Project Manual

HCA MIDWEST HEALTH

LEE'S SUMMIT MEDICAL CENTER

Lee's Summit Medical Center
Hybrid OR Addition

2100 SE Blue Parkway
Lee's Summit, Missouri

Volume 2 of 2

(Divisions 15 thru 32)

March 23, 2020

ACIB Project #3-19058

ACI BOLAND ARCHITECTS

SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following items which apply to all Division 21 sections:

1. Submittals.
2. Coordination drawings.
3. Record documents.
4. Maintenance manuals.
5. Piping materials and installation instructions common to most piping systems.
6. Transition fittings.
7. Dielectric fittings.
8. Mechanical sleeve seals.
9. Sleeves.
10. Grout.
11. Flashing.
12. Through penetration firestop assemblies.
13. Fire protection demolition.
14. Equipment installation requirements common to equipment sections.
15. Painting and finishing.
16. Supports and anchorages.

B. Section includes pipe, fittings, valves, and connections for sprinkler standpipe, combination sprinkler and standpipe systems, firestopping relating to fire suppression work and firestop accessories.

C. Related Documents:

1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
5. ASME B16.25 - Buttwelding Ends.
6. ASME B16.3 - Malleable Iron Threaded Fittings.
7. ASME B16.4 - Gray Iron Threaded Fittings.
8. ASME B16.5 - Pipe Flanges and Flanged Fittings.
9. ASME B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.

B. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.
3. ASTM A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe.(Metric)
4. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
5. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
6. ASTM B32 - Standard Specification for Solder Metal.
7. ASTM B75 - Standard Specification for Seamless Copper Tube.
8. ASTM B75M - Standard Specification for Seamless Copper Tube (Metric).
9. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
10. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
11. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
12. ASTM B251M - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube (Metric).
13. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
14. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
15. ASTM F442/F442M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).
16. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

C. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association:

1. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

E. National Fire Protection Association:

1. NFPA 13 - Installation of Sprinkler Systems.
2. NFPA 14 - Standard for the Installation of Standpipe, Private Hydrants and Hose Systems.
3. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances.

F. Underwriter Laboratories, Inc.:

1. UL 1887 - Fire Tests of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.

1.3 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PE: Polyethylene plastic.
3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

H. Firestopping (Through-Penetration Protection System): Sealing of stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 PERFORMANCE REQUIREMENTS

A. The fire protection system in the existing area to be extended to new addition. The new hybrid OR and support areas will require a pre-action system. Smoke detection shall provide pre-action release.

B. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

1.5 SUBMITTALS

A. Product Data for each kind of product indicated.

B. Welding certificates.

C. Firestopping Schedules: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

D. Submittal of shop drawings, product data, and samples will be accepted only when signed and submitted by this Contractor and the General Contractor. Data submitted from

subcontractors and material suppliers directly to the Architect/Engineer will not be processed.

E. Shop drawings submitted without this Contractor's signature or approval and verification will not be approved. Quantities will not be checked or verified. It is the Contractor's responsibility to provide the proper quantities required to complete the job.

F. Portions of the work requiring a shop drawing submittal shall not begin until the shop drawing has been approved by the Engineer.

G. Submit wiring diagrams for all equipment requiring field wiring clearly showing all required connections. This Contractor will send one copy of Engineer approved shop drawings to the Electrical Contractor with a transmittal letter. Forward one copy of the transmittal letter to the Engineer's office.

H. Where catalog cuts are used, mark them to indicate equipment, capacities, controls, fittings, valves, sizes, etc.

I. Reference each item to applicable specification paragraph number and plan sheet number. Reference items not appearing in base specification to applicable alternate numbers, change order numbers, letters of authorization, etc.

J. Engineers acceptance of Compliance Submittals will not relieve Contractor from his responsibility for any deviations from the requirements of the Contract Documents unless Contractor has in writing called Engineer's attention to such deviation at the time of submission and Engineer has given written approval to the specific deviation, nor shall any acceptance by Engineer relieve Contractor from responsibility for errors or omissions in Compliance Submittals.

K. See other Division 21 sections for specific requirements regarding submittal of delegated design items.

L. Firestopping Engineering Judgments: For conditions not covered by UL or WH listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.6 GENERAL WORK REQUIREMENTS

A. Permits:

1. Obtain and pay for all licenses and permits, fees, inspection and certificates required for the execution of this work.
2. Pay fees and charges for connection to outside services and use of property.
3. Deliver permits and certificates to the Architect to be transmitted to the Owner.

1.7 RESPONSIBILITY

A. This Contractor will be held responsible for any and all damage to any part of the building or to the work of other contractors, as may be caused through his operation.

B. This contractor shall make all provisions for entry of equipment, installed under this contract, to the installed location. This contractor shall provide openings in existing construction if necessary. This contractor shall do all repair necessary to restore the building to the original condition. During the period of entry of equipment and removal of trash, no disruption of the Owner's normal business shall occur.

1.8 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of components and tag numbering.

C. Operation and Maintenance Data: Submit spare parts lists.

1.9 QUALITY ASSURANCE

A. Execute work in compliance with all applicable Federal, State and Municipal laws, codes, ordinances, and local customs regarding the trade to perform the work. The Contractor is required to verify that all installations comply with applicable codes. The codes applicable to this specific project may be listed on the Architect's code compliance sheet. If not, it is the Contractor's responsibility to determine which codes apply to the installations. Where code requirements conflict with those shown on the drawings and specifications, the code requirements shall take precedence. The Contractor shall notify the Architect immediately of any discrepancies between the applicable code requirements and the documents. Changes made to comply with the applicable requirements shall not justify an additional cost.

B. Inspect the existing site and conditions and check the drawings and specifications to be fully informed of the requirements for completion of the work. Lack of such information shall not justify an extra to the contract price.

C. The Fire Protection Work shall include labor, materials, and equipment to install systems and place in proper working order, as shown on plans and hereinafter specified. The installation shall include all labor, materials, tools, transportation, equipment, services and facilities, required for the complete, proper and substantial installation of all mechanical work shown on the plans, and/or outlined in these specifications. The installation shall include all materials, appliances, and apparatus not specifically mentioned herein or noted on the drawings, but which are necessary to make a complete working installation of all mechanical systems.

D. Material and equipment shall be new, of best quality and design and free from defects. A manufacturer's nameplate affixed in a conspicuous place will be required on each major component of equipment stating manufacturer's name, address and catalog number.

E. Furnish testing equipment and test all piping systems under methods and conditions as specified.

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

G. 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.

H. Electrical Characteristics for Fire Protection 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.

I. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 and ASTM E814 with 0.10-inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.

1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.

a. Floor Penetrations within Wall Cavities: T-Rating is not required.

J. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.

1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

K. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

L. Fire Resistant Joints between Floor Slabs and Exterior Walls: ASTM E119 with 0.10-inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

M. Surface Burning Characteristics: 25/50 flame spread/smoke developed index when tested in accordance with ASTM E84.

N. Surface Burning Characteristics: Maximum 25/50 flame spread/smoke developed index when tested in accordance with ASTM E84.

O. Perform Work in accordance with NFPA 13 standard.

1.10 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Product storage and handling requirements.

B. Deliver and store valves in shipping containers, with labeling in place.

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

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

E. Furnish cast iron and steel valves with temporary protective coating.

F. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.12 WORKMANSHIP AND COORDINATION

A. Make installation substantially as shown on plans.

B. Pipe and duct routing and equipment location shown on the drawings are schematic in nature. Make alterations in location of apparatus or piping as may be required to conform to building construction without extra charge.

C. Equipment service clearances, per equipment manufacturer's specifications, shall be maintained from general construction. No pipe shall be installed within these clearances. No piping shall be installed above electrical panels, starters or switchgear, or in elevator equipment rooms.

D. Cooperate with other contractors in their installation of work.

E. The ductwork shall take precedence over all pipe work except where it is necessary to maintain an even grade on the piping.

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

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

H. Coordinate requirements for access panels and doors for Fire Protection items requiring access that are concealed behind finished surfaces.

I. Use only experienced mechanics.

1.13 ENVIRONMENTAL REQUIREMENTS

A. Do not apply sealants, caulking, or mastic materials outside the range of the manufacturer's installation instructions.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F (15 degrees C).

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

D. Provide ventilation in areas to receive solvent cured materials.

1.14 ELECTRONIC DOCUMENT REQUESTS

A. The Contractor may request the use of the bidding documents in electronic format (CAD, BIM, PDF etc.) for use in preparation of shop drawings and coordination drawings.

B. Professional Engineering Consultants, P.A. (PEC) reserves the right to refuse requests for electronic files at its sole discretion. The format of the files will be at PEC's sole discretion.

C. All electronic documents provided are provided on an as-is basis and are utilized by the Contractor at his own risk. All files provided by the Engineer are subject to PEC's standard "CADD/Electronic File Disclaimer". This disclaimer can be provided upon request.

D. At PEC's sole discretion, per sheet fee of up to $50 may be required to cover the costs of preparing the electronic files for transmission.

E. By obtaining the bid document CAD or BIM files, the Contractor is not relieved from his duty to create construction, shop and coordination drawings.

1.15 FIRE PROTECTION COORDINATION DRAWINGS

A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of Fire Protection equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of piping, equipment, hangers, and materials. Include the following:

    a. Clearances for installing and maintaining insulation.
    b. Clearances for servicing and maintain equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
    c. Equipment connections and support details.
    d. Exterior wall and foundation penetrations.
    e. Fire-rated wall and floor penetrations.
    f. Underground piping.
    g. Sizes and locations of required concrete pads and bases.
    h. Numbered valve location diagrams.
    i. Valve stem movement.
    j. Pipe expansion loops.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Submit drawing to Architect to review for completeness. These drawings will be reviewed and returned with comments. They will not be approved as a shop drawing.

1.16 RECORD DOCUMENTS

A. Prepare record documents in accordance with Division 1. These drawings shall reflect the actual "As-Built" condition including any change orders, of the mechanical systems and installation. In addition to the requirements specified in Division 1, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location

diagrams, complete with valve tag chart. Refer to Identification Section. Indicate actual inverts and horizontal locations of underground piping.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, contract modifications, and actual equipment and materials installed.

1.17 MAINTENANCE MANUALS

A. Prepare Maintenance Manuals in accordance with Division 1 Sections. In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control stopping, shutdown, and emergency instructions.
3. Maintenance procedures for routing preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Approved shop drawing submittals.
5. Servicing instructions and lubrication charts and schedules.
6. Copy of valve tag chart.

1.18 FINAL ELECTRONIC SUBMITTAL

A. In addition to the hard-copy record documents above, provide a set of electronic documents in PDF formats on CD-ROM media. The electronic shall include the following:

1. Floor plans, O&M manuals, approved shop drawings, and valve tag schedules.
2. The floor plans shall contain labels and links for each piece of equipment specified in this Division. The equipment links shall open the O&M manual for the respective piece of equipment with a single mouse click. Valve tag links shall open the appropriate portion of the valve tag schedule.
3. It is anticipated that there will be separate PDF floor plan documents for each class of equipment, and separate PDF valve tag floor plan(s) for each unique system. The exact format and quantity of PDF documents shall be submitted to the Owner for approval prior to creation of the comprehensive final submittal.

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. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified or pre-approved equals.

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.

2.3 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials.

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 Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

D. 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 (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.5 MECHANICAL SLEEVE SEALS

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

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

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

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

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

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

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

G. Molded PE: Reusable, PE, tapered-cup shaped and smooth-outer surface with nailing flange for attaching to wooden forms.

2.7 GROUT

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

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.8 FLASHING

A. Metal Flashing: 26 gage (0.5 mm) thick galvanized steel.

B. Metal Counterflashing: 22 gage (0.8 mm) thick galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb./sq. ft (24.5 kg/sq m) sheet lead.
2. Soundproofing: 1 lb./sq. ft (5 kg/sq m) sheet lead.

D. Flexible Flashing: 47 mil (1.2 mm) thick sheet of material compatible with roofing. Coordinate with Architectural roofing specifications.

E. Caps: Steel, 22 gage (0.8 mm) minimum; 16 gage (1.5 mm) at fire resistant elements.

2.9 FIRESTOPPING

A. Manufacturers:

1. Hilti Corp.
2. 3M fire Protection Products

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Silicone Firestopping Elastomeric Firestopping: Single or multiple component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Single or multiple component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: As selected from manufacturer's full range of colors.

D. Coordinate the above requirements with Division 7.

2.10 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

C. General:

1. Furnish UL listed products.
2. Select products with rating not less than rating of wall or floor being penetrated.

D. Non-Rated Surfaces:

1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

2.11 ACCESS DOORS

A. If specified in Division 7 that section shall apply. Where not specified in Division 7 provide access doors as follows.

B. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

C. Frames: 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

1. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
2. For gypsum wallboard or plaster: perforated flanges with wallboard bead.

3. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

D. Flush Panel Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

E. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

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

1. Bar-Co., Inc.
2. J.L. Industries.
3. Karp Associates, Inc.
4. Milcor Div. Inryco, Inc.
5. Nystrom, Inc.

2.12 DRIP PANS

A. Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drainline connections.

2.13 PIPE HANGERS AND SUPPORTS

A. Conform to NFPA 13 and NFPA 14.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (15 to 40 mm): Carbon steel, adjustable swivel, split ring.

C. Hangers for Pipe Sizes 2 inch (50 mm) and Over: Carbon steel, adjustable, clevis.

D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

E. Wall Support for Pipe Sizes to 3 inches (80 mm): Cast iron hook.

F. Wall Support for Pipe Sizes 4 inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.

G. Vertical Support: Steel riser clamp.

H. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

PART 3 - EXECUTION

3.1 FIRE PROTECTION DEMOLITION REQUIREMENTS

A. The existing areas surrounding the remodel area are fully occupied and shall remain operational throughout the duration of this project.

B. This contractor shall closely coordinate with the Owner and/or his representative the timing and schedule for any temporary cutoffs of any mechanical systems. The valve location and scheduled shutdown shall be closely coordinated with the Owner. It is recognized that temporary shutdown of systems will be required. These shall be scheduled in advance with Owner's representatives and restored to full service at the end of the work period.

C. Disconnect, demolish, and remove Fire Protection 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.

D. 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.

E. Contractor shall provide protective plastic drop cloths to protect the existing occupied areas and equipment from dust and debris during the construction work and shall clean the areas of all construction dirt daily, and upon completion of the work.

F. Connection to existing piping for HVAC, medical gas, fire sprinkler or domestic water will require temporary shutdown of those mains to accomplish the new tie-ins. Closely coordinate and schedule this work with the Owner. Perform such work on weekends or nights as required by Owner's use and schedule.

G. All drained piping risers and mains shall be refilled with fluid and properly vented by this Contractor.

H. Coordinate with General Contractor the removal and replacement of all existing ceilings, walls, etc. as required for mechanical demolition work.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping in accordance with NFPA 13 for sprinkler systems, NFPA 14 for standpipe and hose systems, and NFPA 24 for service mains.

B. Pipe Hangers and Supports:

1. Install in accordance with NFPA 13 and NFPA 14.
2. Install hangers to with minimum 1/2-inch (15 mm) space between finished covering and adjacent work.
3. Place hangers within 12 inches (300 mm) of each horizontal elbow.
4. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
6. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
7. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

C. Slope piping and arrange systems to drain at low points. Install eccentric reducers to maintain top of pipe level.

D. Do not penetrate building structural members unless indicated.

E. Install piping according to the following requirements and Division 21.

F. Sections specifying piping systems.

G. 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 specially noted and approved on Coordination Drawings.

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

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

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

K. Install piping to permit valve servicing.

L. Install piping at indicated slopes.

M. Install piping free of sags and bends.

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

O. Install piping to allow application of insulation.

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

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

1. New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    c. Insulated Piping: One-piece, stamped-steel type with spring clips.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or stamped steel type with polished chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type or stamped steel with polished chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw.
g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass or stamped steel type with chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass or stamped steel type with chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

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

S. 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 (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) 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 (DN 150).
b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) 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 (50 mm) above finished floor level. Refer to Division 07 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 Sections for materials and installation.

T. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) 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.

U. 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 (25-mm) 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.

V. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.3 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. The Contractor shall field verify all existing conditions and dimensions. The Contractor shall make field adjustments as required to accommodate the new work.

B. Verify final equipment locations for roughing-in.

C. 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 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.

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

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3.5 PIPING CONNECTIONS

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

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric nipples and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

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

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

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

3.7 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1. In addition to the requirements specified in Division 1, the following requirements apply:

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

B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed work.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements of the Contract Documents.
4. Remove samples of installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Upon written instructions from the Architect, uncover and restore work to provide for Architect/Engineer observation of concealed work.

3.8 PAINTING

A. Painting of Fire Protection systems, equipment, and components is specified in other divisions.

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

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 Fire Protection materials and equipment.

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

3.10 GROUTING

A. Mix and install grout for Fire Protection 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.

3.11 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs. Refer to Division 7.

B. Seal floor, shower, and mop sink drains watertight to adjacent materials.

3.12 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating. Install per manufacturer's instructions to comply with appropriate listing.

D. Fire Rated Surface:

1. Seal openings as follows:

a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
b. Size sleeve allowing minimum of 1-inch (25 mm) void between sleeve and building element.
c. Pack void with backing material.
d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

E. Non-Rated Surfaces:

1. Seal openings, where required by code, through non-fire rated openings as follows:

a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
b. Size sleeve allowing minimum of 1-inch (25 mm) void between sleeve and building element.
c. Install type of firestopping material recommended by manufacturer.

2. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
3. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms, and data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and pipe.

F. Inspect installed firestopping for compliance with specifications and submitted schedule.

G. Clean adjacent surfaces of firestopping materials.

3.13 INSTALLATION OF ACCESS DOORS

A. Provide access doors in construction wherever access is required for valves, dampers, equipment, etc.

B. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

3.14 INSTALLATION OF DRIP PANS

A. Locate drip pans under piping passing within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods

to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection and run to nearest Fire Protection drain or elsewhere as indicated.

3.15 CLEANING

A. Refer to Division 1 for general requirements for final cleaning.

B. Contractor shall clean work area of all construction dirt and debris at the end of each workday.

3.16 WARRANTIES

A. Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.

B. Compile and assemble the warranties as specified into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. This Contractor shall warrant all material and equipment installed by him for a period of one year after completion of the project.

END OF SECTION

SECTION 21 13 13
WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.

B. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUMMARY

A. Section Includes:
1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.
4. Alarm devices.

B. Related Documents:
1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.3 DEFINITIONS

A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than 250 psig (1725 kPa).

B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. 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.

1.5 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
1. Obtain copy of fire-hydrant flow test records or contact local water and/or fire departments to perform a fire-hydrant flow test. Include flow test results with hydraulic calculations:

C. 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, fittings, valves, and backflow preventers.

2. Sprinkler Occupancy Hazard Classifications per NFPA 13.
3. Minimum Density for Automatic-Sprinkler Piping Design per NFPA 13.
4. Minimum Density for Deluge-Sprinkler Piping Design per NFPA 13.
5. Maximum Protection Area per Sprinkler: Per UL listing.
6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:

D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

E. Water Quality Testing and Treatment:
1. The Fire Protection Contractor shall obtain samples of the supply water for the proposed location. The Fire Protection Contractor shall perform testing of this water to determine:
a. The presence of properties which may lead to accelerated corrosion of the sprinkler piping, including corrosion due to microbially influenced corrosion (MIC). Based on the determination of these tests, the contractor shall provide water treatment systems, or piping which is specially manufactured to resist the properties present in the water, required to protect the piping from premature corrosion.
b. The presence of solids and minerals in the water which may lead to sediment buildup that will negatively affect system performance. Based on the determination of these tests, the contractor shall provide water treatment systems, filtration, alternate water supplies, or return bends to maintain required system performance.

1.6 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 wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For all sprinkler systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Engineer shall be licensed in the state where project is located.

D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the electrical, plumbing, HVAC, structural and other building systems are shown and coordinated with each other, using input from installers of the items involved.

E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations.
1. 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.

F. Fire-hydrant flow test report.

G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

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

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler 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 Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
   1. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

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

E. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."
   2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

1.8 PROJECT CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
   1. Notify Architect no fewer than two days in advance of proposed interruption of sprinkler service.
   2. Do not proceed with interruption of sprinkler service without Architect's written permission.

1.9 COORDINATION

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

1.10 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. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method. Pipe sizes 2" and below.

B. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end. Pipe sizes 2-1/2" and above.

C. Galvanized and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.

E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

J. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
      b. Corcoran Piping System Co.
      c. National Fittings, Inc.
      d. Shurjoint Piping Products.
      e. Tyco Fire & Building Products LP.
      f. Victaulic Company.
   2. Pressure Rating: 175 psig (1200 kPa) for standard pressure systems; minimum.
   3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 536, ductile-iron casting; with dimensions matching steel pipe. Short-pattern, with flow equal to standard pattern fittings.
   4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and ASTM A449 compliant bolts and nuts.
      a. Rigid: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with NFPA-13. Installation-Ready, for direct stab installation without field disassembly. Couplings shall be fully installed at visual pad-to-pad offset contact. Couplings that require gapping of bolt pads or specific torque ratings for proper installation are not permitted.
      b. Flexible: Use in locations where vibration attenuation and stress relief are required.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
   1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
   2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

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

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

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. Grooved Joint Lubricants: Lubricate gaskets with lubricant supplied by the coupling manufacturer in accordance with published installation instructions. The lubricant shall be approved for the gasket eleastomer and system media.

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
1. Valves shall be UL listed or FM approved.
2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).

B. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International, Inc.
   b. Victaulic Company.
2. Standard: UL 1091 except with ball instead of disc.
3. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
4. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
5. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.

C. Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. Anvil International, Inc.
   c. Clow Valve Company; a division of McWane, Inc.
   d. Fire-End & Croker Corporation.
   e. Kennedy Valve; a division of McWane, Inc.
   f. Mueller Co.; Water Products Division.
   g. NIBCO INC.
   h. Potter Roemer.
   i. Reliable Automatic Sprinkler Co., Inc.
   j. Tyco Fire & Building Products LP.
   k. Victaulic Company.
   l. Viking Corporation.
   m. Watts Water Technologies, Inc.
2. Standard: UL 312.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Type: Swing check; spring-assisted for vertical or horizontal installation.
5. Body Material: Cast ductile iron.
6. End Connections: Flanged or grooved.

D. Bronze OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. United Brass Works, Inc.
2. Standard: UL 262.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Bronze.
5. End Connections: Threaded.

E. Iron OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. Anvil International, Inc.
   c. Clow Valve Company; a division of McWane, Inc.
   d. Fire-End & Croker Corporation.
   e. Kennedy Valve; a division of McWane, Inc.
   f. Mueller Co.; Water Products Division.
   g. NIBCO INC.
   h. Potter Roemer.
   i. Reliable Automatic Sprinkler Co., Inc.
   j. Tyco Fire & Building Products LP.
   k. Victaulic Company.
   l. Viking Corporation.
   m. Watts Water Technologies, Inc.
2. Standard: UL 262.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

F. Indicating-Type Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International, Inc.
   b. Fivalco Inc.
   c. Global Safety Products, Inc.
   d. Kennedy Valve; a division of McWane, Inc.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Shurjoint Piping Products.
   h. Tyco Fire & Building Products LP.
   i. Victaulic Company.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Valves NPS 2 (DN 50) and Smaller:
   a. Valve Type: Ball or butterfly.
   b. Body Material: Bronze or brass.
   c. End Connections: Threaded or grooved.
5. Valves NPS 2-1/2 (DN 65) and Larger:
   a. Valve Type: Butterfly.
   b. Body Material: Cast or ductile iron.
   c. End Connections: Flanged, grooved, or wafer.
   d. Seat: Pressure responsive elastomer.
   e. Stem: Stainless steel.
6. Valve Operation: Weatherproof actuator housing with two integral electrical, 115 - V ac, prewired, two-circuit, supervisory switch visual indicating device.

G. NRS Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. American Valve, Inc.
   c. Clow Valve Company; a division of McWane, Inc.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Kennedy Valve; a division of McWane, Inc.
   f. Mueller Co.; Water Products Division.
   g. NIBCO INC.

h. Tyco Fire & Building Products LP.
i. Victaulic Company.
2. Standard: UL 262.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Body Material: Cast iron with indicator post flange.
5. Stem: Nonrising.
6. End Connections: Flanged or grooved.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig (1200 kPa) minimum.

B. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Affiliated Distributors.
b. Anvil International, Inc.
c. Barnett.
d. Conbraco Industries, Inc.; Apollo Valves.
e. Fire-End & Croker Corporation.
f. Fire Protection Products, Inc.
g. Flowserve.
h. FNW.
i. Jomar International, Ltd.
j. Kennedy Valve; a division of McWane, Inc.
k. Kitz Corporation.
l. Legend Valve.
m. Metso Automation USA Inc.
n. Milwaukee Valve Company.
o. NIBCO INC.
p. Potter Roemer.
q. Red-White Valve Corporation.
r. Southern Manufacturing Group.
s. Stewart, M. A. and Sons Ltd.
t. Tyco Fire & Building Products LP.
u. Victaulic Company.
v. Watts Water Technologies, Inc.

2.6 SPECIALTY VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
a. Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AFAC Inc.
b. Globe Fire Sprinkler Corporation.
c. Reliable Automatic Sprinkler Co., Inc.

d. Tyco Fire & Building Products LP.
e. Venus Fire Protection Ltd.
f. Victaulic Company.
g. Viking Corporation.

2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Valve internal components shall be replaceable without removal of valve from installed position.
5. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
6. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
7. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AFAC Inc.
b. Reliable Automatic Sprinkler Co., Inc.
c. Tyco Fire & Building Products LP.
2. Standard: UL 1726.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4 (DN 20).
6. End Connections: Threaded.

2.7 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International, Inc.
b. National Fittings, Inc.
c. Shurjoint Piping Products.
d. Tyco Fire & Building Products LP.
e. Victaulic Company.
2. Standard: UL 213.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AGF Manufacturing Inc.
b. Reliable Automatic Sprinkler Co., Inc.
c. Tyco Fire & Building Products LP.
d. Victaulic Company.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum for low pressure systems.
4. Body Material: Cast-bronze or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.

6. Inlet and Outlet: Threaded or grooved ends.

C. Branch Line Testers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkhart Brass Mfg. Company, Inc.
   b. Fire-End & Croker Corporation.
   c. Potter Roemer.
2. Standard: UL 199.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AGF Manufacturing Inc.
   b. Triple R Specialty.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.
   e. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast-bronze or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

E. Adjustable Drop Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CECA, LLC.
   b. Corcoran Piping System Co.
   c. Merit Manufacturing; a division of Anvil International, Inc.
2. Standard: UL 1474.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fivalco Inc.
   b. FlexHead Industries, Inc.
   c. Gateway Tubing, Inc.
   d. Victaulic Company.
2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with open-gate bracket for connection to ceiling grid.
4. The drop shall include a UL approved Series AH2 or AH2-CC braided hose with a bend radius to 2" to allow for proper installation in confined spaces.
5. Union joints shall be provided for ease of installation.

6. The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 or AB2 bracket. The bracket shall allow installation before the ceiling tile is in place.
7. Pressure Rating: 175 psig (1200 kPa) minimum.
8. Size: Same as connected piping, for sprinkler.

2.8 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFAC Inc.
2. Globe Fire Sprinkler Corporation.
3. Reliable Automatic Sprinkler Co., Inc.
4. Tyco Fire & Building Products LP.
5. Victaulic Company.
6. Viking Corporation.

B. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Residential Sprinklers: 175 psig (1200 kPa) maximum.
3. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.

C. Automatic Sprinklers with Heat-Responsive Element:
1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Residential Applications: UL 1626.
4. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
5. Quick response for healthcare applications.

D. Dry Pendant Automatic Sprinkler Heads:
1. Dry pendent style sprinklers
2. Sprinkler and deflector shall be of all brass frame construction attached to a 1" diameter galvanized extension nipple of specified length, having a machined 1" NPT thread. Extension nipple shall have an extended inlet above the thread. Internal construction shall consist of an inner tube/yoke assembly with orifice adapter consisting of all brass parts. Inlet seal assembly shall consist of a Teflon-coated spring washer with brass cap. Sprinklers shall have a frangible glass bulb thermal operating element with sealed adjustable seat adapter in conformance with UL requirements.
3. Dry pendent sprinklers shall be capable of providing 1-1/2" (38 mm) of escutcheon adjustment
4. Characteristics: Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

E. Sprinkler Finishes:
1. Chrome plated.
2. Bronze.
3. Painted.

F. Special Coatings:
1. Wax.
2. Corrosion-resistant paint.

G. 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.

H. Sprinkler Guards:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Reliable Automatic Sprinkler Co., Inc.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.
d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

I. Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.9 ALARM DEVICES

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

B. Water-Motor-Operated Alarm:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Globe Fire Sprinkler Corporation.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.
d. Viking Corporation.
2. Standard: UL 753.
3. Type: Mechanically operated, with Pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.
5. Size: 10-inch (250-mm) diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: NPS 3/4 (DN 20).
8. Outlet: NPS 1 (DN 25) drain connection.

C. Electrically Operated Alarm Bell:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Fire-Lite Alarms, Inc.; a Honeywell company.
b. Notifier; a Honeywell company.
c. Potter Electric Signal Company.
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 6-inch (150-mm) minimum- diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ADT Security Services, Inc.
b. McDonnell & Miller; ITT Industries.
c. Potter Electric Signal Company.
d. System Sensor; a Honeywell company.
e. Viking Corporation.
f. Watts Industries (Canada) Inc.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: 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.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig (1725 kPa).
7. Design Installation: Horizontal or vertical.

E. Pressure Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AFAC Inc.
b. Barksdale, Inc.
c. Detroit Switch, Inc.
d. Potter Electric Signal Company.
e. System Sensor; a Honeywell company.
f. Tyco Fire & Building Products LP.
g. United Electric Controls Co.
h. Viking Corporation.
2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Fire-Lite Alarms, Inc.; a Honeywell company.
b. Kennedy Valve; a division of McWane, Inc.
c. Potter Electric Signal Company.
d. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

2.10 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMETEK; U.S. Gauge Division.
2. Ashcroft, Inc.
3. Brecco Corporation.
4. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

D. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Division 22.

C. Install shutoff valve, check valve, pressure gage, and drain.

3.3 PIPING INSTALLATION

A. 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.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

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

D. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

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

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

L. 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 (DN 8) 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.

M. Fill sprinkler system piping with water.

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21.

O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 21.

P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21.

3.4 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

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

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

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.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606 in accordance with the manufacturer's published instructions. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints. 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, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606 in accordance with the manufacturer's published instructions. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints. 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, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

K. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

L. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 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 backflow preventers in potable-water-supply sources.

D. Specialty Valves:
   1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
   2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
   3. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.6 SPRINKLER INSTALLATION

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

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

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

D. Do not install sprinklers that have been dropped, damaged, show a visible loss of fluid, or a cracked bulb.

3.7 IDENTIFICATION

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

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Leak Test: After installation, charge systems 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. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
   4. Energize circuits to electrical equipment and devices.
   5. Coordinate with fire-alarm tests. Operate as required.
   6. Coordinate with fire-pump tests. Operate as required.
   7. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 CLEANING

A. Clean dirt and debris from sprinklers.

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

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.11 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
   1. Standard-weight, galvanized or black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be one of the following:
   1. Thinwall Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.12 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: Pendent sprinklers in lay-in ceilings to match existing; concealed sprinklers in hard ceilings to match existing spaces.
   3. Wall Mounting: Sidewall sprinklers.
   4. Sprinklers shall be quick response type.

B. Provide sprinkler types in subparagraphs below with finishes indicated.
   1. Concealed Sprinklers: Rough brass, with factory-painted chrome cover plate.
   2. Flush Sprinklers: Bright chrome, with bright chrome escutcheon.
   3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
   4. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.
   5. Wax coated or painted with corrosion resistant paint where exposed to acids, chemicals, or other corrosive fumes.
   6. Field painting of sprinkler heads will not be allowed in any situation.

END OF SECTION

SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following items which apply to all Division 22 sections:
1. Submittals.
2. Coordination drawings.
3. Record documents.
4. Maintenance manuals.
5. Piping materials and installation instructions common to most piping systems.
6. Transition fittings.
7. Dielectric fittings.
8. Mechanical sleeve seals.
9. Sleeves.
10. Escutcheons.
11. Grout.
12. Flashing.
13. Through penetration firestop assemblies.
14. Plumbing demolition.
15. Equipment installation requirements common to equipment sections.
16. Painting and finishing.
17. Concrete bases.
18. Supports and anchorages.

B. Related Documents:
1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

H. Firestopping (Through-Penetration Protection System): Sealing of stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.3 SUBMITTALS

A. Product Data for each kind of product indicated.

B. Welding certificates.

C. Firestopping Schedules: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

D. Submittal of shop drawings, product data, and samples will be accepted only when signed and submitted by this Contractor and the General Contractor. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed.

E. Shop drawings submitted without this Contractor's signature or approval and verification will not be approved. Quantities will not be checked or verified. It is the Contractor's responsibility to provide the proper quantities required to complete the job.

F. Portions of the work requiring a shop drawing submittal shall not begin until the shop drawing has been approved by the Engineer.

G. Submit wiring diagrams for all equipment requiring field wiring clearly showing all required connections. This Contractor will send one copy of Engineer approved shop drawings to the Electrical Contractor with a transmittal letter. Forward one copy of the transmittal letter to the Engineer's office.

H. Where catalog cuts are used, mark them to indicate equipment, capacities, controls, fittings, valves, sizes, etc.

I. Reference each item to applicable specification paragraph number and plan sheet number. Reference items not appearing in base specification to applicable alternate numbers, change order numbers, letters of authorization, etc.

J. Engineers acceptance of Compliance Submittals will not relieve Contractor from his responsibility for any deviations from the requirements of the Contract Documents unless Contractor has in writing called Engineer's attention to such deviation at the time of submission and Engineer has given written approval to the specific deviation, nor shall any acceptance by Engineer relieve Contractor from responsibility for errors or omissions in Compliance Submittals.

1.4 GENERAL WORK REQUIREMENTS

A. Permits:
1. Obtain and pay for all licenses and permits, fees, inspection and certificates required for the execution of this work.
2. Pay fees and charges for connection to outside services and use of property.
3. Deliver permits and certificates to the Architect to be transmitted to the Owner.

B. Utility Services:
1. This Contractor shall pay for all expenses, deposits, reimbursements, etc., required by the local rules and codes for the service to the buildings, complete and ready for use. See plot plan.
2. Consult gas, water and sewer utility for their requirements and for coordinating with their installation. Contractor shall provide any work thus required beyond that indicated by the drawings and specifications. He shall bear all expense involved

for the complete installation of the gas service (both temporary and permanent) to the building ready for operation, including utility service charges, except as specifically excluded on the plans.

3. This Contractor shall consult all local departments to verify requirements and bid installation for service in accordance with local codes and Utility company rules and regulations.

1.5 RESPONSIBILITY

A. This Contractor will be held responsible for any and all damage to any part of the building or to the work of other contractors, as may be caused through his operation.

B. This contractor shall make all provisions for entry of equipment, installed under this contract, to the installed location. This contractor shall provide openings in existing construction if necessary. This contractor shall do all repair necessary to restore the building to the original condition. During the period of entry of equipment and removal of trash, no disruption of the Owner's normal business shall occur.

1.6 QUALITY ASSURANCE

A. Execute work in compliance with all applicable Federal, State and Municipal laws, codes, ordinances, and local customs regarding the trade to perform the work. The Contractor is required to verify that all installations comply with applicable codes. The codes applicable to this specific project may be listed on the Architect's code compliance sheet. If not, it is the Contractor's responsibility to determine which codes apply to the installations. Where code requirements conflict with those shown on the drawings and specifications, the code requirements shall take precedence. The Contractor shall notify the Architect immediately of any discrepancies between the applicable code requirements and the documents. Changes made to comply with the applicable requirements shall not justify an additional cost.

B. Inspect the existing site and conditions and check the drawings and specifications to be fully informed of the requirements for completion of the work. Lack of such information shall not justify an extra to the contract price.

C. The Plumbing Work shall include labor, materials, and equipment to install systems and place in proper working order, as shown on plans and hereinafter specified. The installation shall include all labor, materials, tools, transportation, equipment, services and facilities, required for the complete, proper and substantial installation of all mechanical work shown on the plans, and/or outlined in these specifications. The installation shall include all materials, appliances, and apparatus not specifically mentioned herein or noted on the drawings, but which are necessary to make a complete working installation of all mechanical systems.

D. Material and equipment shall be new, of best quality and design and free from defects. A manufacturer's nameplate affixed in a conspicuous place will be required on each major component of equipment stating manufacturer's name, address and catalog number.

E. Furnish testing equipment and test all piping systems under methods and conditions as specified.

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

G. 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.

H. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing

and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

I. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 and ASTM E814 with 0.10-inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
   1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
   2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
      a. Floor Penetrations within Wall Cavities: T-Rating is not required.

J. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
   1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
   2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

K. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

L. Fire Resistant Joints between Floor Slabs and Exterior Walls: ASTM E119 with 0.10-inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

M. Surface Burning Characteristics: 25/50 flame spread/smoke developed index when tested in accordance with ASTM E84.

1.7 DELIVERY, STORAGE, AND HANDLING

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

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

1.8 WORKMANSHIP AND COORDINATION

A. Make installation substantially as shown on plans.

B. Pipe and duct routing and equipment location shown on the drawings are schematic in nature. Make alterations in location of apparatus or piping as may be required to conform to building construction without extra charge.

C. Equipment service clearances, per equipment manufacturer's specifications, shall be maintained from general construction. No pipe shall be installed within these clearances. No piping shall be installed above electrical panels, starters or switchgear, or in elevator equipment rooms.

D. Cooperate with other contractors in their installation of work.

E. The ductwork shall take precedence over all pipe work except where it is necessary to maintain an even grade on the piping.

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

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

H. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces.

I. Use only experienced mechanics.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not apply sealants, caulking, or mastic materials outside the range of the manufacturer's installation instructions.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F (15 degrees C).

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

D. Provide ventilation in areas to receive solvent cured materials.

1.10 ELECTRONIC DOCUMENT REQUESTS

A. The Contractor may request the use of the bidding documents in electronic format (CAD, BIM, PDF etc.) for use in preparation of shop drawings and coordination drawings.

B. Professional Engineering Consultants, P.A. (PEC) reserves the right to refuse requests for electronic files at its sole discretion. The format of the files will be at PEC's sole discretion.

C. All electronic documents provided are provided on an as-is basis and are utilized by the Contractor at his own risk. All files provided by the Engineer are subject to PEC's standard "CADD/Electronic File Disclaimer". This disclaimer can be provided upon request.

D. At PEC's sole discretion, per sheet fee of up to $50 may be required to cover the costs of preparing the electronic files for transmission.

E. By obtaining the bid document CAD or BIM files, the Contractor is not relieved from his duty to create construction, shop and coordination drawings.

1.11 PLUMBING COORDINATION DRAWINGS

A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:
   1. Indicate the proposed locations of piping, equipment, hangers, and materials. Include the following:
      a. Clearances for installing and maintaining insulation.
      b. Clearances for servicing and maintain equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
      c. Equipment connections and support details.
      d. Exterior wall and foundation penetrations.
      e. Fire-rated wall and floor penetrations.
      f. Underground piping.
      g. Sizes and locations of required concrete pads and bases.
      h. Numbered valve location diagrams.
      i. Valve stem movement.
      j. Pipe expansion loops.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Submit drawing to Architect to review for completeness. These drawings will be reviewed and returned with comments. They will not be approved as a shop drawing.

1.12 RECORD DOCUMENTS

A. Prepare record documents in accordance with Division 1. These drawings shall reflect the actual "As-Built" condition including any change orders, of the mechanical systems and installation. In addition to the requirements specified in Division 1, indicate the following installed conditions:
   1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Identification Section. Indicate actual inverts and horizontal locations of underground piping.
   2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
   3. Approved substitutions, contract modifications, and actual equipment and materials installed.

1.13 MAINTENANCE MANUALS

A. Prepare Maintenance Manuals in accordance with Division 1 Sections. In addition to the requirements specified in Division 1, include the following information for equipment items:
   1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control stopping, shutdown, and emergency instructions.
   3. Maintenance procedures for routing preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
   4. Approved shop drawing submittals.
   5. Servicing instructions and lubrication charts and schedules.
   6. Copy of valve tag chart.

1.14 FINAL ELECTRONIC SUBMITTAL

A. In addition to the hard-copy record documents above, provide a set of electronic documents in PDF formats on CD-ROM media. The electronic shall include the following:
   1. Floor plans, O&M manuals, approved shop drawings, and valve tag schedules.
   2. The floor plans shall contain labels and links for each piece of equipment specified in this Division. The equipment links shall open the O&M manual for the respective piece of equipment with a single mouse click. Valve tag links shall open the appropriate portion of the valve tag schedule.
   3. It is anticipated that there will be separate PDF floor plan documents for each class of equipment, and separate PDF valve tag floor plan(s) for each unique system. The exact format and quantity of PDF documents shall be submitted to the Owner for approval prior to creation of the comprehensive final submittal.

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. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified or pre-approved equals.

2.2 PIPE, TUBE, AND FITTINGS

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

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

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials.

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 Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

D. 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 (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

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

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

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

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

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

G. Molded PE: Reusable, PE, tapered-cup shaped and smooth-outer surface with nailing flange for attaching to wooden forms.

2.7 ESCUTCHEONS

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

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

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated and rough brass.

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

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

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

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

2.8 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.9 FLASHING

A. Metal Flashing: 26 gage (0.5 mm) thick galvanized steel.

B. Metal Counterflashing: 22 gage (0.8 mm) thick galvanized steel.

C. Lead Flashing:
   1. Waterproofing: 5 lb./sq. ft (24.5 kg/sq m) sheet lead.
   2. Soundproofing: 1 lb./sq. ft (5 kg/sq m) sheet lead.

D. Flexible Flashing: 47 mil (1.2 mm) thick sheet of material compatible with roofing. Coordinate with Architectural roofing specifications.

E. Caps: Steel, 22 gage (0.8 mm) minimum; 16 gage (1.5 mm) at fire resistant elements.

2.10 FIRESTOPPING

A. Manufacturers:
   1. Hilti Corp.
   2. 3M fire Protection Products

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
   1. Silicone Firestopping Elastomeric Firestopping: Single or multiple component silicone elastomeric compound and compatible silicone sealant.

2. Foam Firestopping Compounds: Single or multiple component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: As selected from manufacturer's full range of colors.

D. Coordinate the above requirements with Division 7.

2.11 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

C. General:
1. Furnish UL listed products.
2. Select products with rating not less than rating of wall or floor being penetrated.

D. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

2.12 ACCESS DOORS

A. If specified in Division 7 that section shall apply. Where not specified in Division 7 provide access doors as follows.

B. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

C. Frames: 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
1. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
2. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
3. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

D. Flush Panel Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

E. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

F. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bar-Co., Inc.

2. J.L. Industries.
3. Karp Associates, Inc.
4. Milcor Div. Inryco, Inc.
5. Nystrom, Inc.

2.13 DRIP PANS

A. Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drainline connections.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION REQUIREMENTS

A. The existing areas surrounding the remodel area are fully occupied and shall remain operational throughout the duration of this project.

B. This contractor shall closely coordinate with the Owner and/or his representative the timing and schedule for any temporary cutoffs of any mechanical systems. The valve location and scheduled shutdown shall be closely coordinated with the Owner. It is recognized that temporary shutdown of systems will be required. These shall be scheduled in advance with Owner's representatives and restored to full service at the end of the work period.

C. 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.

D. 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.

E. Contractor shall provide protective plastic drop cloths to protect the existing occupied areas and equipment from dust and debris during the construction work and shall clean the areas of all construction dirt daily, and upon completion of the work.

F. Connection to existing piping for HVAC, medical gas, fire sprinkler or domestic water will require temporary shutdown of those mains to accomplish the new tie-ins. Closely coordinate and schedule this work with the Owner. Perform such work on weekends or nights as required by Owner's use and schedule.

G. All drained piping risers and mains shall be refilled with fluid and properly vented by this Contractor.

H. Coordinate with General Contractor the removal and replacement of all existing ceilings, walls, etc. as required for mechanical demolition work.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

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

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

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or stamped steel type with polished chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type or stamped steel with polished chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw.
      g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
      h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
   2. Existing Piping: Use the following:
      a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
      b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass or stamped steel type with chrome-plated finish.
      d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass or stamped steel type with chrome-plated finish.
      e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
      f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
      g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

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

N. 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 (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) 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 (DN 150).
      b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) 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 (50 mm) above finished floor level. Refer to Division 07 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 Sections for materials and installation.

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) 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.

P. 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 (25-mm) 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.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.3 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. The Contractor shall field verify all existing conditions and dimensions. The Contractor shall make field adjustments as required to accommodate the new work.

B. Verify final equipment locations for roughing-in.

C. 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.

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

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

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

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

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Nonpressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

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

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

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 using manufacturer certified mechanics and tools.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric nipples and flanges to connect piping materials of dissimilar metals.

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

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

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

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

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

3.7 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1. In addition to the requirements specified in Division 1, the following requirements apply:
   1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
   1. Uncover work to provide for installation of ill-timed work.
   2. Remove and replace defective work.
   3. Remove and replace work not conforming to requirements of the Contract Documents.
   4. Remove samples of installed work as specified for testing.
   5. Install equipment and materials in existing structures.
   6. Upon written instructions from the Architect, uncover and restore work to provide for Architect/Engineer observation of concealed work.

3.8 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in other divisions.

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

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 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.

3.11 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs. Refer to Division 7.

B. Seal floor, shower, and mop sink drains watertight to adjacent materials.

3.12 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating. Install per manufacturer's instructions to comply with appropriate listing.

D. Fire Rated Surface:
   1. Seal openings as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
      b. Size sleeve allowing minimum of 1-inch (25 mm) void between sleeve and building element.
      c. Pack void with backing material.
      d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

E. Non-Rated Surfaces:
   1. Seal openings, where required by code, through non-fire rated openings as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
      b. Size sleeve allowing minimum of 1-inch (25 mm) void between sleeve and building element.
      c. Install type of firestopping material recommended by manufacturer.
   2. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
   3. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms, and data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and pipe.

F. Inspect installed firestopping for compliance with specifications and submitted schedule.

G. Clean adjacent surfaces of firestopping materials.

3.13 INSTALLATION OF ACCESS DOORS

A. Provide access doors in construction wherever access is required for valves, dampers, equipment, etc.

B. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

3.14 INSTALLATION OF DRIP PANS

A. Locate drip pans under piping passing within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection and run to nearest plumbing drain or elsewhere as indicated.

3.15 CLEANING

A. Refer to Division 1 for general requirements for final cleaning.

B. Contractor shall clean work area of all construction dirt and debris at the end of each workday.

3.16 WARRANTIES

A. Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.

B. Compile and assemble the warranties as specified into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. This Contractor shall warrant all material and equipment installed by him for a period of one year after completion of the project.

END OF SECTION

SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Bronze angle valves.
2. Brass ball valves.
3. Bronze ball valves.
4. Iron, single-flange butterfly valves.
5. Iron, grooved-end butterfly valves.
6. Brass, grooved-end butterfly valves.
7. Bronze swing check valves.
8. Iron swing check valves.
9. Iron swing check valves with closure control.
10. Iron, grooved-end swing check valves.
11. Bronze gate valves.
12. Iron gate valves.
13. Bronze globe valves.
14. Iron globe valves.
15. Chainwheels.

B. Related Documents:
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

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

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

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, grooved ends, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

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

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

D. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 6 (DN 150) and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 4 (DN 100) and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

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

2.2 BRONZE ANGLE VALVES

A. Class 125, Bronze Angle Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hammond Valve.
b. Milwaukee Valve Company.

2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 150, Bronze Angle Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Stockham Division.
b. Kitz Corporation.

2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 300 psig (2070 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

2.3 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
d. Hammond Valve.
e. Jamesbury; a subsidiary of Metso Automation.
f. Kitz Corporation.
g. Legend Valve.
h. Milwaukee Valve Company.
i. NIBCO INC
j. Red-White Valve Corporation.

2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.4 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

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

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves
c. Crane Co.; Crane Valve Group; Crane Valves
d. Hammond Valve
e. Legend Valve.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Viega
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded or press fit.
g. Seats: PTFE or TFE.
h. Stem: Bronze, blowout proof.
i. Handle: Metal with powder coating.
j. Ball: Chrome-plated brass.
k. Port: Full.

B. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division
e. Hammond Valve.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Viega

2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded or press fit.
g. Seats: PTFE or TFE.
h. Stem: Bronze, blowout proof.
i. Handle: Metal with powder coating.
j. Ball: Chrome-plated brass.
k. Port: Regular.

2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group, Stockham Division
d. DeZurik Water Controls.

e. Hammond Valve.
f. Kitz Corporation.
g. Legend Valve.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Red-White Valve Corporation.
k. Spence Strainers International; a division of CIRCOR International, Inc.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

B. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group, Stockham Division
d. DeZurik Water Controls.
e. Hammond Valve.
f. Kitz Corporation.
g. Legend Valve.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Red-White Valve Corporation.
k. Spence Strainers International; a division of CIRCOR International, Inc.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

2.6 IRON, GROOVED-END BUTTERFLY VALVES

A. 175 CWP, Iron, Grooved-End Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kennedy Valve: a division of McWane, Inc.
b. Tyco Fire Products LP; Grinnell Mechanical Products.
c. Victaulic Company

2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 175 psig (1200 kPa).
c. Body Material: Coated, ductile iron.
d. Stem: Two-piece stainless steel.
e. Disc: Aluminum-bronze.

f. Seat: Pressure-responsive EPDM.

2.7 BRASS, GROOVED-END BUTTERFLY VALVES

A. 300 CWP, Brass, Grooved-End Butterfly Valves:
1. Manufacturer:
a. Victaulic Company.
b. Kennedy
c. Tyco
d. Or approved substitution
2. Description:
a. CWP Rating: 300 psig (2065 kPa).
b. Body Material: Cast brass to UNS C87850.
c. Stem: Stainless steel, offset from the disc centerline to provide complete 360-degree circumferential seating.
d. Disc: Aluminum-bronze.
e. Seat: Fluoroelastomer.

2.8 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Crane Co., Crane Valve Group; Crane Valves.
c. Crane Co., Crane Valve Group; Jenkins Valves.
d. Crane Co., Crane Valve Group; Stockham Division.
e. Hammond Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Jenkins Valves.
c. Crane Co., Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.

d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.9 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Jenkins Valves.
c. Crane Co., Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Legend Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Stockham Division.
2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Composition.
g. Seat Ring: Bronze.
h. Disc Holder: Bronze.
i. Disc: PTFE or TFE.
j. Gasket: Asbestos free.

2.10 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. NIBCO, INC.
2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.

f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed, exterior lever and spring.

B. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Jenkins Valves.
b. Crane Co., Crane Valve Group; Stockham Division.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed, exterior lever and weight.

2.11 IRON, GROOVED-END SWING CHECK VALVES

A. 300 CWP, Iron, Grooved-End Swing Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International, Inc.
b. Tyco Fire Products LP; Grinnell Mechanical Products.
c. Victaulic Company.
2. Description:
a. CWP Rating: 300 psig (2070 kPa).
b. Body Material: ASTM A 536, ductile iron.
c. Seal: EPDM.
d. Disc: Spring-operated, ductile iron or stainless steel.

2.12 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Crane Co., Crane Valve Group; Crane Valves.
c. Crane Co., Crane Valve Group; Jenkins Valves.
d. Crane Co., Crane Valve Group; Stockham Division.
e. Hammond Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.

e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron**,** bronze, or aluminum.

B. Class 125, RS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Crane Co., Crane Valve Group; Crane Valves.
c. Crane Co., Crane Valve Group; Jenkins Valves.
d. Crane Co., Crane Valve Group; Stockham Division.
e. Hammond Valve.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.13 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Jenkins Valves.
c. Crane Co., Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Legend Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.

b. Crane Co., Crane Valve Group; Jenkins Valves.
c. Crane Co., Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Legend Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.14 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Stockham Division.
c. Hammond Valve.
d. Kitz Corporation.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Powell Valves.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, Bronze Globe Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Stockham Division.
c. NIBCO INC.
d. Red-White Valve Corporation.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.

h. Handwheel: Malleable iron, bronze, or aluminum.

2.15 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co., Crane Valve Group; Crane Valves.
b. Crane Co., Crane Valve Group; Jenkins Valves.
c. Crane Co., Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Red-White Valve Corporation.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

2.16 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

D. Examine grooved ends for form and cleanliness. Ends shall be clean and free from indentations and projections in the area from valve, fitting, or pipe end to (and including) the groove.

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 INSTALLATION

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

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

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

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

E. Install chainwheels on operators for butterfly, gate, and globe valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly or gate valves.
   2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
   3. Throttling Service: Globe or angle, ball, or butterfly valves.
   4. Pump-Discharge Check Valves:
      a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
      b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.
      c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

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

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded or solder end.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded end.
   3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded ends.
   6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
   7. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:
   1. Bronze Angle Valves: Class 125, bronze disc.
   2. Ball Valves: Two piece, full port, brass or bronze with brass or bronze trim.
   3. Bronze Swing Check Valves: Class 125, bronze or nonmetallic disc.
   4. Bronze Globe Valves: Class 125, bronze or nonmetallic disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM or NBR seat, aluminum-bronze disc.
2. Iron, Grooved-End Butterfly Valves: 175 CWP.
3. Iron Swing Check Valves: Class 125, metal or nonmetallic-to-metal seats.
4. Iron Swing Check Valves with Closure Control: Class 125, lever and spring or weight.
5. Iron, Grooved-End Swing Check Valves: 300 CWP.
6. Iron Globe Valves: Class 125.

END OF SECTION

SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Building attachments.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.
11. Miscellaneous equipment.

B. Related Documents:
1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment where required.

1.4 SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers
1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless steel.

B. Strap-Type, Fiberglass Pipe Hangers:
1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous thread rod, washer, and nuts made of stainless steel.

2.4 METAL FRAMING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Tube & Conduit.
2. Cooper B-Line, Inc.
3. Unistrut Corporation; Tyco International, Ltd.

B. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

C. Standard: MFMA-4.

D. Channels: Continuous slotted steel channel with inturned lips.

E. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

F. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

G. Metallic Coating: Hot-dipped galvanized.

H. Paint Coating: Epoxy.

I. Plastic Coating: Polyurethane.

2.5 FIBERGLASS STRUT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Tube & Conduit
2. Champion Fiberglass, Inc.
3. Cooper B-Line, Inc.
4. SEASAFE, INC.; a Gibraltar Industries Company.

B. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.
1. Channels: Continuous slotted fiberglass channel with inturned lips.
2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.6 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) or ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength.

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

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

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.7 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated, provide factory- fabricated building attachments comply with MSS SP-58, of one of the following MSS types listed, selected by Installer to

suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Attachment materials to building structure shall be approved by the Structural Engineer.

B. Where concrete structure occurs hang piping using 1/2" diameter Phillips red head wedge anchors or equal by Hilti.
   1. Concrete Inserts: MSS Type 18.
   2. Top Beam C-Clamps: MSS Type 19.
   3. Side Beam or Channel Clamps: MSS Type 20.
   4. Center Beam Clamps: MSS Type 21.
   5. Welded Beam Attachments: MSS Type 22.
   6. C-Clamps: MSS Type 23.
   7. Top Beam Clamps: MSS Type 25.
   8. Side Beam Clamps: MSS Type 27.
   9. Steel Beam Clamps with Eye Nut: MSS Type 28.
   10. Linked Steel Clamps with Eye Nut: MSS Type 29.
   11. Malleable Beam Clamps: MSS Type 30.
   12. Steel Brackets: One of the following for indicated loading:
      a. Light Duty: MSS Type 31.
      b. Medium Duty: MSS Type 32.
      c. Heavy Duty: MSS Type 33.
   13. Side Beam Brackets: MSS Type 34.
   14. Plate Lugs: MSS Type 57.
   15. Horizontal Travelers: MSS Type 58.

2.8 PIPE STANDS

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

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

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

D. High-Type, Single-Pipe Stand:
   1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. Base: 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:
   1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   2. Bases: One or more; plastic.
   3. Vertical Members: Two or more protective-coated-steel channels.
   4. Horizontal Member: Protective-coated-steel channel.
   5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

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

2.9 PIPE POSITIONING SYSTEMS

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

2.10 EQUIPMENT SUPPORTS

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

2.11 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

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

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

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

G. Installation of Building Attachments:
   1. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.
   2. Use power driven anchors or expansion anchors at concrete structure.
   3. Install supplementary steel angles, fastened or welded to building structure as required to support pipe and accessories. Use 3" x 3" x 1/4" steel angle with long leg vertical, or heavier if required.

H. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Sections for how system interfaces with roofing system.

I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.

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

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

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

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

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

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

P. Insulated Piping:
1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) 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 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

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

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

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

3.3 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 PAINTING

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

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

3.6 INSTALLATION - PIPE HANGER AND SUPPORT

A. Install in accordance with ASME B31.9, MSS SP 58, MSS SP69, and MSS SP 89.

B. Support horizontal and vertical piping as scheduled.

C. Install hangers with minimum 1/2-inch (13 mm) space between finished covering and adjacent work.

D. Provide clearance in hangers and from structure and other equipment for installation of insulation.

E. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment.

F. Design hangers for pipe movement without disengagement of supported pipe

G. Comply with MSS SP-69 for pipe-hanger selections and applications that are not otherwise specified.

H. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

I. Use stainless-steel pipe hangers, fiberglass pipe hangers, fiberglass strut systems and stainless-steel or corrosion-resistant attachments for outdoors and/or hostile environment applications.

J. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing. Use vinyl-coated hangers and attachments for PEX, PVC, and CPVC piping. Use stainless steel hangers and stainless-steel attachments on stainless steel pipes.

K. Use padded hangers for piping that is subject to scratching, including plastic pressure piping and all glass piping.

L. Use thermal-hanger shield inserts for insulated piping and tubing.

M. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified elsewhere, 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 (DN 15 to DN 750).
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), 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 (DN 20 to DN 200).
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
   12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
   13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
   16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
   17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
   18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
   19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
   20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

N. Vertical-Piping Clamps: Unless otherwise indicated and except as specified elsewhere, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

O. Hanger-Rod Attachments: Unless otherwise indicated and except as specified elsewhere, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) 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 (49 to 232 deg C) piping installations.

P. Building Attachments: Unless otherwise indicated and except as specified elsewhere, 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 (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
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.

Q. Saddles and Shields: Unless otherwise indicated and except as specified elsewhere, 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.

R. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not otherwise specified.

S. Comply with MFMA-103 for metal framing system selections and applications that are not otherwise specified.

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

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

3.7 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

3.8 SCHEDULES

HORIZONTAL PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING Feet (m)	HANGER ROD DIAMETER Inches (mm)
ABS thru 3 inches (75)	4 (1.2)	1/2 (13)
ABS 4 to 12 inch (300)	4 (1.2)	7/8 (22)
Cast Iron to 5 inch	5 (1.5)	5/8 (15)
Cast Iron 6 to 12 inch	5 (1.5)	7/8 (22)
Cast Iron with 10-foot (3 m) length of pipe to 5 inch	10 (3)	5/8 (15)
Cast Iron with 10-foot (3m) length of pipe 6 to 12 inch	10 (3)	7/8 (22)
CPVC, 1 inch (25 mm) and smaller	3 (0.9)	1/2 (13)
CPVC, 1-1/4 inch (32 mm) to 3 inch (75)	4 (1.2)	1/2 (13)
CPVC, 4 inch (100) to 8 inch (200)	4 (1.2)	7/8 (22)
Copper Tube, 1-1/4 inch (32 mm) and smaller	5 (1.5)	3/8 (10)
Copper Tube, 1-1/2 inch (38 mm) to 5 inches (DN125)	8 (2.4)	1/2 (13)
Copper Tube 6 inch (DN150)	10 (3)	5/8 (16)
Copper Tube 8 inch (DN200)	10 (3)	3/4 (19)
Fiberglass up to 4 inch (100 mm)	10 (3)	5/8 (16)
Glass up to 4 inch (100mm)	5 (1.5)	5/8 (16)
PEX 1 inch (25 mm) and smaller	2.5 (.75)	3/8 (9)
Polybutylene	2.67 (0.8)	3/8 (9)
Polypropylene 3 inches (75 mm) and smaller	3 (.9)	1/2 (13)

Polypropylene 4 inches (100 mm) to 8 inches (200 mm)	4 (1.2)	7/8 (22)
PVC 3 inches (75 mm) and smaller	4 (1.2)	1/2 (13)
PVC 4 inches (100 mm) to 8 inch (100 mm)	4 (1.2)	7/8 (22)
PVDF up to 3 inch (75 mm)	2.5 (.75)	1/2 (13)
PVDF 4 inch (100mm) to 6 inch (150 mm)	4 (12)	3/4 (19)
Stainless Steel or Steel, 3 inches (75 mm) and smaller	12 (3.7)	1/2 (13)
Stainless Steel or Steel, 4 inches (100 mm) to 6 inch (150 mm)	12 (3.7)	3/4 (19)
Stainless Steel or Steel, 8 inches (200 mm) and larger	12 (3.7)	7/8 (22)

NOTE: 1. Where code requirements for hangers are more stringent than above, code requirements shall apply.
2. Place hangers within 12 inches (300 mm) of each horizontal elbow, fitting, valve and coupling.
3. Support horizontal cast iron pipe adjacent to each hub.
4. Rod diameters may be reduced one size for double-rod hangers, with 3/8 inch (10mm) minimum rods.

VERTICAL PIPE SUPPORT SPACING	
PIPE MATERIAL	MAXIMUM SUPPORT SPACING Feet (m)
ABS	4 (1.2)
Cast Iron	15 (4.5)
CPVC 1 inch (25 mm) and smaller	5 (1.5)
CPVC 1-1/4 inch (32mm) and larger	6 (1.8)
Copper Tube	10 (3)
Fiberglass	12 (3.7)
Glass	8 (24)
PEX	4 (1.2)
Polypropylene	5 (1.5)
PVC	4 (1.2)
PVDF	4 (1.2)
Steel or Stainless Steel	15 (4.5)

NOTE: 1. Where not otherwise indicated, support vertical piping at each floor.
2. Support cast iron at hubs.
3. Support riser piping independently of connected horizontal piping.

END OF SECTION

SECTION 22 05 48
VIBRATION CONTROLS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Freestanding and restrained spring isolators.
5. Housed spring mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Restrained vibration isolation roof-curb rails.
12. Seismic snubbers.
13. Restraining braces and cables.
14. Steel and inertia, vibration isolation equipment bases.

1.3 PERFORMANCE REQUIREMENTS

A. Wind-Restraint:
1. Basic Wind Speed: 90 mph (145 km/hr)
2. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) 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, or higher as required by local code.

1.4 ACTION SUBMITTALS

A. 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.

B. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

E. Field quality-control test reports.

1.6 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 Building Code 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."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control.
2. Mason Industries.
3. Vibration Mountings & Controls, Inc.

B. Pads (Type I): Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene, rubber, or hermetically sealed compressed fiberglass.

C. Mounts (Type 2): Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

D. Restrained Mounts (Type 2): All-directional mountings with seismic restraint.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

E. Spring Isolators (Type 3): 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. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).

6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators (Type 4): Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Spring Mounts (Type 4): Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch (6-mm) travel up or down before contacting a resilient collar.

H. Elastomeric Hangers (Type 2): 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.

I. Spring Hangers (Type 3): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop (Type 3): 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. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
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.

K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) 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 (3.45 MPa) and for equal resistance in all directions.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

A. Steel Base (Type B): Factory-fabricated, welded, structural-steel bases and rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) 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.

B. Inertia Base (Type C): Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanized 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. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:
   1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

C. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of 40 feet (12 m) o. c., and longitudinal supports a maximum of 80 feet (24 m) o. c.
   3. Brace a change of direction longer than 12 feet (3.7 m).

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

G. 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.

H. 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.

I. 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 prestressed 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 MOTION

A. Install flexible connections in piping where they cross building 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.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 PLUMBING VIBRATION-CONTROL DEVICE SCHEDULE

			Equipment Location											
			Slab on Grade			Floor Span: Up to 20 ft			Floor Span: 20 to 30 ft			Floor Span: 30 to 40 ft		
Equipment Type	Horsepower and Other	RPM	Base Type	Isolator Type	Min. Defl., in.	Base Type	Isolator Type	Min. Defl., in.	Base Type	Isolator Type	Min. Defl., in.	Base Type	Isolator Type	Min. Defl., in.
Air Compressors and Vacuum Pumps														
Tank mounted Horiz	≤10	All	A	3	0.75	A	3	0.75	A	3	1.50	A	3	1.50
	≥15	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50
Tank mounted vert.	All	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50
Base mounted	All	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50
Large reciprocating	All	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50
Pumps														
Close coupled	≤7.5	All	B	2	0.25	C	3	0.75	C	3	0.75	C	3	0.75
	≥10	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50
Large inline	5 to 25	All	A	3	0.75	A	3	1.50	A	3	1.50	A	3	1.50
	≥30	All	A	3	1.50	A	3	1.50	A	3	1.50	A	3	2.50
End suction and split case	≤40	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50
	50 to 125	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	2.50
	≥150	All	C	3	0.75	C	3	1.50	C	3	2.50	C	3	3.50

Base Types:
A. No base, isolators attached directly to equipment.
B. Structural steel rails or base.
C. Concrete inertia base.
D. Curb mounted base.

Isolator Types:
1. Pad, rubber, or glass fiber.
2. Rubber floor isolator or hanger.
3. Spring floor isolator or hanger.
4. Restrained spring isolator.
5. Thrust restraint.

Table adapted from the Chapter 48 of the 2011 ASHRAE HVAC Applications Handbook

END OF SECTION 220548

SECTION 22 05 53
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.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

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 including color scheme, wording, symbols, and letter size.

D. Valve numbering scheme including color scheme, wording, symbols, and letter size.

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

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. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032-inch (0.8-mm); Stainless steel, 0.025-inch (0.64-mm); Aluminum, 0.032-inch (0.8-mm); or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
   3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches

(1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
2. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
3. 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).
4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

C. 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).

D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

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

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

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

2.3 PIPE LABELS

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

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

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

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

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
   1. Tag Material: Multilayer, multicolored plastic, 0.0625 inch (1.6mm); Brass, 0.032-inch (0.8-mm); Stainless steel, 0.025-inch (0.64-mm); Aluminum, 0.032-inch (0.8-mm); or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches (100 by 178 mm).
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Yellow background with black lettering.

2.6 PLASTIC UNDERGROUND PIPE MARKERS

A. Brightly colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; mechanical 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. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings.
8. There shall be a minimum of one label for each system per room.

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; 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.

3.6 UNDERGROUND PIPE MARKERS

A. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finish grade, directly above buried pipe.

END OF SECTION

SECTION 22 07 00
PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plumbing piping insulation, jackets and accessories.
   2. Plumbing equipment insulation, jackets and accessories.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 REFERENCES

A. ASTM International:
   1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   3. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
   4. ASTM C450 - Standard Practice for Prefabrication and Field Fabrication of Thermal Insulating Fitting Covers for NPS Piping, Vessel Lagging, and Dished Head Segments.
   5. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   6. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
   7. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
   8. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
   9. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
   10. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   11. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   12. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

B. National Fire Protection Association:
   1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

C. Underwriters Laboratories Inc.:
   1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

A. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

B. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84, UL 723, and NFPA 255. Any items exposed in return air plenums shall not exceed 25/50 for flame and smoke.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

D. Perform work in accordance with applicable local and state codes.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years experience.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

B. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
1. CertainTeed.
2. Knauf.
3. Johns Manville.
4. Owens-Corning.

B. Manufacturers for Closed Cell Elastomeric Insulation Products:
1. Aeroflex. Aerocell.
2. Armacell, LLC. Armaflex.
3. Nomaco. K-flex.

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.23 at 75 degrees F (0.034 at 24 degrees C).
   2. Operating Temperature Range: 0 to 850 degrees F (minus 18 to 454 degrees C).
   3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F (minus 29 to 66 degrees C).

B. TYPE P-2: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
   1. Thermal Conductivity: 0.28 at 75 degrees F (0.040 at 25 degrees C).
   2. Operating Temperature Range: Range: Minus 70 to 220 degrees F (minus 57 to 104 degrees C)

2.3 PIPE INSULATION JACKETS

A. PVC Plastic Pipe Jacket:
   1. Product Description: ASTM D1784, one-piece molded type fitting covers and sheet material, off-white color.
   2. Thickness: 30 mil (51 mm).
   3. Connections: Brush on welding adhesive or tacks.

B. Aluminum Pipe Jacket:
   1. ASTM B209.
   2. Thickness: 0.032 inch (0.80 mm) thick sheet.
   3. Finish: Embossed.
   4. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
   5. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
   6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.020 inch (0.50 mm) thick stainless steel.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches (40 mm) diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Minimum 6 inches (150 mm) long.

D. Piping 2 inches (50 mm) diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches (150 mm) long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum or stainless steel jacket single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C612; glass fiber, rigid board, noncombustible with factory applied foil scrim kraft jacket.
   1. Thermal Conductivity: 0.24 at 75 degrees F (0.035 24 degrees C).
   2. Operating Temperature Range: 0 to 450 degrees F (minus 18 to 232 degrees C).
   3. Density: 3.0 pound per cubic foot (48 kilogram per cubic meter).
   4. Jacket Temperature Limit: minus 20 to 150 degrees F (minus 29 to 66 degrees C).

B. TYPE E-2: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
   1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 25 degrees C).
   2. Operating Temperature Range: Range: Minus 70 to 220 degrees F (minus 57 to 105 degrees C).

2.6 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:
   1. Product Description: ASTM D1784, sheet material, off-white color.
   2. Minimum Service Temperature: minus 40 degrees F (minus 40 degrees C).
   3. Maximum Service Temperature: 150 degrees F (66 degrees C).
   4. Moisture Vapor Transmission: ASTM E96; 0.002 perm-inches.
   5. Thickness: 30 mil (0.75 mm).
   6. Connections: Brush on welding adhesive or tacks.
   7. PVC jackets installed outdoors shall be UV resistant.

B. Aluminum Equipment Jacket:
   1. ASTM B209.
   2. Thickness: 0.025 inch (0.64 mm) thick sheet.
   3. Finish: Embossed.
   4. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
   5. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
   6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.

2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

2.8 ADHESIVES:

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aeroseal.
      b. Armacell LCC; 520 Adhesive.
      c. Foster Products Corporation, H.B. Fuller Company; 85-75.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify piping and equipment has been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Division 07 for penetrations of assemblies with fire resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature:

1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:
1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with stud, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Hot Piping Systems at or less than 140 degrees F (60 degrees C):
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

F. Hot Piping Systems greater than 140 degrees F (60 degrees C):
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

G. Inserts and Shields:
1. Piping 1-1/2 inches (40 mm) Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches (50 mm) Diameter and Larger: Install insert between support shield and piping and under finish jacket.
    a. Insert Configuration: Minimum 6 inches (150 mm) long, of thickness and contour matching adjoining insulation; may be factory fabricated.
    b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

H. Insulation Terminating Points:
1. Condensate Piping: Insulate entire piping system and components to prevent condensation.

I. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer's recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet (3 meters) above finished floor): Finish with PVC jacket and fitting covers.

K. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

L. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

M. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like materials, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.

N. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

O. Prepare pipe insulation for finish painting. Refer to Division 09.

3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:
1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F (60 degrees C) Or Less:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment Containing Fluids Over 140 degrees F (60 degrees C):
1. Insulate flanges and unions with removable sections and jackets.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

G. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting, PVC jacket and fitting covers or aluminum jacket.

H. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

I. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

J. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

K. Prepare equipment insulation for finish painting. Refer to Division 09.

3.4 SCHEDULES

A. Water Supply Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches (mm)
Domestic Hot Water Supply and Recirculation	P-1	1-1/4 inches (50 mm) and smaller 2 inches (65 mm) and larger	1.0 (25) 1.5 (40)
Domestic Cold Water	P-1	All Sizes	1.0 (25)

B. Drainage Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches (mm)
Storm Piping (horizontal and vertical above ground within building)	P-1	All sizes	1.0 (25)
Storm Piping (vertical above ground in chases and in walls).	P-1	All sizes	0.5 (13)

C. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS inches (mm)
Roof Drain Bodies	E-1 or E-2	0.5 (13)
Domestic Water Pump Bodies	E-2	0.5 (13)

END OF SECTION

SECTION 22 08 00
COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plumbing commissioning description.
   2. Plumbing commissioning responsibilities.

B. Related Sections:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 REFERENCES

A. Associated Air Balance Council:
   1. AABC - AABC Commissioning Guideline.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE Guideline 1 - The HVAC Commissioning Process.

C. National Environmental Balancing Bureau:
   1. NEBB - Procedural Standards for Building Systems Commissioning.

1.3 COMMISSIONING DESCRIPTION

A. Plumbing commissioning process includes the following tasks:
   1. Testing and startup of Plumbing equipment and systems.
   2. Equipment and system verification checks.
   3. Assistance in functional performance testing to verify equipment and system performance.
   4. Provide qualified personnel to assist in commissioning tests, including seasonal testing.
   5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
   6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
   7. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.
   8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
   9. Provide training for systems specified in this Section with coordination by Commissioning Authority.

1.4 COMMISSIONING SUBMITTALS

A. Draft Forms: Submit draft of system verification form and functional performance test checklist.

B. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified.

C. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.

B. Operation and Maintenance Data: Submit revisions to operation and maintenance manuals when necessary revisions are discovered during commissioning.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASHRAE Guideline 1.

1.7 COMMISSIONING RESPONSIBILITIES

A. Equipment or System Installer Commissioning Responsibilities:
1. Attend commissioning meetings.
2. Provide instructions and demonstrations for Owner's personnel.
3. Ensure subcontractors perform assigned commissioning responsibilities.
4. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
5. Develop startup and initial checkout plan using manufacturer's startup procedures and functional performance checklists for equipment and systems to be commissioned.
6. During verification check and startup process, execute plumbing related portions of checklists for equipment and systems to be commissioned.
7. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
8. Provide manufacturer's representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
9. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
10. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
11. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
12. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
13. Provide factory supervised startup services for equipment and systems so specified. Coordinate work with manufacturer and Commissioning Authority.
14. Perform verification checks and startup on equipment and systems as specified.
15. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
16. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
17. Conduct plumbing system orientation and inspection.

1.8 COMMISSIONING MEETINGS

A. Attend initial commissioning meeting and progress commissioning meetings as required by Commissioning Authority.

1.9 SCHEDