c. Oil traps.
   d. Double risers.
   e. Wall and floor penetrations.
   f. Equipment connection details.
2. Indicate elevation difference between compressor and evaporator, refrigerant flows, and other information to ensure proper operation and compliance with warranties of connected equipment.
3. Show interface and spatial relationships between piping and equipment.

1.3 INFORMATIONAL SUBMITTALS
A. Welding certificates.
B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE
A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING
A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Line Test Pressure for Refrigerant R-134a:
B. Line Test Pressure for Refrigerant R-407C:
C. Line Test Pressure for Refrigerant R-410A:

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube:
   1. ASTM B 88, Type K or L
   2. ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8/A5.8M.

F. Flexible Connectors:
   2. End Connections: Socket ends.
   3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
   5. Maximum Operating Temperature: 250 deg F.

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 selected in piping application articles.

B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.

C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.

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

E. Flanged Unions:
   1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3. Apply rust-resistant finish at factory.
   2. Gasket: Fiber asbestos free.
   3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
   4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
   5. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
7. Maximum Operating Temperature: 330 deg F.

F. Flexible Connectors:

2. End Connections:
   a. NPS 2 and Smaller: With threaded-end connections.
   b. NPS 2-1/2 and Larger: With flanged-end connections.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
5. Maximum Operating Temperature: 250 deg F.

2.4 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
3. Operator: Rising stem and hand wheel.
5. End Connections: Socket, union, or flanged.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
5. End Connections: Socket, union, threaded, or flanged.
6. Maximum Opening Pressure: 0.50 psig.
8. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
4. End Connections: Copper spring.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

1. Manufacturers:
   a. Danfoss Inc.
2. Emerson Climate Technologies.
8. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24, 115, or 208-V ac coil.
10. Maximum Operating Temperature: 240 deg F.

F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
4. End Connections: Threaded.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with AHRI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
5. Seat: Polytetrafluoroethylene.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and 24, 115, or 208-V ac coil.
11. Maximum Operating Temperature: 240 deg F.

I. Straight-Type Strainers:

2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
5. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:

2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
5. End Connections: Socket or flare.
7. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
9. Maximum Operating Temperature: 240 deg F.

M. Permanent Filter Dryers: Comply with AHRI 730.

2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
9. Maximum Operating Temperature: 240 deg F.

N. Mufflers:
   2. End Connections: Socket or flare.
   4. Maximum Operating Temperature: 275 deg F.

O. Receivers: Comply with AHRI 495.
   1. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   2. Comply with UL 207; listed and labeled by an NRTL.
   4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
   5. End Connections: Socket or threaded.
   7. Maximum Operating Temperature: 275 deg F.

P. Liquid Accumulators: Comply with AHRI 495.
   2. End Connections: Socket or threaded.
   4. Maximum Operating Temperature: 275 deg F.

2.5 REFRIGERANTS
A. ASHRAE 34, R-134a: Tetrafluoroethane.
B. ASHRAE 34, R-407C: Difluoromethane / Pentafluoroethane / 1,1,1,2-Tetrafluoroethane.
C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT
A. Unless otherwise required by the manufacturer or applicable codes, provide the following for all applications including suction, hot gas, and safety piping:
   1. Aboveground Locations:
      a. Sizes up to NPS 3/4: ACR, soldered with wrought copper fittings.
      b. Sizes greater than NPS 3/4 to NPS 4: Type K, brazed with wrought copper fittings.
      c. Sizes above NPS 4: Schedule 40, black-steel and wrought-steel fittings with welded joints.
2. Belowground Locations
   a. Sizes up to NPS 4: Type K, brazed with wrought copper fittings.
   b. Sizes above NPS 4: Schedule 40, black-steel and wrought-steel fittings with welded joints.

3. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-size, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot-gas bypass valves.
   4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install receivers sized to accommodate pump-down charge.
M. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Install refrigerant piping according to ASHRAE 15.

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 adjacent to machines to allow service and maintenance.

F. Install piping free of sags and bends.

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

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

I. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

J. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels where valves or equipment requiring maintenance is concealed behind finished surfaces.

K. Install refrigerant piping in protective conduit where installed belowground.

L. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

M. Slope refrigerant piping as follows:

  1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  2. Install horizontal suction lines with a uniform slope downward to compressor.
  3. Install traps and double risers to entrain oil in vertical runs.
  4. Liquid lines may be installed level.

N. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

O. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:

  1. Shot blast the interior of piping.
2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to Division 23Section, "Identification for HVAC Piping and Equipment."

R. Install sleeve seals for piping penetrations of concrete exterior walls and slabs, interior walls, ceilings, and floors. Comply with requirements for sleeve seals specified in Division 23Section "Common Work Results."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23Section "Common Work Results."

3.4 PIPE JOINT CONSTRUCTION

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

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

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

   1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to 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. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

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

3.5 HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
   a. Fill system with nitrogen to the required test pressure.
   b. System shall maintain test pressure at the manifold gage throughout duration of test.
   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.
3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION
SECTION 233113
METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg. Metal ducts include the following:
   1. Rectangular ducts and fittings.
   2. Single-wall, round, and flat-oval spiral-seam ducts and formed fittings.
   3. Double-wall, round, and flat-oval spiral-seam ducts and formed fittings.
   4. Duct liner.

B. Related Sections include the following:
   1. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset FRP ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
   2. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
   3. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
   4. Division 23 Section "Breechings, Chimneys, and Stacks".
   5. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment".
   6. Division 23 Section "Air Duct Accessories" for fire and smoke
   7. Division 07 Section "Penetration Firestopping" for firestopping materials and installation methods.

1.2 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.


1.3 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings: CAD-generated and drawn to same scale as contract drawings, minimum 1/8 inch equals 1 foot scale. Show fabrication and installation details for metal ducts.

1. Shop drawings required for all areas of the building
2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Duct sizes shown on the drawings are net free area and indicate design intent. When obstructions occur within the duct from motorized actuators, damper frames, duct liner, etc., the duct size shall be increased to preserve free area design intent. Duct layout indicating the following:

   a. Sizes and pressure classes.
   b. Elevations of top and bottom of ducts.
   c. Dimensions of main duct runs from building grid lines.
   d. Fittings.
   e. Duct accessories, including access doors and panels.
   f. Notes indicating deviations from design intent for detailed review by Engineer.

4. Equipment installation based on equipment being used on Project.
5. Submit the following with the initial shop drawing package:

   a. Reinforcement and spacing.
   b. Seam and joint construction.
   c. Penetrations through fire-rated and other partitions.
   d. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.
   e. Dampers

      1) Locations of fire-smoke dampers.
      2) Locations of motorized control dampers.
      3) Indication of location, size, and quantity of damper actuators in the air stream.
      4) Location of damper actuator access for maintenance and inspection.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings are required for all areas and shall remain on site. Coordinate with all trades.

B. Welding certificates.

C. Field quality-control test reports.

1.6 QUALITY ASSURANCE

B. NFPA Compliance:
   1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
   2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.7 DELIVERY, STORAGE, AND HANDLING

A. After fabrication and before the ductwork is installed it shall be “wiped clean” and “heat-shrink wrapped” or some other method of wrap for maintaining a clean ductwork system during delivery to and storage at the jobsite.

B. Deliver ducts with all openings protected and sealed. Maintain covered openings through shipping, storage, and handling to prevent entrance of dirt, debris, and moisture.

C. The area provided for duct storage at the jobsite shall be clean, dry and exposure to dust minimized.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view and minimum 26 gage thickness.

C. Stainless Steel: ASTM A 480/A 480M, Type 304, and having a No. 2D finish for concealed ducts and for exposed ducts.

D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 DUCT LINER

A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.

   1. Manufacturers:

      a. CertainTeed Corp.; Insulation Group.
c. Knauf Fiber Glass GmbH.
d. Owens Corning.

2. One inch thick, 1½ pound maximum density, Johns-Manville Permacote Linacoustic or equivalent, glass fiber duct liner having a minimum effective “K” value of 0.24 at 75°F, a roughness (e) factor of 0.0008 feet and sound absorption coefficients as published for that material. The duct liner shall conform to the requirements of ASTM C 1071, with an NRC not less than 0.65 as tested per ASTM C423 using a Type ‘A’ mounting and a thermal conductivity no higher than 0.25 at 75°F mean temperature. The material and coatings shall comply with the flame spread, fuel contributed and smoke developed ratings of NFPA 90A as tested in accordance with UL-723 and shall meet Life Safety Standards as established by NFPA 90A and 90B. The coating shall contain an EPA Registered immobilized anti-microbial agent and shall be rated to avoid erosion at 5000 fpm velocity (and tested at 12,500 fpm velocity). All edges shall be treated with factory-applied edge coating.

B. Flexible Elastomeric Duct Liner: Comply with NFPA 90A or NFPA 90B.

1. Manufacturers:
   a. Armstrong World Industries, Inc.
   b. K-flex.

   a. Thickness: 1 inch.
   b. Thermal Conductivity (k-Value): 0.24 at 75 deg F mean temperature.
   c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
   d. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

3. Liner shall be utilized in supply, exhaust, and return ducts as indicated.

2.3 DUCT FIRE WRAP

A. Fire wrap: An assembly providing at least a 2-hour fire rating for sheet metal ducts.

B. Manufacturers:
   1. Pabco.
   2. Unifrax: FyreWrap.


D. Where permitted by local codes, the products above may be a substitute for a 2-hour fire rated gypsum board covering.

2.4 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

E. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.

F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
   1. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
   2. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
   3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.6 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
   1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
   2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Nexus Inc.
   c. Ward Industries, Inc.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, metal cleat, and gasket details.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Lockformer.

2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.7 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

B. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

1. Manufacturers:
   b. SEMCO Incorporated.
   c. Spiral Pipe of Texas
   d. Lewis & Lambert
   e. Gowco, Inc.
   f. Spiramir

C. Flat-Oval, Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

1. Manufacturers:
   b. SEMCO Incorporated.
   c. Spiral Pipe of Texas
   d. Lewis & Lambert
   e. Gowco, Inc.
   f. Spiramir

D. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.

3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.

4. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.
   a. Manufacturers:
      1) Ductmate Industries, Inc.
      3) SEMCO Incorporated.

E. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

F. Diverging-Flow Fittings: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

G. Fabricate elbows using die-formed, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
   1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
   2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
      a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
      b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.
      c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
      d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
   3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
      a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
      b. Ducts 27 to 50 Inches in Diameter: 0.040 inch.
      c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
      d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
   4. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only.
   5. Round Elbows Larger Than 9 Inches in Diameter: Fabricate pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows.
   6. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
   7. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

H. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:
1. Round Elbows 4 to 8 Inches in Diameter: Two piece, die stamped, with longitudinal seams spot welded, bonded, and painted with PVC aerosol spray.
2. Round Elbows 9 to 26 Inches in Diameter: Standing-seam construction.
3. Round Elbows 28 to 60 Inches in Diameter: Standard welded construction.
4. Other Fittings: Welded joints.
5. Couplings: Slip-joint construction with a minimum 2-inch insertion length.

2.8 DOUBLE-WALL DUCT AND FITTING FABRICATION

A. Manufacturers:
2. SEMCO Incorporated.

B. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.

1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
2. Insulation: 1-inch-thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
   a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.

3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:
   a. Ducts 3 to 8 Inches in Diameter: 0.019 inch with standard spiral-seam construction.
   b. Ducts 9 to 42 Inches in Diameter: 0.019 inch with single-rib spiral-seam construction.
   c. Ducts 44 to 60 Inches in Diameter: 0.022 inch with single-rib spiral-seam construction.
   d. Ducts 62 to 88 Inches in Diameter: 0.034 inch with standard spiral-seam construction.

4. Perforated Inner Ducts: Fabricate with 0.028-inch-thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.

5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

C. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.

1. Solid Inner Ducts: Use the following sheet metal thicknesses:
   a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.
   b. Ducts 35 to 58 Inches in Diameter: 0.034 inch.
   c. Ducts 60 to 88 Inches in Diameter: 0.040 inch.

2. Perforated Inner Ducts: Fabricate with 0.028-inch-thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.
PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Primary Supply Ducts (before Air Terminal Units): 3-inch wg
5. All other ducts: 2.5 inch wg (750 Pa), positive or negative based on service.

B. All ducts shall be galvanized steel except as follows, unless otherwise indicated:

1. Range Hood Exhaust Ducts: Comply with NFPA 96.
   b. Exposed: Type 304, stainless steel with finish to match kitchen equipment and range hood.
   c. Fully weld all seams and joints.

2. Wet Exhaust Service Ducts:
   a. Construction:
      1) Type 304, stainless steel with finish to match kitchen equipment and range hood. Fully weld all seams and joints.
      2) Aluminum, soldered with seams and laps arranged on top of duct.

3.2 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install ducts with fewest possible joints.

C. Install fabricated fittings for changes in directions, size, and shape and for connections.

D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws.

E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Install duct liner in exhaust and return ducts from equipment inlet connection to 25'-0"upstream of inlet, minimum.
I. Provide break away flange for all stainless steel ductwork at fire/smoke damper interfaces. Install stainless steel drain pans extending beyond in all directions with automatic condensate pumps and piping to nearest code approved drain at break away.

J. Concel ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

K. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

L. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

M. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

N. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

O. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant.

P. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Refer to SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems.", unless otherwise indicated.

Q. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

R. Paint interiors of metal ducts that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections. Painting not required for ducts serving mechanical, electrical and data rooms.

S. Provide concrete pipe curb in floors of mechanical equipment areas or other wet areas 4 inches above finished floor level.

T. Provide temperature range for duct mounted thermometer dials: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

3.3 INSTALLATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with complete adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
E. Do not apply liner with longitudinal joints in rectangular ducts, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.

G. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

H. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   1. Fan discharges.
   2. Intervals of lined duct preceding unlined duct.
   3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.

I. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

J. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

3.4 SPECIAL INSTALLATION REQUIREMENTS FOR SPECIAL EXHAUST APPLICATIONS

A. Wet Exhaust Ducts:
   1. Exhaust ductwork shall be all welded construction suitable for a negative or positive pressure of 2" w.c. All seams and joints shall be watertight.
      a. Concealed duct: 24 gage all welded aluminum or 18 gage stainless steel, minimum.
      b. Exposed duct: 18 stainless steel gage with a #4 finish. All seams ground and polished.
   2. Ductwork shall be sloped toward the dishwasher connections at 1/8" per linear foot, minimum.
   3. Locations required:
      a. Central sterile washing equipment.
      b. Sterilizer exhaust services.

3.5 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for ducts, per Seal Class ‘A’.

B. Seal ducts before external insulation is applied.
3.6 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. Install concrete inserts before placing concrete.

E. Support Ducts per SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for ducts.

F. Do not use powder-actuated concrete fasteners

3.7 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 FIELD QUALITY CONTROL

A. The leak testing shall be observed by the General Contractor’s representative and the Owner’s representative. Provide 48 hours notification of such tests.

B. All ducts shall be tested. Submit a written report. The contractor is required to maintain on-site a set of ductwork prints that are shaded in different colors to show the duct section isolated for each test. Also the Contractor shall indicate on the print the date each section of duct was tested and the final percent leakage rate measured for each test section.

C. If any duct section fails the leakage test, the contractor shall repair the leakage and re-perform the leakage test.

D. The duct systems shall be pressure tested for leaks at their specified pressure ratings and shall be within the maximum allowed by the following:

   1. Primary Air (medium pressure ducts) Systems – 3% leakage.
   2. Other Systems – 2% leakage.

E. The leakage test shall be performed using a kit as furnished by United McGill Corp. or approved equal and shall include the following components:

   1. Blower
   2. Two manometers or U-tubes
   3. Calibrated orifice tube

F. The leakage test procedure is as follows:
1. Carefully seal off all openings (except one for connecting the test equipment) to the duct run-out section to be tested.
2. Connect the downstream end of the orifice tube to the duct system using a piece of flexible tubing.
3. Connect one manometer to the static taps on the tube to read orifice differential pressure. Connect the other manometer to a 5/16” tap in the duct at least one foot from the blower connection to read test static pressure.
4. Attach the blower to the orifice tube and block off the inlet to prevent over pressurizing a tight system.
5. Start the blower and slowly open the inlet until the desired test static pressure is reached. Let the blower run for at least one minute to insure a steady state.
6. At this point, the air flowing through the orifice tube is going into the duct system and is equal to the amount leaking out. This leakage rate can be read from the calibration chart on the orifice tube. This measured cfm is used to determine the leakage percent.
7. If the duct system is too large and the allowable leakage is greater than the capacity of the blower, the system shall be tested in several sections and the results added together.

3.9 DUCT CLEANLINESS AND DUCT CLEANING

1. DUCT CLEANLINESS
   a. It is the intent to provide an installation of a ductwork system that appears to be visibly clean.
   b. A visual inspection of porous and non-porous ductwork components must be monitored by the Contractor to ensure that the system is visibly clean. The system has excessive dust or debris when an accumulation of particles can be observed in the ductwork. An interior surface is considered visibly clean when it is free from non-adhered substances and debris.
   c. Cleanliness verification shall be performed after the ductwork system has been “wiped clean” and prior to the application of any piece of equipment or component being used in operation.
   d. If air handling units are operated without the pre-filters and the final filters in place, the ductwork shall be replaced or vacuumed per Article B “Cleaning New Systems” below.

2. Condition of new ductwork shall include the following measures:
   a. Any internal exposed mastic sealant to be removed.
   b. The light coating of oil on machine formed sheet metal ductwork is to be removed.
   c. The discoloration marks from the plasma cutting process must be removed.
   d. Before installation of the individual duct sections they are to be visually inspected for dust and/or debris, and wiped clean, if necessary.
   e. After the ductwork has been installed, the cleanliness procedure shall be to temporarily cover the open ends of the ductwork to prevent dust and debris of finding its way to the system.
   f. If vacuuming is required to adequately clean the ductwork, the vacuum cleaner must be HEPA filtered and capable of achieving a minimum of 40 inches of water gage. The vacuum should be fitted with a 2.5” round nylon brush attached to a 1.5” diameter vacuum hose.

3. Conditions of existing ductwork and equipment within the systems that serve the renovated areas shall be visually inspected for dust and debris.
a. If dust and/or debris is observed within the existing system, it shall be cleaned to remove all visual dust and debris. This process may include the addition of access doors to facilitate the “wiping” and/or “vacuuming” of the ductwork systems.
b. The system cleanliness procedures shall be adhered to during the construction process of the renovations.
c. New ductwork required for additions within the existing renovated area shall follow the procedures addressed above for the new ductwork.
d. If vacuuming is required to adequately clean the ductwork, the vacuum cleaner must be HEPA filtered and capable of achieving a minimum of 40 inches of water gage. The vacuum should be fitted with a 2.5” round nylon brush attached to a 1.5” diameter vacuum hose.

B. CLEANING NEW SYSTEMS

1. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
2. Use service openings, as required, for physical and mechanical entry and for inspection.
   a. Create other openings to comply with duct standards.
   b. Disconnect flexible ducts as needed for cleaning and inspection.
   c. Remove and reinstall ceiling sections to gain access during the cleaning process.
3. Vent vacuuming system to the outside. Include HEPA filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.
4. Clean the following metal duct systems by removing surface contaminants and deposits:
   a. Air outlets and inlets (registers, grilles, and diffusers).
   b. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   c. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   d. Coils and related components.
   e. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
   f. Supply-air ducts, dampers, actuators, and turning vanes.
5. Mechanical Cleaning Methodology:
   a. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
   b. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   c. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
   d. Do not permit fibrous-glass duct liner to get wet. Remove and replace wet duct liner.
   e. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Cleanliness Verification:
a. Visually inspect metal ducts for contaminants.
   b. Where contaminants are discovered, re-clean and reinspect ducts.

C. CLEANING EXISTING SYSTEMS

1. Use service openings, as required, for physical and mechanical entry and for inspection.
   a. Use existing service openings where possible.
   b. Create other openings to comply with duct standards.
   c. Disconnect flexible ducts as needed for cleaning and inspection.
   d. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
   e. Remove and reinstall ceiling sections to gain access during the cleaning process.

2. Mark position of dampers and air-directional mechanical devices before cleaning, and
   restore to their marked position on completion.

3. Particulate Collection and Odor Control:
   a. When venting vacuuming system inside the building, use HEPA filtration with
      99.97 percent collection efficiency for 0.3-micron size (or larger) particles.
   b. When venting vacuuming system to the outside, use filtration to contain debris
      removed from HVAC system, and locate exhaust down wind and away from air
      intakes and other points of entry into building.

4. Clean the following metal duct systems by removing surface contaminants and deposits:
   a. Air outlets and inlets (registers, grilles, and diffusers).
   b. Supply, return, and exhaust fans including fan housings, plenums (except ceiling
      supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and
      drive assemblies.
   c. Air-handling unit internal surfaces and components including mixing box, coil
      section, air wash systems, spray eliminators, condensate drain pans, humidifiers
      and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   d. Coils and related components.
   e. Return-air ducts, dampers, and actuators except in ceiling plenums and
      mechanical equipment rooms.
   f. Supply-air ducts, dampers, actuators, and turning vanes.
   g. Dedicated exhaust and ventilation components and makeup air systems.

5. Mechanical Cleaning Methodology:
   a. Clean metal duct systems using mechanical cleaning methods that extract
      contaminants from within duct systems and remove contaminants from building.
   b. Use vacuum-collection devices that are operated continuously during cleaning.
      Connect vacuum device to downstream end of duct sections so areas being
      cleaned are under negative pressure.
   c. Use mechanical agitation to dislodge debris adhered to interior duct surfaces
      without damaging integrity of metal ducts, duct liner, or duct accessories.
   d. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct
      liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or
      delaminated or that has friable material, mold, or fungus growth.
   e. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan
      operational. Rinse coils with clean water to remove latent residues and cleaning
      materials; comb and straighten fins.
   f. Provide operative drainage system for washdown procedures.
g. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.

6. Cleanliness Verification:
   a. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
   b. Visually inspect metal ducts for contaminants.
   c. Where contaminants are discovered, re-clean and reinspect ducts.

7. Gravimetric Analysis: At discretion and expense of Owner, sections of metal duct system, chosen randomly by Owner, may be tested for cleanliness according to NADCA vacuum test gravimetric analysis.
   a. If analysis determines that levels of debris are equal to or lower than suitable levels, system shall have passed cleanliness verification.
   b. If analysis determines that levels of debris exceed suitable levels, system cleanliness verification will have failed and metal duct system shall be re-cleaned and re-verified.

8. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

END OF SECTION
SECTION 233300
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Ceiling fire dampers.
7. Combination fire and smoke dampers.
8. Duct silencers.
10. Turning vanes.
11. Duct-mounting access doors.
12. Flexible connectors.
13. Flexible ducts.
14. Duct accessory hardware.

B. Related Sections include the following:

1. Division 23 Section "Instrumentation and Control for HVAC" for electric and pneumatic damper actuators.
2. Division 23 Section "Metal Ducts" for duct construction and fittings.
3. Division 28 Section "Fire Detection and Alarm" for duct-mounting fire and smoke detectors.

1.2 DEFINITIONS

A. Low Leakage: Class 1A as defined by AMCA Standard 511, equating to less than 3cfm/ft2of damper area, at differential pressure of 1-inch wgess than 8cfm/ft2of damper area, at differential pressure of 4-inch wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Ceiling fire dampers.
7. Combination fire and smoke dampers.
8. Duct silencers.
10. Duct-mounting access doors.
11. Flexible connectors.
12. Flexible ducts.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Special fittings.
   3. Motorized-control damper installations.
   4. Fire-damper, smoke-damper, and combination fire- and smoke-damper installations, including sleeves and duct-mounting access doors.
   5. Identify duct velocity and pressure class of duct system dampers are installed in.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.5 QUALITY ASSURANCE


1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent, rounding up, for each type of amount installed with a minimum of one.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A 480/A 480M.
D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.


F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Duro Dyne Corp.
5. Loren Cook.
7. Potteroff.
8. Prefco Products, Inc.

B. Description: Multiple or single-blade, parallel action gravity balanced, with [center-pivoted] blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

C. Frame: [Galvanized sheet steel] [Extruded aluminum], with welded corners and mounting flange.

D. Blades: 0.050-inch-thick aluminum sheet.

E. Blade Seals: Neoprene.

F. Blade Axles: [Nonferrous] [Galvanized steel].

G. Tie Bars and Brackets: [Aluminum] [Galvanized steel].

H. Return Spring: Adjustable tension.

2.3 VOLUME DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Flexmaster U.S.A., Inc.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. National Controlled Air.
10. Ruskin Company.
12. Young Regulator Company.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
2. Dampers integral to building envelope shall be AMCA 511 Class 1 rated, minimum.

C. Duct Dampers.

1. Standard Volume:
   a. Multiple- or single-blade, parallel- or opposed-blade design, AMCA 511 Class 2 rated, with linkage outside airstream, and suitable for horizontal or vertical applications. Blade and frame materials shall match.
   b. Steel:
      1) Frames: Hat-shaped, [galvanized] [stainless] sheet steel channels, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
      2) Roll-Formed Blades: [Galvanized] [Stainless] sheet steel.
   c. Aluminum
      1) Frames: Hat-shaped, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
      2) Roll-Formed Blades: 0.10-inch-thick aluminum sheet.
      3) Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
   d. Blade Axles: [Galvanized steel] [Stainless steel] [Nonferrous].
   e. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve.
   f. Tie Bars and Brackets: [Aluminum][Galvanized Steel].

2. Low-Leakage Volume:
   a. Multiple-blade, parallel- or opposed-blade design as indicated, AMCA 511 Class 1A rated, with linkage outside airstream, and suitable for horizontal or vertical applications. Blade and frame materials shall match.
   b. Steel:
      1) Frames: Hat, U-, or angle-shaped, [galvanized] [stainless] sheet steel channels, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2) Roll-Formed Blades: 0.064-inch-thick, [galvanized] [stainless] sheet steel.

c. Aluminum:
   1) Frames: Hat, U-, or angle-shaped, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
   2) Roll-Formed Blades: 0.10-inch-thick aluminum sheet.
   3) Extruded Blades: 0.050-inch-thick extruded aluminum.

d. Blade Axles: [Galvanized steel] [Stainless steel] [Nonferrous].

e. Bearings: Oil-impregnated bronze or stainless-steel sleeve thrust or ball.

f. Blade Seals: Vinyl or Neoprene.

g. Jamb Seals: Cambered [stainless steel] [aluminum].

h. Tie Bars and Brackets: [Galvanized steel] [Aluminum].

3. Remote Mounted:
   a. Rack-and-pinion controller fabricated from minimum 14 gage galvanized steel with graduations for positive locking control.
   b. Control cable shall be .054” stainless steel in 1/16” flexible galvanized casing.

D. Duct Tap-Offs
   1. Duct tap offs from rectangular or round duct are round, conical connector, with spin-in or twist-in collar, and integral damper. Include bead from using mechanical strap.
   2. Side taps, consisting of an eccentric wedge pointing into the flow narrowing to a round duct are also acceptable.
   3. Construction materials and pressure class shall identical to the attached duct system.

E. Jackshaft: Pipe matching linkage material rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.4 MOTORIZED CONTROL DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. American Warming and Ventilating.
   3. Duro Dyne Corp.
   6. METALAIRE, Inc.
   7. Nailor Industries Inc.
   8. National Controlled Air.

B. General Description: Class 1A, AMCA 511, parallel or opposed-blade airfoil design; galvanized-steel frames with holes for duct mounting; galvanized-steel damper blades with maximum blade width of 8 inches.

1. Secure blades to 1/2-inch-diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Provide parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for low leakage.

2.5 FIRE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Greenheck.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. National Controlled Air.
7. Penn Ventilation Company, Inc.
8. Potteroff.
9. Prefco Products, Inc.
10. Ruskin Company.

B. Fire dampers shall be labeled according to UL 555, Class 1.

C. Fire Rating: 1-1/2 and 3 hours.

1. Type 304, stainless-steel dampers are also available for corrosive atmospheres.

D. Frame: fabricated with roll-formed galvanized steel; with mitered and interlocking corners.

1. Provide multiple-blade type for dynamic applications.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.


G. Resets:
1. Fusible Links: Replaceable, 165 deg F (74 deg C) rated.
2.6 CEILING FIRE DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. Greenheck.
   4. METALAIRE, Inc.
   5. Nailor Industries Inc.
   6. National Controlled Air.
   7. Penn Ventilation Company, Inc.
   8. Potteroff.
   9. Prefco Products, Inc.
  10. Ruskin Company.

B. General Description: Labeled according to UL 555C, Class 1; comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Resets:
   1. Fusible Links: Replaceable, 165 deg F (74 deg C)rated.

2.7 SMOKE AND COMBINATION FIRE / SMOKE DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. Greenheck.
   3. Nailor Industries Inc.
   4. National Controlled Air.
   5. Penn Ventilation Company, Inc.
   6. Potteroff.
   7. Ruskin Company.

B. General Description: Labeled according to UL 555S, Class 1. Combination fire and smoke dampers shall be labeled according to UL 555 for 1-1/2-hour rating.

C. Resets:
   1. Automatic.

D. Frame and Blades: 0.064-inch-thick, galvanized sheet steel.

E. Mounting Sleeve: Factory-installed galvanized sheet steel; length to suit wall or floor application.

F. Damper Motors: Modulating and two-position action.
1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

4. Outdoor Motors and Motors in Outside-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at 10 degrees lower than ASHRAE 99.6% Heating DB.

5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.

6. Electrical Connection: 115 V, single phase, 60 Hz.

2.8 DUCT SILENCERS

A. Manufacturers:

1. Dynasonics.
2. I.A.C.
3. Industrial Noise Control, Inc.
5. Ruskin Company.
6. SEMCO.

B. General Description: Factory-fabricated and -tested, round or rectangular silencers with performance characteristics and physical requirements as indicated. Gage and material of casing shall be no less than the requirements of the system served.

C. Fire Performance: Adhesives, sealants, packing materials, and accessory materials shall have fire ratings not exceeding 25 for flame-spread index and 50 for smoke-developed index when tested according to ASTM E 84.

D. Rectangular Units: Fabricate casings with solid galvanized sheet metal for outer casing and ASTM A 653/A 653M, G90, perforated galvanized sheet metal for inner casing.

E. Round Units:

1. Outer Casings:

2. Interior Casing, Partitions, and Baffles:
   b. At least 0.034 inch thick and designed for minimum aerodynamic losses.

F. Sheet Metal Perforations: 1/8-inch diameter for inner casing and baffle sheet metal.

G. Fill Material: Inert, moisture proof, and vermin-proof material, packed under not less than 5 percent compression.
1. **Erosion Barrier:**
   a. Polymer or Tedlar bag enclosing fill and heat-sealed before assembly.
   b. Mylar layer attached with adhesive between fill and airstream.

H. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.

1. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
2. Lock form and seal or continuously weld joints.
3. **Suspended Units:** Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
4. **Reinforcement:** Cross or trapeze angles for rigid suspension.

I. **Source Quality Control:**

1. **Acoustic Performance:** Test according to ASTM E 477.
2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000-fpm face velocity.
3. **Leak Test:** Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

### 2.9 ELECTRIC DUCT HEATERS

A. **Manufacturers**

1. Bel Thermal Units
2. Chromalox
3. Indeeco
4. Nailor
5. Warren Products

B. **Description:** Slip-in-type, open-coil design with integral control box factory wired and installed. Include the following features:

1. Primary and secondary over-temperature protection.
2. Nickel chrome 80/20 heating elements.
3. **Airflow switch.**
5. **Fuses** (for coils more than 48 A).
7. Pneumatic-electric switches and relays.
8. Magnetic contactor for each step of control (for three-phase coils).

### 2.10 TURNING VANES

A. Fabricate to comply with SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. **Manufactured Turning Vanes:** Fabricate 1-1/2-inch-wide, double-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.
1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Duro Dyne Corp.
   c. Dynasonics.
   d. I.A.C.
   e. METALAIRE, Inc.
   f. SEMCO.
   g. Ward Industries, Inc.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill, with Mylar or Tedlar wrap around fill.

D. Acoustic Elbows: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill, with Mylar or Tedlar wrap around fill.

2.11 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

   1. Manufacturers:
      a. American Warming and Ventilating.
      b. Ductmate Industries, Inc.
      c. Flexmaster U.S.A., Inc.
      d. Greenheck.
      f. Nailor Industries Inc.

   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

   3. Provide number of hinges and locks as follows:
      a. Less Than 12 Inches Square: Secure with two sash locks.
      b. Up to 18 Inches Square: Two hinges and two sash locks.
      c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
      d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

   1. Manufacturers:
      a. Ductmate Industries, Inc.
      b. Flexmaster U.S.A., Inc.

   2. Frame: Galvanized sheet steel, with spin-in notched frame.
D. Pressure Relief Access Door: Single or double wall and duct mounting; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated, latches, and retaining chain.

1. Manufacturers:
   a. American Warming and Ventilating.
   b. Ductmate Industries, Inc.
   c. Greenheck.
   d. KEES, Inc.
   f. Nexus PDQ.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

E. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

F. Insulation: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.12 FLEXIBLE CONNECTORS

A. Manufacturers:

   1. Ductmate Industries, Inc.
   2. Duro Dyne Corp.
   3. Ventfabrics, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with NFPA 90A & 90B.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Select metal compatible with ducts.


   1. Minimum Weight: 26 oz./sq. yd.
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

   1. Minimum Weight: 24 oz./sq. yd.
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.


   1. Minimum Weight: 16 oz./sq. yd.
   2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F.
   1. Minimum Weight: 14 oz./sq. yd.
   2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F.

2.13 FLEXIBLE DUCTS

A. Manufacturers:
   1. Flexmaster U.S.A., Inc.
   3. Thermaflex.
   4. Wiremold.

B. Noninsulated Flexible Ducts: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
   1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
   3. Temperature Range: Minus 20 to plus 175 deg F.

C. Insulated Flexible Ducts: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation with a minimum value of R-6; polyethylene or aluminized vapor barrier film.
   1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
   3. Temperature Range: Minus 20 to plus 175 deg F.

D. Metal Lined Insulated Flexible Ducts: UL 181, Class 1, Triple locked aluminum inner core; fibrous glass insulation with a minimum value of R-6.
   1. Pressure Rating: 6-inch wg (1500 Pa) positive and 2-inch wg (500 Pa) negative.
   3. Temperature Range: Minus 20 to plus 250 deg F

   Insulated Fabric Ducts: UL 181, Class 1, with Chlorinated Polyethylene (CPE) inner core supported by helical wound galvanized steel; fibrous-glass insulation with a minimum R-6 value.
   4. Pressure Rating: 6-inch wg (1500 Pa) positive and 2-inch wg (500 Pa) negative.
   6. Temperature Range: Minus 20 to plus 250 deg F

D. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap, in sizes 3 through 18 inches to suit duct size.

2.14 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.
PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.

B. Where damper actuators are located in the air stream, increase duct free area to maintain design intent.

C. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

D. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

E. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

F. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

G. Install duct test holes where indicated and required for testing and balancing purposes.

H. Install remote dampers a minimum of 5 feet, or two duct diameters, whichever is greater, before air device.

I. Remote dampers shall include controller box as approved by architect.

J. Provide test holes at fan inlets and outlets and elsewhere as indicated.

K. Install fire and smoke dampers, with reset operators or fusible links, according to manufacturer's UL-approved written instructions.

L. Install duct silencers rigidly to ducts.

M. Install duct heaters square to duct and perpendicular to air travel. Provide disconnecting means at heater.

N. Connect duct discharge temperature sensor downstream of duct heater.

O. Connect controlling thermostat or control cable to duct heater.

P. Install turning vanes in all square elbows, except for combustion air, dryer vent, and grease duct services, unless otherwise indicated.

Q. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

R. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

S. Connect terminal units to supply ducts.
T. Connect diffusers or light troffer boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

U. Do not use flexible ducts to change directions.

V. Connect flexible ducts to metal ducts with draw bands.

W. Flexible duct may only be installed above hard ceilings with direct access to all both ends of the flexible duct runs. Flexible duct shall not be installed more than 24” inside a hard ceiling edge or transition.

3.2 END SWITCH APPLICATIONS

A. Install an end switches for each damper:
   1. Motorized control damper.

B. Connect each motorized control damper to the FMS.

C. Connect each fire and fire/smoke damper to the fire alarm system.

3.3 FIRE AND FIRE/SMOKE DAMPER APPLICATIONS

1. Unless otherwise indicated, provide dampers according to the following criteria:
   a. Type-A dampers
      1) Pressure: up to 2 inches wg.
      2) Velocity: up to 1500 ft/min.
      3) Duct dimensions: greater than 14 inches, square.
   b. Type-B dampers
      1) Pressure: up to 8 inches wg.
      2) Velocity: up to 3500 ft/min
   c. Type-C dampers
      1) Pressure: greater than 8 inches wg.
      2) Velocity: greater than 3500 ft/min.

2. Where dampers are required at sidewall grilles, damper shall be Frame Style G for flush installation of air device.

3. Damper sleeves may be omitted where not required by the manufacturer’s listed assembly, code, or these documents.

3.4 DUCT ACCESS DOOR APPLICATIONS

A. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
   1. On both sides of duct coils.
2. Downstream from volume dampers, motorized dampers, and equipment.
3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
5. On sides of ducts where adequate clearance is available.

B. Install the following sizes for duct-mounting, rectangular access doors:
   1. One-Hand or Inspection Access: 8 by 8 inches.
   3. Head and Hand Access: 18 by 18 inches.

C. Install the following sizes for duct-mounting, round access doors:
   1. One-Hand or Inspection Access: 8 inches in diameter.
   3. Head and Hand Access: 12 inches in diameter.

D. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.5 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION
SECTION 233400
HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Airfoil centrifugal fans.
2. Backward-inclined centrifugal fans.
3. Centrifugal roof ventilators.
4. Forward-curved centrifugal fans.
5. In-line centrifugal fans.
7. Propeller fans.

B. Related Sections include the following:

1. Division 03 Sections "Cast-in-Place Concrete" and "Miscellaneous Cast-in-Place Concrete".
2. Division 07 Section "Roof Accessories" for roof curbs, equipment supports, and roof penetrations.
3. Division 23 Section "Air Duct Accessories" for flexible connectors, dampers, etc. are specified in.
4. Division 23 Section "Common Motor Requirements for HVAC" for fan motors.
5. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment".
6. Division 23 Section "Identification for HVAC Piping and Equipment" for fan label requirements.
7. Division 23 Section "Instrumentation and Controls for HVAC".
8. Division 23 Section "Variable Frequency Drives".
9. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan performance ratings on actual Project site elevations above sea level.

B. Operating Limits: Classify according to AMCA 99.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Fan schedule, by equipment mark, with capacity selections indicating required accessories.
2. Certified fan performance curves with system operating conditions indicated.
3. Certified fan sound-power ratings.
4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
5. Material thickness and finishes, including color charts.
6. Dampers, including housings, linkages, and operators.
7. Fan speed controllers, including, but not limited to, variable speed drives.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Short-circuit current rating of equipment assembly. Rating must match the rating of the overcurrent protective device serving the assembly.
3. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.4 SIMULTANEOUS ACTION SUBMITTALS

A. HVAC Fan Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Coordination Study.”

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Data to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.
E. Fans shall not exceed 85% of class rating at the selection point.

F. Sound-Power Level Ratings:
   1. Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data."
   2. Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans."
   3. Label fans with the AMCA-Certified Ratings Seal.
   4. Raw sound discharge for fans shall not exceed 95 dB in the 63, 125, and 250 Hz bands.

G. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final locations, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.9 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Belts: One set(s) for each belt-driven unit.

1.11 LABELS

A. All fans shall have a firmly affixed metal nameplate recording the design air capacity, static pressure, and brake horsepower.
PART 2 - PRODUCTS

2.1 AIRFOIL CENTRIFUGAL FANS

A. Manufacturers:

2. Chicago Blower Corporation.
4. Loren Cook Company.
5. New York Blower Company (The).
6. Twin City Fan & Blower.

B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

C. Housings: Formed panels to make curved-scroll housings with shaped cutoff, with doors or panels to allow access to internal parts and components.

1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Air-tight all welded housing construction.
3. Spun inlet cone with flange.
4. Outlet flange.

D. Airfoil Wheels:

1. Wheels shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19.
2. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange.
3. Heavy backplate.
4. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
5. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Bearings:

1. Bearing Types:
   c. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
2. Bearing Rating Life:
   a. Ball-Bearings: ABMA 9, L10 at 200,000.
   b. Roller-Bearings: ABMA 11, L10 at 200,000.

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.5.
   2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   3. Motor Pulleys:
      a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
      b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
   4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

H. Accessories:
   1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
   2. Cleanout Door: Quick-opening, latch-type gasketed door allowing access to fan scroll, of same material as housing.
   3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
   4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
   5. Inlet Screens: Grid screen of same material as housing.
   6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Manufacturers:
   2. Barry Blower Div.; Penn Ventilation Companies, Inc.
   3. Chicago Blower Corporation.
   5. Loren Cook Company.
   7. Twin City Fan & Blower.
B. **Description:** Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

C. **Housings:** Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
   1. **Panel Bracing:** Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   2. **Air-tight all welded housing construction.**
   3. **Spun inlet cone with flange.**
   4. **Outlet flange.**

D. **Backward-Inclined Wheels:**
   1. **Wheels shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19.**
   2. **Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange.**
   3. **Backplate.**
   4. **Backward-inclined blades welded or riveted to flange and backplate.**
   5. **Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.**

E. **Shafts:** Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   1. **Turned, ground, and polished hot-rolled steel with keyway.** Ship with a protective coating of lubricating oil.
   2. **Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.**

F. **Bearings:**
   1. **Bearing Types:**
      a. **Prelubricated and Sealed Shaft Bearings:** Self-aligning, pillow-block-type ball bearings.
      b. **Grease-Lubricated Shaft Bearings:** Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
      c. **Grease-Lubricated Shaft Bearings:** Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   2. **Bearing Rating Life:**
      a. **Ball-Bearings:** ABMA 9, L10 at 200,000.
      b. **Roller-Bearings:** ABMA 11, L10 at 200,000.

G. **Belt Drives:** Factory mounted, with final alignment and belt adjustment made after installation.
   1. **Service Factor Based on Fan Motor Size:** 1.5.
   2. **Fan Pulleys:** Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   3. **Motor Pulleys:**
      a. **For motors through 10 hp, use adjustable pitch.** Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.

4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

H. Accessories:

1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
2. Cleanout Door: Quick-opening, latch-type gasketed door allowing access to fan scroll, of same material as housing.
3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
5. Inlet Screens: Grid screen of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.3 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers:

2. Carnes Company HVAC.
3. FloAire.
5. Loren Cook Company.
6. Penn Ventilation.
7. Twin City Fan & Blower.

B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

D. Fan Wheels:

1. Wheels shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19.
2. Aluminum hub and wheel with backward-inclined blades.
E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
4. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

G. Roof Curbs:

1. Factory fabricated; galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
2. Configuration: Self-flashing without a cant strip, with mounting flange.
3. Overall Height: Coordinate curb height with roofing system for minimum clearances above finished roof deck as follows:
   a. Supply intake: 36 inches.
   b. General exhaust discharge: 12 inches.
5. Metal Liner: Galvanized steel.
6. Mounting Pedestal: Galvanized steel with removable access panel.

2.4 FORWARD-CURVED CENTRIFUGAL FANS

A. Manufacturers:

2. Chicago Blower Corporation.
4. Loren Cook Company.
5. New York Blower Company (The).
6. Twin City Fan & Blower.

B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

C. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.

1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Air-tight all welded housing construction.
3. Spun inlet cone with flange.
4. Outlet flange.

D. Forward-Curved Wheels:
1. Wheels shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19.
2. Baked-enamel or galvanized steel construction with inlet flange.
4. Shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and backplate.
5. Cast-steel hub swaged to backplate and fastened to shaft with set screws.

E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Bearings:
1. Bearing Types:
   c. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
2. Bearing Rating Life:
   a. Ball-Bearings: ABMA 9, L10 at 200,000.
   b. Roller-Bearings: ABMA 11, L10 at 200,000.

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
1. Service Factor Based on Fan Motor Size: 1.5.
2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
3. Motor Pulleys:
   a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

H. Accessories:
1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
2. Cleanout Door: Quick-opening, latch-type gasketed door allowing access to fan scroll, of same material as housing.
3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
5. Inlet Screens: Grid screen of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.5 IN-LINE CENTRIFUGAL FANS

A. Manufacturers:
   2. Carnes Company HVAC.
   4. Loren Cook Company.
   5. Penn Ventilation.
   6. Twin City Fan & Blower.

B. Description: In-line, direct-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

E. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

F. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

G. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
   3. Companion Flanges: For inlet and outlet duct connections.
   4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
   5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
2.6 MIXED-FLOW FANS

A. Manufacturers:
   1. Loren Cook Company.
   2. Greenheck.
   3. Twin City Fan & Blower.

B. Description: Fan wheel and housing, straightening vane section, factory-mounted motor with belt drive, and accessories.

C. Housings: Galvanized steel.
   1. Inlet and Outlet Connections: Outer mounting frame and companion flanges.
   2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
   3. Mixed-Flow Outlet Connection: One flanged discharge(s) perpendicular to fan inlet.

D. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.

E. Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.5.
   2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
   3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
   4. Motor Pulleys:
      a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
      b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
   5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   7. Shaft Bearings: Radial, self-aligning ball or roller bearings.
      a. Ball-Bearing Rating Life: ABMA 9, L10 at 200,000.
      b. Roller-Bearing Rating Life: ABMA 11, L10 at 200,000.
      c. Extend lubrication lines to outside of casing and terminate with grease fittings.

F. Accessories:
   1. Mounting Clips: Clips welded to fan housing, of same material as housing.
   2. Inlet and Outlet Screens: Wire-mesh screen on fans not connected to ductwork of same material as housing.
   3. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
   4. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
   5. Outlet Cones: Round-to-round transition of same material as housing.
   6. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.

G. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
H. Factory Finishes:
   1. Sheet Metal Parts: Prime coat before final assembly.
   2. Exterior Surfaces: Baked-enamel finish coat after assembly.
   3. Retain coatings for special protection applications. Review manufacturer's data for specific trade names and literature.
      a. Apply to finished housings.
      b. Apply to fan wheels.

2.7 PROPELLER FANS

A. Manufacturers:
   2. Carnes Company HVAC.
   3. Chicago Blower Corporation.
   5. Loren Cook Company.
   7. Penn Ventilation.
   8. Twin City Fan & Blower.

B. Description: Direct- or belt-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.

C. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

D. Fan Wheels:
   1. Steel: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
   2. Aluminum: Replaceable, cast or extruded, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.4.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
      a. Ball-Bearing Rating Life: ABMA 9, L10 at 200,000.
   4. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
   5. Motor Pulleys:
      a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
      b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
   6. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

F. Accessories:
1. Motorized Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
3. Wall Sleeve: Galvanized steel to match fan and accessory size.
4. Weathershield Hood: Galvanized steel to match fan and accessory size.
5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2.8 UTILITY SET FANS

A. Manufacturers:
2. Greenheck.
3. Loren Cook Company.
5. Penn Ventilation.
6. Twin City Fan & Blower.

B. Description: Direct or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

C. Housing: Fabricated of steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
1. Housing Discharge Arrangement: Adjustable to eight standard positions.

D. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
1. Blade Materials: Steel or Aluminum.
2. Blade Type: Backward inclined, forward curved, airfoil.
3. Spark-Resistant Construction: AMCA 99, Type B.

E. Fan Shaft:
1. Turned, ground, and polished steel; keyed to wheel hub.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9 L10 at 200,000.

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
1. Service Factor Based on Fan Motor Size: 1.5.
2. Motor Pulleys:
   a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

H. Accessories:
1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Access Door: Gasketed door in scroll with latch-type handles.
4. Inlet Screens: Removable wire mesh.
5. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.

I. Coatings: Powder-baked enamel.

**PART 3 - EXECUTION**

3.1 INSTALLATION
A. Install fans level and plumb.
B. Equipment shall be supported as described in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment ".
C. Secure roof mounted fans to roof curbs with cadmium-plated hardware.
D. Install units with clearances for service and maintenance.

3.2 CONNECTIONS
A. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified in duct systems.
B. Duct installation and connection requirements are specified in other Division 23Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
C. Install ducts adjacent to fans to allow service and maintenance.
D. For fans with scroll drains, install line-sized piping from drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.
E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
F. Connect wiring according to Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Replace fan and motor pulleys as required to achieve design airflow.
11. Shut unit down and reconnect automatic temperature-control operators.
12. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fans. Refer to Division 01 Section “Demonstration and Training.”

END OF SECTION
SECTION 233600
AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Dual-duct air terminal units.
   2. Fan-powered air terminal units.
   3. Shutoff single-duct air terminal units.
   4. Air valves.

B. Related Sections include the following:
   1. Division 23 Section "Hydronic Piping".
   2. Division 23 Section “General-Duty Valves for HVAC Piping” for valves and accessories for piping.
   3. Division 23 Section “Instrumentation and Control for HVAC”.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

B. LEED Submittals:
   1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - “Systems and Equipment.”
   2. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
   2. Wiring Diagrams: Power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Size and location of initial access modules for acoustic tile.
   3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data” include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section “Product Requirements.”

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.


D. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

E. Verification of Performance: Rate air terminal units according to ARI 880.

1.6 COORDINATION

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
1. Enviro-tec.
2. Kreuger.
3. METALAIRE, Inc.; Metal Industries Inc.
5. Phoenix Corporation.
7. Titus.
2.2 GENERAL

A. Provide factory mounted Andover controls package.

B. Terminal units shall not exceed NC 26 at 3” w.g. per AHRI 880.

C. Terminals with hydronic reheat shall implement two PID loops, one with the zone temperature as the input and the second one with the box DAT as input.

2.3 UNIT CONTROLS

A. Factory-Mounted and -Wired Controls: Electrical components including, differential pressure sensor and air flow sensing tubes, shall be mounted in NEMA 250, Type 1 control box with removable cover, mounted on side of unit and sealed from airflow. Incorporate single-point electrical connection to power source.

   1. Control Transformer: Factory mounted for 24 VAC control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source. Units with fans shall also require fan start/stop relay.

   2. Wiring Terminations: Fan and controls to terminal strip, and terminal lugs shall match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.

   3. Primary air Belimo damper actuator and Andover’s pressure independent primary air controller.

   4. Airflow sensing tubes:

      a. Sensing tubes of the multipoint, automatic averaging type shall be included in each unit inlet.

      b. Dual-duct units shall have airflow sensing tubes at the unit outlet.

      c. Airflow sensing tubes are to include ‘tees’ utilized as balancing taps for field adjustment of the maximum (and minimum) primary CFM, without having to remove tubes from controller.

      d. The balancing taps shall be used in conjunction with a flow chart on each terminal unit to permit readjustment of the primary air. Field readjustment shall be by means of adjustment screws.

   5. A schematic drawing shall be affixed to each box indicating proper hookups for electronic thermostats.

B. DDC Controls: Bidirectional damper operators and microprocessor-based controller and room sensor shall be compatible with temperature controls specified in Division 23 Section "Instrumentation and Control for HVAC" and shall have the following features:

   1. Damper Actuators: 24 V, powered open.

   2. Velocity Sensors: Multipoint array with velocity sensors in all air inlets and air outlet and integral to unit.

   3. Terminal Unit Controller: Pressure independent, variable-air or constant-volume controller with electronic airflow transducers factory calibrated to minimum and maximum air volumes, and having the following features:

      a. Proportional, plus integral control of room temperature.

      b. Time-proportional reheat-coil control.

      c. Occupied and unoccupied operating mode.

      d. Remote reset of airflow or temperature set points.
e. Adjusting and monitoring with portable terminal.
f. Communication with temperature-control system specified in Division 23Section
   "Instrumentation and Control for HVAC."

2.4 HEATING COILS

A. Hot-Water: Copper tube, mechanically expanded into aluminum-plate fins; leak tested
   underwater to 200 psig; and factory installed.
   1. Minimum two-row coils with tube thickness not less than 0.016”.
   2. Coil performance shall be based on ARI 410.

B. Where indicated, boxes shall be provided with a hot water heating coil and modulating control
   valve.

C. Heating coils shall be removable without removing the terminal unit.

2.5 SHUTOFF SINGLE-DUCT AIR TERMINAL UNITS

A. Configuration: Variable-volume damper assembly inside unit casing with control components
   located inside a protective metal shroud.

B. Casing: 0.034-inch steel.
   a. Casing Lining:
   b. Thermal insulation equivalent in performance to 1-inch-thick, coated, fibrous-glass
      duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with
      one of the following nonporous sheets:
         1) Foil.
         2) Tedlar.
   c. Adhesive attached, 3/4-inch-thick, polyurethane foam insulation.
   d. All linings and adhesives shall comply with the following standards:
      1) ASTM E 84 for Flame and Smoke, 25/50.
      2) ASTM C 665 for Fungi Resistance.
      3) UL 181 for Air Erosion and Mold Growth and Humidity.
      4) UL 723 for Flame and Smoke, 25/50.

   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to dampers and other parts requiring service,
      adjustment, or maintenance; with airtight gasket.

C. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades
   onto shaft with nylon-fitted pivot points located inside unit casing.
   1. Automatic Flow-Control Assembly: Combined spring rates shall be matched for each
      volume-regulator size with machined dashpot for stable operation.
   2. Factory-calibrated and field-adjustable assembly with shaft extension for connection to
      externally mounted control actuator.
D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

   1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 6-inch wg inlet static pressure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units level and plumb.

B. Maintain sufficient clearance for normal service and maintenance to all portions, including coil connections.

   1. Provide at least 24” clear in front of terminal unit control panel access.
   2. Provide at least NEC clearances in front of terminal unit disconnects.

3.2 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 air terminal units to allow service and maintenance.

C. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

D. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts".

E. Ground units with electric heating coils according to Division 26 Section "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

G. 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.

H. Install 24VAC transformer for all terminal unit controls.

I. Install discharge air temperature sensor at each terminal unit.

3.3 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 233713
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.
B. Related Sections include the following:
   1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
   2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
   3. Division 23 Section "Particulate Air Filtration" for HEPA media applied in HEPA filter grilles.

1.2 ACTION SUBMITTALS
A. Product Data: For each product indicated, include the following:
   1. Data Sheet: Indicate drawing designation, model number, size, materials of construction, finish, and mounting details; and performance data including throw and drop, accessories, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Kreuger.
B. MetalAire, Inc.; Metal Industries Inc.
C. Nailor.
D. Price Industries.
E. Titus.

2.2 CAPACITIES AND CHARACTERISTICS
A. Provide Grilles, Registers, and Diffusers with capacities and characteristics as indicated in the drawings.
B. Maximum NC shall be 25 at CFM indicated, including neck damper.

C. Coordinate frame style with drawings.

D. Finish: Baked enamel, color selected by Architect.

E. Ceiling mounted critical environment grilles, registers, and diffusers shall have an independent hanger or chain to structure.

F. Insulate the top of the following supply air diffusers directly under an exposed roof.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Deliver and store clean and shrink wrapped. Touch up any paint damage.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Install insulation blankets on the back-pan of all air devices directly under an exposed roof. Refer to Division 23 "HVAC Insulation".

E. At each ceiling and sidewall take-off from a duct, install an adjustable volume extractor with appropriate operator. Refer to Division 23 "Air Duct Accessories".
3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION
SECTION 234000
HVAC AIR CLEANING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

B. Related Sections include the following:
   1. Division 23 Section “Metal Ductwork” for duct materials and pressure classes.

C. References and Standards
   2. ANST/UL-900 - Test Performance of Air Filter Units.
   3. ANSI/UL 586 - Test Performance of High Efficiency Particulate, Air Filter Units.
   7. DOE-STD-3020-97, SPECIFICATION FOR HEPA FILTERS USED BY DOE CONTRACTORS, January 1997
   8. IEST-RP-CC001.3 - HEPA and ULPA Filters -, The Institute of Environmental Science and Technology, Rolling Meadows, IL.
   9. IEST-RP-CC034.1 - HEPA and ULPA Filter Leak Tests - The Institute of Environmental Science and Technology, Rolling Meadows, IL.
   12. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.2 DEFINITIONS

A. DOP: Dioctyl phthalate or bis-(2-ethylhexyl) phthalate.

B. HEPA: High-efficiency particulate air.

C. ULPA: Ultra low penetration air.

1.3 ACTION SUBMITTALS

A. Product Data: Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test
method; fire classification; furnished specialties; frame construction and materials; and accessories for each model indicated.

B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.
   1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
   2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

1.4 INFORMATIONAL SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

B. Manufacturer’s Letter:
   1. Manufacturer shall provide a letter of compliance along with cost proposal stating that the manufacturer complies with all requirements of specifications and drawings.
   2. For HEPA filter housing seals, manufacturer shall also provide written assurance that sealant is compatible with all decontamination materials including VHP.

C. When specified performance characteristics are not published in the manufacturer's literature, the submittal data shall include certified documentation of performance by an approved independent test laboratory.

D. For HEPA filter housings, all welding procedures, welders and welder operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX. All production welds shall be visually inspected per standard procedure per ANSI/AWS D9.1-1990, “Specifications for Welding Sheet Metal” and shall be recorded with a certified weld inspection and report.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated. Refer to Division 01 Section “Product Requirements.”

B. Comply with ARI 850.

C. Comply with ASHRAE 52.1 and ASHRAE 52.2 for method of testing and rating air-filter units.

D. Comply with NFPA 90A and NFPA 90B.

E. Manufacturer: All manufacturers shall specialize in the production of components specified herein for not less than three years documented experience and shall also issue a complete catalog with all data for the total product as described in “Submittals” above.
1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide one complete set of filters for each filter bank. If system includes prefilters, provide only prefilters.
2. Provide one complete set of filters for each section of each unit to be installed when the project is turned over to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Configuration: Fabricate with fan(s), coils, etc. plus accessories, including:

1. Filters.
2. Filter Housings and Frames.
3. Filter Gauges.

B. Fabrication: Conform to AMCA 99 and ARI 430.

C. All air filters shall be listed as Class 1 in accordance with Underwriters' Laboratories, Inc., Building Materials Director requirements, except ultrahigh efficiency filters (HEPA) shall be manufactured of materials that are so listed by UL.

2.2 FILTERS

A. Type "A": Permanent Washable.

1. Manufacturers:
   a. AAF International
   b. Camfil Type 44
   c. Air-Maza P-5

2. Description: Viscous coated, high velocity filters.
3. Frame: Cardboard.
4. Thickness: 2".
5. Initial Resistance: Initial clean resistance to air flow shall not exceed 0.10" w.g.
6. Maximum Face Velocity: The net velocity shall not exceed 500 FPM.
7. Installation: Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles.

B. Type "B": Sectional, Renewable Media.

1. Manufacturers:
   a. American Air Filter RENU
   b. Camfil D/C 22

2. Description: Adhesive coated glass fiber media pads enclosed in sectional frames.
3. Frame: 16 gauge galvanized steel with mechanism for changing filter media.
4. Thickness: 2”.
5. Initial Resistance: Initial clean resistance to air flow shall not exceed 0.10” w.g.
6. Maximum Face Velocity: The net velocity shall not exceed 350 FPM.
7. Installation: Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles.

C. Type "C": Replaceable, Dry.

1. Manufacturers:
   a. Camfill 30/30.
   b. American Air Filter.
   c. Air Guard.
   d. Flanders.
2. Description: Pleated, disposable, nonwoven, lofted cotton media. The media shall be cemented to the inside of the frame to prevent air bypass.
3. Frame: Galvanized steel frame with 96% free support grid and contour stabilizers. The support grid and frame shall be continuously bonded to the leaving air face of the media.
4. Performance: MERV 8 (30%).
5. Thickness: 2”.
6. Initial Resistance: Initial clean resistance to air flow shall not exceed 0.30” w.g.
7. Maximum Face Velocity: The net velocity shall not exceed 500 FPM.
8. Installation: Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles.
9. Capacity: a 24” x 24” size shall be certified for a dust holding capacity of not less than 200 grams of ASHRAE Test Dust at 500 FPM and a final resistance of 1.0” w.g.

D. Type "D": Replaceable, Dry.

1. Manufacturers:
   a. AmAir 1100.
   b. Flanders 62RM11.
   c. Camfill AP Eleven.
2. Description: High density, microfine glass fiber media laminated to a nonwoven synthetic backing. The media shall be cemented to the inside of the frame to prevent air bypass.
3. Frame: Galvanized beverage board frame with 96% free support grid and contour stabilizers. The support grid and frame shall be continuously bonded to the leaving air face of the media.
4. Performance: MERV 11 (65%).
5. Thickness: 4” – 12”.
6. Initial Resistance: Initial clean resistance to air flow shall not exceed 0.35” w.g.
7. Maximum Face Velocity: The net velocity shall not exceed 500 FPM.
8. Installation: Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles.
9. Capacity: a 24” x 24” x 12” size shall be certified for the dust holding capacity above to a final resistance of 1.0” w.g.

E. Type "E": Replaceable, Dry.

1. Manufacturers:
a. Camfill Aeropac or N/S Model III.
b. American Air Filter.
c. Flanders.

2. Description: High density, microfine glass fiber media laminated to a nonwoven synthetic backing. The media shall be cemented to the inside of the frame to prevent air bypass.

3. Frame: Galvanized beverage board frame with 96% free support grid and contour stabilizers. The support grid and frame shall be continuously bonded to the leaving air face of the media.

4. Performance: MERV 14 (90%).

5. Thickness: 12”.

6. Initial Resistance: Initial clean resistance to air flow shall not exceed 1.0” w.g.

7. Maximum Face Velocity: The net velocity shall not exceed 500 FPM.

8. Installation: Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles.

9. Capacity: a 24” x 24” x 12” size shall be certified for the dust holding capacity above to a final resistance of 1.75” w.g.

2.3 FILTER HOUSINGS AND FRAMES

A. Side Access Housings

1. All housings shall:
   a. Be fabricated of not less than an all welded 16 gauge galvanized steel and be equipped with standing flanges and hinged access doors at both ends.
   b. Receive filters of any manufacturer without alteration to filter, including 2” deep panel type prefilters, or housing.
   c. Incorporate a permanent provision for sealing the filters against leakage around the entire perimeter of each filter, eliminating the need to purchase replacement filters with factory applied gasket strips. Replaceable woven pile seals shall be an integral component of the downstream flange of each extrusion so that the seals are compressed by the pressure drop across the filters, preventing bypass of unfiltered air.
   d. Not exceed 36 inches in direction of air flow.
   e. Be constructed and rated for use at listed air handling unit static pressures.

2. Doors are to be fitted with positive sealing, heavy duty multiple latches and with sponge neoprene gaskets.

3. Provide housings with static pressure taps.

B. Face Access Housings

1. All housings shall:
   a. Be fabricated of not less than 16 gauge galvanized steel with holes prepunched for convenient assembly into banks.
   b. Be a minimum of 2-5/8” deep for maximum structural strength and resistance to racking.
   c. Be fitted with polyurethane foam gaskets, held in place by long lasting adhesive, and with a minimum of four heavy duty spring type fasteners.

2. Fasteners shall attach to the frames without requiring tools and shall be capable of withstanding 25 pounds of pressure without deflection.
3. All joints in the field assembled banks of frames shall be thoroughly caulked to prevent bypass of unfiltered air between frames and surrounding ductwork or plenum chambers.

2.4 FILTER GAUGES

A. Manufacturers:

1. Airguard Industries, Inc.
2. Dwyer Instruments, Inc.

B. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Diameter: 4-1/2 inches.
2. Range: The range of the scale shall start at 0 and end no greater than 1" w.g. (250 Pa) above the filter manufacturer’s recommended final resistance for the type of filter to which the gauge is being applied.

C. Accessories: Each gauge shall be provided with an adjustable signal flag, two static pressure tips with compression fittings, two three-way vent valves with compression fittings, two lengths of aluminum tubing, and a mounting plate with screws.

D. For HEPA filter banks, the following shall also apply:

1. Factory mounted photohelic gauge by Dwyer, 3003 SGT or engineer approved equal.
2. Gauge shall have zero adjustment capability.
3. In lieu of aluminum, provide stainless steel tubing, fittings, mounting brackets, identification labels.
4. Identification labels shall be stitch welded to mounting bracket.
5. Each gauge assembly shall be complete with stainless steel inline HEPA filters, tee fitting, gauge decontamination port, and 2-way stainless steel plug valves.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install filter frames according to manufacturer’s written instructions.

B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

C. Install filters in position to prevent passage of unfiltered air.

D. Install filter gauge for each filter bank.

E. An integral transmitter shall read differential pressure across each filter bank and report to the FMS.

F. Install filter gauge static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.
G. Coordinate filter installations with duct and air-handling unit installations.

H. Electrical wiring and connections are specified in Division 26 Sections.

I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

J. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

3.2 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components, filter and filter-frame installation, and electrical wiring, and to assist in field testing. Report results in writing.

B. HEPA Filters:

1. All HEPA filter housing requires that the filters can be quantitatively leak tested.
2. The injection port and sampling ports shall be of sufficient size for insertion of the output line from the aerosol generator or photometer probe used by the owner or its authorized testing agency.
3. Total leak test or efficiency test and scan leak tests shall be performed.
4. The scan test apparatus must be qualified to be capable of traversing the entire filter sealing gasket and the perimeter of the filter support/duct housing structure in addition to the filter. Each test system is qualified only once prior to conducting periodic leak tests. The total leak test is prescribed in ASME N510-1989, Section 10, and the scan leak test is prescribed in IEST-RP-CC034.1.
5. Access to Inject Challenge Aerosol: Access is required to permit the injection of challenge aerosol upstream of the filter. The aerosol can be injected at a device served by the filter system or via a port installed in the ductwork upstream of the features that accomplish the tasks listed in the following Sections.
6. Mixing Devices Upstream of the Filter: The challenge aerosol should be mixed thoroughly using installed devices that are designed to induce turbulence, or by adding a device to create mixing by inducing turbulence, such as a Stairmand disk.
7. Qualification to Ensure Uniform Downstream Concentration for Total Leak Test: Thorough mixing is required for any leaking aerosol downstream from the filter. Turbulence shall be induced using engineered system in the downstream airflow that produces mixing. An engineered turbulence induction and sampling manifold system which collects samples at multiple points downstream of all portions of the filter after mixing for concurrent measurement of the average concentration is allowed.
8. Scan Test to Measure All Leaks:

a. Scanning one inch from the downstream ("clean") face of the filter is allowed provided that an engineered system shall be installed in the filter system at the time the system is built.
b. The scan test apparatus must be qualified by demonstrating it can measure leaks along the entire filter sealing gasket and the perimeter of the filter support/duct housing structure as well as leaks in the filter itself.
c. The scanning system shall consists one or more funnel shaped collectors attached to an apparatus that can traverse over the duct section at one inch from the face of the HEPA filter in an overlapping fashion as prescribed in IEST-RPCC034.1. 6.0 Acceptance Criteria for In-Place Leakage Tests.
d. The scan leak test measuring instrument shall be discrete particle measuring type with the ability to record and integrate individual leak test.

e. Engineer and Owner shall review and approve any proposed alternative.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION
SECTION 235100
BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes the following:
   1. Listed double-wall vents.
B. Related Sections include the following:
   1. Division 23 Section "HVAC Fans" for induced-draft and mechanical fans and for motorized and barometric dampers.
   2. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 ACTION SUBMITTALS
A. Product Data: For the following:
   1. Type B and BW vents.
   2. Type L vents.
   3. Special gas vents.
   5. Guy wires and connectors.
B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
   2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS
A. Welding certificates.
B. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE
A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.5 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."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. American Metal Products; MASCO Corporation.
2. Ampco.
3. Hart & Cooley, Inc.
4. Metal-Fab, Inc.
5. Selkirk Inc.; Selkirk Metalbestos and Air Mate.

2.2 LISTED TYPE B AND BW VENTS

A. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F continuously for Type B, or 550 deg F continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.

B. Construction: Inner shell and outer jacket separated by at least a 1/4-inch airspace.

C. Inner Shell: ASTM B 209, Type 3105 aluminum.

2.3 LISTED TYPE L VENTS

A. Description: Double-wall metal vents tested according to UL 641 and rated for 570 deg F continuously, or 1700 deg F for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.

B. Construction: Inner shell and outer jacket separated by at least a 2-inch airspace filled with high-temperature, ceramic-fiber or mineral-wool insulation.

C. Inner Shell: ASTM A 666, Type 304 stainless steel.

D. Outer Jacket: Stainless steel.

E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Stack cap designed to exclude 90 percent of rainfall.

2.4 LISTED SPECIAL GAS VENTS

A. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211.

B. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.

C. Inner Shell: ASTM A 959, Type 29-4C stainless steel.

D. Outer Jacket: Stainless steel.

2.5 LISTED BUILDING-HEATING-APPLIANCE FLUES AND CHIMNEYS

A. Description: Double-wall metal vents tested according to UL 103 and UL 959 and rated for 1400 deg F continuously, or 1800 deg F for 10 minutes; with positive or negative flue pressure complying with NFPA 211.

B. Construction: Inner shell and outer jacket separated by at least a 2-inch annular space filled with high-temperature, ceramic-fiber insulation.

C. Inner Shell: ASTM A 666, Type 304 stainless steel.

2.6 ACCESSORIES

A. General: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

B. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Listed Type B and BW Vents: Vents for certified gas appliances.

B. Listed Type L Vent: Vents for low-heat appliances.

C. Listed Special Gas Vent: Condensing gas appliances.

D. Listed Building-Heating-Appliance Flues and Chimneys:

1. Engine generators: from muffler discharge to final point of exhaust termination

E. Schedule 40 Steel Pipe:

1. Engine generators

   a. From muffler discharge to final point of exhaust termination.
   b. From engine generator to muffler.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
B. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

E. For condensing appliances, lap joints in direction of condensate flow.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION
SECTION 235216
CONDENSING BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, condensing boilers, trim, and accessories for generating hot water.

1.2 ACTION SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.

2. Wiring Diagrams: Power, signal, and control wiring.


1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control test reports.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

E. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
1.4 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For boilers to include in emergency, operation, and
      maintenance manuals.

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. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure
      Vessel Code.
   C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas
      and Oil Fired Boilers - Minimum Efficiency Requirements."
   D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N,
      "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
   E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating
      Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities
      having jurisdiction.

1.6 COORDINATION
   A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete,
      reinforcement, and formwork requirements are specified in Division 03.

1.7 WARRANTY
   A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or
      replace components of boilers that fail in materials or workmanship within specified warranty
      period.
      1. Warranty Period for Pulse-Combustion Boilers:
         a. Leakage and Materials: 10 years from date of Substantial Completion.
         b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for five
            years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers:
      2. Fulton Boiler Works, Inc.
      3. Lochinvar Corporation.
2.2 MANUFACTURED UNITS

A. Description: Factory-fabricated, -assembled, and -tested, condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

B. Heat Exchanger:
   1. Type 316L, stainless-steel primary and secondary combustion chamber.
   2. Finned-copper primary and stainless-steel secondary heat exchangers.

C. Pressure Vessel: Carbon steel with welded heads and tube connections.

D. Burner: Natural gas, self-aspirating and self-venting after initial start.

E. Blower: Centrifugal fan to operate during each burner firing sequence. Blower shall also prepurge and postpurge the combustion chamber as required by design.
   1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
      a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

G. Ignition: Spark or carbide hot surface source with 100 percent main-valve shutoff with electronic flame supervision.

H. Casing:
   1. Jacket: Sheet metal, with snap-in or interlocking closures.
   2. Control Compartment Enclosure: NEMA 250, Type 1A.
   3. Finish: Baked-enamel or powder-coated protective finish.
   4. Insulation: Minimum 2-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
   5. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
   6. Mounting base to secure boiler to concrete base.
      a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

I. Circulator Pump: Manufacturer provided circulation pump with cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.

J. Condensate Trap: Cast-iron body with stainless-steel internal parts.
2.3 TRIM

Hot Water

1. Include devices sized to comply with ANSI B31.9, "Building Services Piping."
2. Aquastat Controllers: Operating, firing rate, and high limit.
4. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
7. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.4 CONTROLS

A. Refer to Division 23 Section "Instrumentation and Control for HVAC."

B. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Operating Pressure Control: Factory wired and mounted to cycle burner.
4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant water temperature. Maintain set point plus or minus 2 percent.

a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

b. Include manufacturer’s firing sequence for selection of multiple boilers.

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

D. Facility Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.

1. Hardwired Points:

b. Control: On/off operation, hot water supply temperature set-point adjustment.

2. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation.

2.5 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 1 for indoor enclosures.
2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to fused disconnect switch.
5. Provide branch power circuit to each motor and to controls with a circuit breaker.
6. Provide each motor with overcurrent protection.

C. Ratings

1. Short-Circuit Current: Match rating of overcurrent protective device serving motor controllers.

2.6 VENTING KITS

A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.7 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Install boilers level on 6" tall concrete base. Concrete materials and installation requirements are specified in Division 03.

B. Vibration Isolation: Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install gas-fired boilers according to NFPA 54.

D. Assemble and install boiler trim.

E. Install electrical devices furnished with boiler but not specified to be factory mounted.

F. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results for HVAC."

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.
H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.

I. Boiler Venting:
   1. Install flue venting kit and combustion-air intake.
   2. Connect full size to boiler connections. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks."

J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform installation and startup checks according to manufacturer's written instructions.
   2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
      b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: Provide on-site assistance in adjusting system to suit actual occupied conditions for 12 months of Substantial Completion.

E. Performance Tests:
   1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
   2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
   3. Perform field performance tests to determine capacity and efficiency of boilers.
      a. Test for full capacity.
      b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
   4. Repeat tests until results comply with requirements indicated.
   5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Video training sessions. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 235700

HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes shell-and-tube and plate heat exchangers.

B. Related sections include the following:
   1. Division 23 Section “General-Duty Valves for HVAC Piping” for valves and accessories for piping.
   2. Division 23 Section “HVAC Insulation”.
   3. Division 23 Section “Hydronic Piping”.
   4. Division 23 Section ”Instrumentation and Controls for HVAC”.
   5. Division 23 Section “Steam and Condensate Heating Piping”.

1.2 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

   1. Design Calculations: Calculate requirements for selecting seismic restraints and for designing bases.
   2. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room, 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. Tube-removal space.
   2. Structural members to which heat exchangers will be attached.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.
1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of heat exchangers and are based on the specific equipment indicated. Refer to Division 01 Section “Product Requirements.”

B. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, “Pressure Vessels,” Division 1.

C. Registration: Fabricate and label shell-and-tube heat exchangers to comply with the Tubular Exchanger Manufacturers Association’s standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Alfa Laval Thermal, Inc.
B. Armstrong Pumps, Inc.
C. ITT Industries; Bell & Gossett.
D. Mueller, Paul Company.
E. Taco, Inc.

2.2 GASKETED PLATE HEAT EXCHANGERS

A. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets. Provide heat exchanger rated for domestic water service and compliant with NSF 61.

B. Frame:
   1. Capacity to accommodate 50 percent additional plates.
   2. Painted carbon steel with provisions for anchoring to support.
   3. Frame shall allow up to 15% thermal expansion with no loss of performance.

C. End-Plate Material: Painted carbon steel.
D. Tie Rods and Nuts: Steel or stainless steel.
E. Plate Material: 0.024 inch thick before stamping; Type 304 stainless steel.
F. Gasket Material: Nitrile rubber or EPDM.
G. Piping Connections:
   1. End plate with welded carbon-steel nozzles. Threaded pipe connection for NPS 2 and smaller; carbon-steel flanged pipe connection for larger sizes.

H. Enclose plates in a solid aluminum or stainless-steel removable shroud.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HEAT-EXCHANGER INSTALLATION

A. Install shell-and-tube heat exchangers on saddle supports.

B. Install plate-and-frame heat exchangers on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.

C. Install shutoff valves at heat-exchanger inlet and outlet connections.

D. Install relief valves on heat-exchanger heated-fluid connection and install pipe from relief valves, full size of valve connection, to floor drain.

E. Install vacuum breaker at heat-exchanger steam inlet connection.

F. Install hose end valve to drain shell.

3.4 FIELD QUALITY CONTROL

A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers. Refer to Division 01 Section "Demonstration and Training."
SECTION 237313
MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes constant and variable volume, modular air-handling units with coils for indoor installations.

B. Related Sections include the following:
1. Division 23 Section “Hydronic Pumps” for in-pan condensate pumps.
2. Division 23 Section “Humidifiers” for steam grid and evaporative humidifiers not an integral part of modular indoor air-handling units specified in this Section.
3. Division 23 Section “Hydronic Piping” for accessories and piping requirements at hydronic coils integral to units.
4. Division 23 Section, “Instrumentation and Control for HVAC” for type, arrangement, and sequences for modular AHUs.
5. Division 23 Section “HVAC Air Filtration” for filter performances.
6. Division 23 Section “Steam and Condensate Piping” for accessories and piping requirements at steam coils to units.
7. Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment” for seismic and wind restraint requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of modular indoor air-handling unit indicated. Include the following:
1. Certified fan-performance curves with system operating conditions indicated.
2. Certified fan-sound power ratings.
3. Certified coil-performance ratings with system operating conditions indicated.
4. Motor ratings, electrical characteristics, and motor and fan accessories.
5. Material gages and finishes.
6. Filters with performance characteristics.
7. Dampers, including housings, linkages, and operators.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.
1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
4. Short-circuit current rating of equipment assembly.
1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each unit to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain modular indoor air-handling units through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of modular indoor air-handling units and are based on the specific system indicated. Refer to Division 01 Section “Product Requirements.”

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. NFPA Compliance: Modular indoor air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

E. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

F. ARI Certification: Modular indoor air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

G. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of structural-steel support members.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than [five] <Insert number> years from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than [five] \(<insert\ number>\) years from date of Substantial Completion.

3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than [three] \(<insert\ number>\) years from date of Substantial Completion.

4. Warranty Period for Control Boards: Manufacturer's standard, but not less than [three] \(<insert\ number>\) years from date of Substantial Completion.

5. In conjunction with and supporting Factory warranty OEM shall furnish complete factory authorized service and maintenance of equipment for \(<insert\ number>\) year from Date of Substantial Completion by factory trained technicians.

6. OEM shall provide quarterly, annual, and bi-annual maintenance in compliance with or exceeding ASHRAE Standard 180-2008.

7. [Complete Warranty: Provide one a [five] year warranty to include both parts and labor. Warranty shall cover the entire unit and factory accessories, including the following:

   1. Coils
   2. Dampers and damper actuators
   3. Fans
   4. Motors
   5. Motor starters
   6. VFDs
   7. Heat exchangers
   8. Control panel]

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Filters: A minimum of one set for each modular indoor air-handling unit.
   2. Fan Belts: [One] \(<insert\ number>\) set[s] for each modular indoor air-handling unit fan.
   3. Gaskets: [One] \(<insert\ number>\) set[s] for each access door.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. JCI / YORK, a Johnson Controls company. Basis of Design.

B. Temtrol.

2.2 MANUFACTURED UNITS

A. Modular indoor air-handling units shall be factory assembled and consist of fans, motor and drive assembly, coils, damper, plenums, filters, condensate pans, mixing dampers, control devices, and other accessories, sections, or components as shown in the Contract Documents.

B. Provide protection for all openings and components during equipment transport. Externally mounted components shall be protected during all phases of transport from exposure, including moisture and ambient temperatures outside of any component’s operating range. Externally
mounted components include, but are not limited to, VFD’s, actuators, sensors, and weather hoods.

2.3 CABINET

A. Unit leakage not to exceed 1% of design CFM at 8” maximum w.g. operation. Leakage to be calculated by totaling all leakage either into or out of the unit.

B. Materials: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
   1. Outside Casing: Galvanized steel, 0.0635 inch thick.
   2. Inside Casing: Galvanized steel, 0.0276 inch thick.
   3. Floor Plate: Galvanized steel, 0.1382 inch thick.

C. Cabinet Insulation: Comply with NFPA 90A or NFPA 90B.
   1. Materials: ASTM C 1071 with coated surface exposed to airstream to prevent erosion of glass fibers.
   2. Thermal performance: units shall have a minimum effective insulating value of R-12.
   3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.
   4. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916.
   5. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
   6. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from and including the cooling coil section.
   7. Location and Application: Encased between outside and inside casing.

D. Access Panels and Doors: Same materials and finishes as cabinet, complete with hinges, latches, handles, and gaskets. Inspection and access panels and doors shall be sized and located to allow periodic maintenance and inspections. Provide access panels and doors in the following locations:
   1. Fan Section: Inspection and access doors.
   2. Access Section: Doors.
   3. Coil Section: Inspection panel.
   4. Damper Section: Inspection and access doors.
   5. Filter Section: Inspection and access doors to allow periodic removal and installation of filters.

E. Condensate Drain Pans: Formed sections of stainless-steel sheet complying with requirements in ASHRAE 62 for all cooling coils. Fabricate pans with slopes in two planes to collect condensate from coils (including coil piping connections and return bends) and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
   1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
   2. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil. Drain intermediate pan to main pan via copper downspout.
F. Condensate Pump: Fractional horsepower, non-ferrous impeller, close or direct coupled pump for installation in drain pan complete with floats or sensors to detect water level and cycle pump accordingly. Each drain pan shall have a minimum of one pump, unless otherwise indicated.

G. Unit Paint

1. External surfaces of unit casings shall be prepared and painted resulting in a minimum 1.5 mil thick coating when dry.
2. Paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 500 consecutive hours.
3. Paint shall be AHU Manufacturer’s standard color, unless otherwise indicated.
4. For units requiring a color other than the AHU Manufacturer’s standard color, the Architect shall provide a quantity of four 2” x 2” paint samples to the AHU Manufacturer at the time of submittal approval.

2.4 FAN SECTION

A. Fan-Section Construction: Belt or direct-drive fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan with vibration isolation.

B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to make curved scroll housings with shaped cutoff, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.

1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Performance Class: AMCA 99-2408, Class II or III.
3. Horizontal Flanged Split Housing: Bolted construction.

C. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

D. Backward-Inclined Fan Wheels: Steel construction with curved inlet flange, backplate, and backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Forward-Curved Fan Wheels: Black-enamel or galvanized-steel construction with inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

F. Airfoil-Fan Wheels: Steel construction with smooth-curved inlet flange, heavy backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

G. Coatings: Hot-dip galvanized.

H. Shafts: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

I. Bearings:

1. Bearing Types:
   c. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

2. Bearing Rating Life:
   a. Ball-Bearings: ABMA 9, L10 at 200,000.
   b. Roller-Bearings: ABMA 11, L10 at 200,000.

J. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.5.
2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
3. Motor Pulleys:
   a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

K. Vibration Control: Install fans on open-spring vibration isolators having a minimum of 1-inch static deflection and side snubbers.

L. Fan-Section Source Quality Control:

2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
3. Fans integral to units shall not exceed 85% of class rating at the selection point.

M. Fan Arrays: For fan sections where 2 or more fans serve a single air stream or unit section, each individual fan shall comply with all parts of this section and the following.
1. Each fan shall be independently driven.
2. All fans shall be factory wired to a single enclosure.
3. For VAV services, the factory supplied enclosure shall:
   a. Include two VFD’s, each sized for 50% of the array for controlling and monitoring fan speed.
   b. Fans shall either modulate speed, or stage individual fans on/off to achieve balanced airflow through the fan array and meet scheduled performance.
   c. Provide contacts in a common terminal strip to monitor all fans. Fan status shall be indicated by an LED in the controls enclosure. A common alarm shall signal the FMS when any fan fails.
4. In the event of the failure of any single fan the remaining fans shall be able to supply to design CFM and ESP as scheduled.
5. Provide motorized or manual damper to isolate each individual fan from array upon fan or motor failure. Isolation damper shall prevent bypass air through the fan array.

2.5 MOTORS

A. General: Comply with requirements in Division 23 Section “Common Motor Requirements for HVAC Equipment.”
B. Noise Rating: Quiet.
C. Provide grounding ring on motor shaft.
D. Provide VFDs for all fan motors.

2.6 COILS

A. Coil Sections: Common or individual, insulated. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
B. Hydronic Coils: Cleanable coil fabricated according to ARI 410.
   1. Piping Connections: Threaded, on same end.
   2. Tubes: Copper.
   3. Fins: Aluminum with fin spacing as scheduled.
      a. Minimum spacing: 8 fins per inch.
      b. Maximum spacing: 12 fins per inch.
      c. Maximum fin length of 120”.
      d. Provide intermediate tube supports for coils over 44” long, with an additional support every multiple of 42” thereafter.
   6. Frames: Minimum thickness 0.0625 inch.
      b. Cooling Coils: Stainless steel channel.
   7. Drain pans: Providing
   8. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
a. Working-Pressure Ratings: 200 psig, 325 deg F.

9. Source Quality Control: Test to 300 psig and to 200 psig underwater.

2.7 DAMPERS

A. General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Damper Operators: Electric and complying with Division 23 Section "Instrumentation and Control for HVAC."

C. Low-Leakage, Outside-Air Dampers: Double-skin, airfoil-blade galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals, in opposed or parallel-blade arrangement as indicated in the Contract Documents with steel operating rods rotating in a stainless-steel sleeve or sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.

2.8 FILTER SECTION

A. Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or the face.


C. Quality Assurance: Comply with NFPA 90A or 90B as required.

2.9 ELECTRICAL

A. The electrical connections for all electrical components in each unit shall be wired by the AHU manufacturer to the exterior of the unit for field connection.

B. Provide disconnect at each motor internal to the unit.

C. Marine Lights

1. Marine lights shall be provided throughout AHUs, but no less than one per section with an access door.
2. Lights shall be compact fluorescent type to minimize amperage draw and shall produce lumens equivalent to a minimum 64 W, instant-start bulb.
3. Lights shall be constructed of safety glass and shall be suitable for wet locations.

D. Marine Light Switches

1. All lights on a unit shall be wired in the factory to a single on-off switch with an integral timer adjustable for up to forty five minutes.
2. Lighting circuit(s) shall be wired by the AHU Manufacturer to a common junction box separate from the VFD or starter so the lights can remain on when the main disconnect to the unit is on or off.
E. Convenience Outlet
   1. Manufacturer shall provide at least one duplex 120-V convenience outlet per fan section.
   2. Outlets shall be wired by AHU Manufacturer to a common junction box separate from VFD or starter so the outlet can remain on when the main disconnect to the unit is on or off.

F. Ratings
   1. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
   B. Examine roughing-in of steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
   A. Concrete Bases: Install floor mounting units on 6-inch-high concrete bases. See Division 23 Section "Common Work Results for HVAC" for concrete base materials and fabrication requirements.
   B. Install modular indoor air-handling units with the following vibration and seismic-control devices. Vibration and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
      1. Units with Internally Isolated Fans: Set units on 1/2" neoprene pads, 40 durometer, on concrete bases. Secure units to anchor bolts concrete bases.
      3. Suspended Units: Suspend units from structural-steel support frame using threaded steel rods and spring hangers.
   C. Arrange installation of units to provide access space around modular indoor air-handling units for service and maintenance.
   D. Install temperature sensor on the leaving side of all cooling and heating coils in AHUs.

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 machine to allow service and maintenance.

C. Connect VFDs to associated fan motors. Comply with Division 23 and 26 for installation requirements.

D. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

E. Install condensate pump in drain pan and route condensate discharge to indirect waste.
   1. Install condensate trap of adequate depth to seal against the pressure of fan section. Install cleanouts in piping at changes of direction.
   2. Install condensate piping at appropriate slope to gravity drain.

F. Connect condensate drain pans using minimum NPS 1-1/4, Type M copper tubing. Extend to nearest equipment or floor drain. Install condensate trap of adequate depth to seal against the pressure of fan section and connect to drain pan. Install cleanouts at changes in direction of condensate piping.

G. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. For units without internally isolated fans, make final duct connections with flexible connections. Internally isolated fan units do not require flexible connections.

H. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

J. 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.

K. Connect all control points indicated in the Contract Documents to the FMS.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
   1. Leak Test: After installation, fill water and steam coils with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
   2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
   3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Final Checks before Startup: Perform the following:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Perform cleaning and adjusting specified in this Section.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
   5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
   6. Set outside- and return-air mixing dampers to minimum outside-air setting.
   7. Comb coil fins for parallel orientation.
   8. Install clean filters.
   9. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

C. Starting procedures for modular indoor air-handling units include the following:
   1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
   2. Measure and record motor electrical values for voltage and amperage.
   3. Manually operate dampers from fully closed to fully open position and record fan performance.
   4. Adjust damper linkages for proper damper operation.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for modular indoor air-handling system testing, adjusting, and balancing.

3.6 CLEANING

A. Clean modular indoor air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

B. After completing system installation and testing, adjusting, and balancing modular indoor air-handling and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain modular indoor air-handling units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 238123
COMPUTER-ROOM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of computer-room air-conditioning units:
   1. Floor-mounting units 6 tons and larger.

1.2 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Short-circuit current rating of equipment assembly.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers of the items involved.

B. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For computer-room air-conditioning units to include in emergency, operation, and maintenance manuals.

B. Warranties: Special warranties specified in this Section.

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. Fabricate and label refrigeration system to comply with ASHRAE 15, “Safety Code for Mechanical Refrigeration.”

D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 01.

F. Units shall be designed to operate with HCFC-free refrigerants.

1.6 COORDINATION

A. Coordinate layout and installation of computer-room air-conditioning units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate installation of computer-room air-conditioning units with computer-room access floor installer.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of computer-room air-conditioning units that fail in materials or workmanship within specified warranty period.

B. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

C. Warranty Period for Humidifiers: Manufacturer's standard, but not less than three years from date of Substantial Completion.

D. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-drive fan.
2. Filters: One set of filters for each unit.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Compu-Aire, Inc.
B. Data Aire Inc.
C. Liebert Corporation.

2.2 FLOOR-MOUNTING UNITS 6 TONS AND LARGER

A. Description and Assembly: Packaged, factory assembled, prewired, and prepiped; consisting of cabinet, fans, filters, humidifier, and controls.

1. Assembly: Downflow air delivery, in blow-through configuration.

B. Cabinet and Frame: Welded steel, suitably braced for rigidity, supporting compressors and other mechanical equipment and fittings; with floor stand with adjustable legs and vibration isolation pads.

2. Insulation: Thermally and acoustically insulate cabinet interior with 1-inch-thick duct liner.
3. Finish of Exterior Surfaces: Baked-on, textured vinyl enamel, color as selected from manufacturer's standard colors.

C. Evaporator Fan: Double inlet, forward curved, centrifugal, and statically and dynamically balanced.

1. Drive: Direct.
2. Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

D. Compressors: Hermetic scroll; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.

1. Refrigeration Circuits: Two, each with hot-gas mufflers, thermal-expansion valve with external equalizer, liquid-line solenoid valve, liquid-line filter-dryer, sight glass with moisture indicator, service shutoff valves, charging valves, accumulator sized for liquid seal under light load, and charge of refrigerant.
2. Refrigerant: R-407C or R-410A.

E. Evaporator Coil: Alternate-row or split-face-circuit, direct-expansion coil of seamless copper tubes expanded into aluminum fins. Mount coil assembly over stainless-steel drain pan having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
F. Air-Cooled Condenser: Corrosion-resistant cabinet, copper-tube aluminum-fin coils arranged for two circuits, multiple direct-drive propeller fans with permanently lubricated ball bearings, and single-phase motors with internal overload protection, integral electric control panel, and disconnect switch. Control capacity by cycling fans.


I. Infrared Humidifier: High-intensity quartz lamps mounted above stainless-steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; prepped and using condensate water from cooling coils with stainless-steel or brass float-valve mechanism; located in bypass airstream; with flush-cycle timer and solenoid drain valve.

J. Integral Electrical Controls: Unit-mounted electrical enclosure with piano-hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control-circuit transformer.

K. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

L. Electronic-Control System: Solid state, with start button, stop button, temporary loss of power indicator, manual-reset circuit breakers, temperature control, humidity control, and monitor panel.
   1. Monitor Panel: Backlighted, with no visible indicator lights until operating function is activated; indicators include cooling, humidification, loss of airflow, change filters, high temperature, low temperature, high humidity, low humidity, high head pressure (each compressor), and low suction pressure (each compressor).
   2. Temperature- and Humidity-Control Modules: Solid state, plug-in; with adjustable set point, push-to-test calibration check button, and built-in visual indicators to show mode of operation.
   3. Location: Behind hinged door in front of unit; isolated from conditioned airstream to allow service while system is operating.

M. Microprocessor-Control System: Continuously monitors operation of process cooling system; continuously displays room temperature and room relative humidity; sounds alarm on system malfunction and simultaneously displays problem. If more than one malfunction occurs, system displays fault in sequence with room temperature and continues to display fault when malfunction is cleared until system is reset.
   1. Malfunctions:
      a. Power Loss.
      b. Loss of Airflow.
      c. Clogged Air Filter.
      d. High Room Temperature.
      e. Low Room Temperature.
      f. High Humidity.
      g. Low Humidity.
      h. Smoke/Fire.
      i. Water-under-Floor.
j. Supply Fan Overload.
k. Compressor No. 1--Overload.
l. Compressor No. 1--Low Pressure.
m. Compressor No. 1--High Pressure.
n. Compressor No. 2--Overload.
o. Compressor No. 2--Low Pressure.
p. Compressor No. 2--High Pressure.

2. LED Display:
b. Humidifying.
c. Dehumidifying.
d. Compressor No. 1 Operating.
e. Compressor No. 2 Operating.
f. Heat Operating.
g. Economy Cooling.

3. Push buttons shall stop and start process cooling system, silence audible alarm, test LED indicators, and display room relative humidity.


5. Additional Monitoring:
   a. Monitor constant and variable motor loads.
b. Monitor variable frequency drive operation.
c. Monitor cooling load.
d. Monitor economizer cycles.
e. Monitor air distribution static pressure and ventilation air volumes.

N. Ratings

1. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install computer-room air-conditioning units level and plumb, maintaining manufacturer's recommended clearances. Install according to ARI Guideline B.

B. Install air-cooled condenser on rubber-in-shear vibration isolators.

C. Install floor-mouting units on bases designed to withstand, without damage to equipment, seismic forces required by code.

3.2 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 machine to allow service and maintenance.

C. Water and Drainage Connections: Comply with applicable requirements in Division 23 Section "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.

D. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping." Provide shutoff valves and piping.

E. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. 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.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   2. After installing computer-room air-conditioning units and after electrical circuitry has been energized, test for compliance with requirements.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that computer-room air-conditioning units are installed and connected according to manufacturer's written instructions and the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

E. After startup service and performance test, change filters and flush humidifier.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.
B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air-conditioning units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
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SECTION 238126
SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components.

B. Related Sections include the following:
   1. Division 23 Section “Hydronic Piping” for condensate piping.
   2. Division 23 Section "Instrumentation and Control for HVAC" for controls components.
   3. Division 23 Section “Common Motor Requirements for HVAC” for all motors.
   4. Division 23 Section "Vibration Isolation" for seismic criteria and restraint performance.

1.2 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Short-circuit current rating of equipment assembly.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

B. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section “Product Requirements.”
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.


D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Units shall be designed to operate with HCFC-free refrigerants.

1.6 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 07 Section "Roof Accessories."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of filters for each unit.
2. Fan Belts: One set of belts for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Carrier Air Conditioning; Div. of Carrier Corporation.

B. Daikin.

C. Lennox Industries Inc.

D. Trane Company (The).

E. York International Corp.
2.2 CONCEALED EVAPORATOR-FAN COMPONENTS

A. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
   1. Insulation: Foil faced, glass-fiber duct liner.
   2. Drain Pans: Stainless steel, with connection for drain; insulated.

B. Coils:
   1. Refrigerant: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
   2. Hydronic: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; and having a two-position control valve.
   3. Electric: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

C. Fan: Forward-curved, double-width wheel of galvanized steel; belt or directly connected to motor.

D. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.


F. Wiring Terminations: Connect motor to chassis wiring with plug connection.

G. Electrical Ratings
   1. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.

2.3 FLOOR-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.
   1. Discharge Grille: Steel with surface-mounted frame or welded steel bars forming a linear grille and welded into supporting panel.
   2. Insulation: Foil faced, glass-fiber, duct liner.
   3. Drain Pans: Stainless steel, with connection for drain; insulated.

B. Coils:
   1. Refrigerant: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
2. Hydronic: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; and having a two-position control valve.
3. Electric: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

C. Fan: Belt or direct drive, centrifugal.

D. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.


F. Electrical Ratings
1. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.

2.4 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enamelled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

B. Coils:
1. Refrigerant: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
2. Hydronic: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; and having a two-position control valve.
3. Electric: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

C. Fan: Belt or direct drive, centrifugal fan.

D. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.


F. Electrical Ratings
1. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.

2.5 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, with baked enamel finish, with removable panels for access to controls and coils, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   1. Compressor Type: Reciprocating or scroll.
   2. Variable speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   3. Refrigerant Charge: R-407C or R-410A.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Low Ambient Kit: Permits operation down to 0 deg F (-18 deg C).

H. Mounting Base: Polyethylene.

I. Electrical Ratings
   1. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.

2.6 ACCESSORIES

A. Control equipment and sequence of operation are specified in Division 23 Sections “Instrumentation and Control for HVAC” and “Sequence of Operations for HVAC Controls.”

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Provide in-pan condensate pump complete with piping, floats, controls, FMS alarm contacts, etc.
   1. Condensate piping to be ASTM B 306, Type DWV copper with wrought copper fittings conforming to ASME B16.22 and soldered.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer’s standard mounting devices securely fastened to building structure.

C. Install compressor-condenser components on 4-inch-thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section “Cast-in-Place Concrete.” Coordinate anchor installation with concrete base.

D. Install roof-mounting compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.

E. Install seismic restraints per site requirements as defined by Architect and/or Structural Engineer.

F. Refer to Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”

G. Install in-pan condensate pump and route discharge to nearest code approved location. Discharge to drain shall be open sight and with an air gap.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Water Coil Connections: Comply with requirements in Division 23 Section “Hydronic Piping.” Connect to supply and return coil with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

2. Condensate Pump Connections: Comply with requirements in Division 23 Section “Hydronic Piping.” Comply with disconnect requirements for power in Division 26.

B. Install piping adjacent to unit to allow service and maintenance.

C. Duct Connections: Duct installation requirements are specified in Division 23 Section “Metal Ducts.” Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section “Air Duct Accessories.”

D. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

E. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.
3.3 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer’s written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
SECTION 238219
FAN COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes fan-coil units and accessories.

B. Related Sections include the following:

   1. Division 23 Section "General-Duty Valves for HVAC Piping" for valves and accessories for piping.
   2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for expansion fittings.
   3. Division 23 Section "HVAC Insulation" for pipe saddles at pipe hangers.
   4. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment".
   5. Division 23 Section "Hydronic Piping" for chilled water, heating water, and condensate piping.
   6. Division 23 Section "Instrumentation and Control for HVAC".
   7. Division 23 Section "Metal Ducts".
   8. Division 23 Section "Packaged Compressor and Condenser Units" for split systems.

1.2 DEFINITIONS

A. FMS: Facility management system.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

   2. Short-circuit current rating of equipment assembly.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

   1. Ceiling suspension components.
   2. Structural members to which fan-coil units will be attached.
   3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
6. Perimeter moldings for exposed or partially exposed cabinets.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For fan-coil units 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. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.
B. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION
A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
B. Coordinate size and location of wall sleeves or roof openings for outdoor-air intake.

1.8 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Compressor failure.
      b. Condenser coil leak.
2. Warranty Period: Five years from date of Substantial Completion.
3. Warranty Period (Compressor Only): Ten years from date of Substantial Completion.
4. Warranty Period (Condenser Coil Only): Five years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan-Coil-Unit Filters: Furnish one spare filter for each filter installed.
2. Fan Belts: Furnish one spare fan belt for each unit installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Carrier Corporation.
B. Daikin.
C. Engineered Air Ltd.
D. Environmental Technologies, Inc.
E. Trane.
F. YORK International Corporation.

2.2 FAN-COIL UNITS

A. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

B. Coil Section Insulation: 1-inch thick, foil-covered, closed-cell foam or matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

C. Main and Auxiliary Drain Pans: Insulated stainless steel or insulated galvanized steel with plastic liner formed to slope from all directions to the drain connection as required by ASHRAE 62. Drain pans shall be removable.

D. Condensate Pump: Fractional horsepower, non-ferrous impeller, close or direct coupled pump for installation in drain pan complete with floats or sensors to detect water level and cycle pump accordingly. Each drain pan shall have a minimum of one pump, unless otherwise indicated.

1. Condensate piping to be ASTM B 306, Type DWV copper with wrought copper fittings conforming to ASME B16.22 and soldered.
E. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.

F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint, unless otherwise indicated by Architect.

1. For non-ducted and exposed units:
   a. Vertical Unit Front Panels: Removable, steel, with steel or cast-aluminum discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
   b. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with steel or cast-aluminum discharge grilles.
   c. Stack Unit Discharge and Return Grille: Aluminum double-deflection discharge grille, and louvered- or panel-type return grille; color as selected by Architect from manufacturer's standard colors. Return grille shall provide maintenance access to fan-coil unit.
   d. Steel recessing flanges for recessing fan-coil units into ceiling or wall.

2. For ducted and partially exposed units:
   a. Vertical Unit Front Panels: Removable, steel, with steel or cast-aluminum discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
   b. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with steel or cast-aluminum discharge grilles.
   c. Steel recessing flanges for recessing fan-coil units into ceiling or wall.
   d. Insulated sheet metal plenums with flex connections where the following services connect to the unit:
      1) Supply air.
      2) Return air.
      3) Outside air.
      4) Relief air.
      5) Bypass air.

G. Outdoor-Air Wall Box: Minimum 0.1265-inch-thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.

1. Louver Configuration: Vertical, rain-resistant louver.
2. Louver Material: Aluminum.
5. Finish: Baked enamel, color as selected by Architect from manufacturer's standard colors.

H. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with electronic or electric, two-position actuators.


J. Coils:
1. **Hydronic:** Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

2. **Steam:** Copper distributing tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 75 psig.

3. **Electric-Resistance Heating:** Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

4. **Indoor Refrigerant Coils:** Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and brazed joints at fittings. Comply with ARI 210/240, and leak test to minimum 450 psig for a minimum 300-psig working pressure. Include thermal expansion valve.

**K. Fan and Motor Board:** Removable.

1. **Fan:**
   a. **Belt-Driven:** Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
   b. **Direct-Driven:** Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

2. **Motor:** Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

3. **Wiring Termination:** Connect motor to chassis wiring with plug connection.

**L. Factory, Hydronic Piping Package:** ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.

1. **Automatic Flow-Control Valve:** Brass or ferrous-metal body; 300-psig working pressure at 250 deg F, with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.

2. **Y-Pattern Hydronic Strainers:** Cast-iron body (ASTM A 126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.

3. **Wrought-Copper Unions:** ASME B16.22.

4. **Risers:** ASTM B 88, Type L copper pipe with hose and ball valve for system flushing.

**M. Control devices are specified in Division 23 Sections "Instrumentation and Control for HVAC".**

**N. Electrical Connection:** Factory wire motors and controls for a single electrical connection.

**O. Electrical Ratings**

1. **Short-Circuit Current:** Match rating of overcurrent protective device serving the equipment assembly.

2. **Available Short-Circuit Current:** As indicated on the Drawings.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Suspend horizontal, suspended fan-coil units from structure with hangers. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Verify installation locations of thermostats and other exposed control sensors with Architect.

E. Do not operate fan coil units without filters installed.

F. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

G. Maintain maintenance and all NEC clearances.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   1. Install piping adjacent to machine to allow service and maintenance.
   2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
   3. Install condensate pump in drain pan and route condensate discharge to indirect waste.
      a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
      b. Install condensate piping at appropriate slope to gravity drain.

B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
D. 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 field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 01 Section “Demonstration and Training.”

END OF SECTION
SECTION 238239
UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.2 DEFINITIONS

A. FMS: Facility management system.
B. CWP: Cold working pressure.
C. PTFE: Polytetrafluoroethylene plastic.
D. TFE: Tetrafluoroethylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Plans, elevations, sections, and details.
   2. Location and size of each field connection.
   3. Details of anchorages and attachments to structure and to supported equipment. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
   4. Location and arrangement of piping valves and specialties.
   5. Location and arrangement of integral controls.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which unit heaters will be attached.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.

6. Perimeter moldings for exposed or partially exposed cabinets.

B. Samples for Initial Selection: Finish colors for units with factory-applied color finishes for Architect’s approval.

C. Manufacturer Seismic Qualification Certification: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Airtherm; a Mestek Company.

B. Carrier Corporation.
2.2 WALL AND CEILING HEATERS

A. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

B. Cabinet:
   1. Front Panel: Stamped-steel louver or extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
   2. Finish: Baked enamel over baked-on primer with manufacturer's color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.


E. Fan: Aluminum propeller directly connected to motor.
   1. Motor: Permanently lubricated, multispeed. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

F. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.

G. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine roughing-in for electrical connections to verify actual locations before unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cabinet unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. For units with filter sections, install new filters in each fan-coil unit within two weeks of Substantial Completion.

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 machine to allow service and maintenance.

C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."

E. Comply with safety requirements in UL 1995.

F. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

G. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of unit heater. Steam specialties are specified in Division 23 Section "Steam and Condensate Heating Piping."

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. 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 field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 01 Section “Demonstration and Training.”

END OF SECTION
SECTION 238413
HUMIDIFIERS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes the following humidifiers:
   1. Self-contained.

B. Related Sections include the following:
   1. Division 23 Section "HVAC Insulation".
   2. Division 23 Section "Steam and Condensate Heating Piping".

1.2 DEFINITION
A. 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.

1.3 ACTION SUBMITTALS
A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, including the piping of safety relief valves, plans, elevations, sections, details of components, manifolds, and attachments to other work.
   2. Short-circuit current rating of equipment assembly.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, 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 to which humidifiers will be attached.
   2. Size and location of initial access modules for acoustical tile.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.
1.6 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with ARI 640, "Commercial and Industrial Humidifiers."

1.7 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Supply one replacement electrode cylinder with each self-contained humidifier.

1.8 COORDINATION
A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Armstrong International, Inc.
B. DRI-STEEM Humidifier Company.
C. Nortec Industries Inc.
D. Pure Humidifier Company.
E. Spirax Sarco.

2.2 SELF-CONTAINED HUMIDIFIERS
A. Gas-Fired Steam Generator: Factory assembled and tested.
   1. Standard: Fabricate and label steam generator to comply with CSA.
   2. Maximum Steam Pressure: 10 inches wg.
   3. Burner Type: Natural-gas fired with modulating, low NOx infrared burner, minimum 82 percent efficient.
   5. Ignition: Hot-surface ignition with flame safety system.
B. Manifold: ASTM A 666, Type 316 stainless-steel tube extending across entire width of duct or plenum and equipped with mounting brackets on ends.

C. Cabinet: Sheet metal enclosure for housing heater cylinder, electrical wiring, components, controls, and control panel. Enclosure shall include baked-enamel finish, hinged or removable access door, and threaded outlet in bottom of cabinet for drain piping.

D. Control Panel:
   1. Factory-wired disconnect switch.
   2. Electronic display.
   3. Programmable keyboard.
   4. Set-point adjustment.
   5. Warning signal indicating end of replaceable cylinder life.
   7. Diagnostic, maintenance, alarm, and status features.
   8. High-water sensor or float to prevent overfilling.

E. Controls:
   1. Microprocessor-based control system for modulating or cycling control, and start/stop and status monitoring for interface to central HVAC instrumentation and controls.
   2. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
   3. Field-adjustable timer to control drain cycle for flush duration and interval.
   4. Controls shall drain tanks if no demand for humidification for more than 72 hours.
   5. Conductivity or Float-type level controls.

F. Accessories:
   1. Humidistat: Wall or Return-duct-mounting, solid-state, electronic-sensor controller capable of full modulation or cycling control as indicated in drawings.
   2. Duct-mounting, high-limit humidistat.
   3. Airflow switch for preventing humidifier operation without airflow.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install humidifiers with required clearance for service and maintenance.

B. Seal humidifier manifold duct or plenum penetrations with flange.
C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA’s “HVAC Duct Construction Standards, Metal and Flexible.”

D. Install stainless-steel drain pan under each manifold mounted in duct.
   1. Construct drain pans to comply with ASHRAE 62.
   2. Connect to condensate trap and drainage piping.
   3. Extend drain pan upstream and downstream from manifold a minimum of 24 inches or as recommended by manufacturer.
   4. Install condensate pump in drain pan to discharge cooled effluent to indirect waste.

E. Install manifold supply piping pitched to drain condensate back to humidifier.

F. For steam injection and heat exchanger humidifiers, install drip leg upstream from steam trap a minimum of 12 inches tall for proper operation of trap.

G. Install steam generator level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC."

H. Install seismic restraints on humidifiers. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

I. Install gas-fired steam generators according to NFPA 54.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Install piping adjacent to humidifiers to allow service and maintenance.
   2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.
   3. Install a drain cooler to reduce the temperature of all effluent discharged to the sanitary system below 140°F.

B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.

C. For gas-fired humidifiers:
   1. Install piping from safety relief valves to nearest floor drain.
   2. Connect gas piping full size to steam-generator, gas-train inlet with union. Gas piping materials and specialties are specified in Division 23 Section "Facility Natural-Gas Piping."
   3. Connect breeching full size to steam-generator outlet. Venting materials are specified in Division 23 Section "Breechings, Chimneys, and Stacks."
   4. Connect combustion-air inlet to intake terminal using PVC piping with solvent-cemented joints. Run from boiler connection to outside and terminate adjacent to flue termination.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. 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.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION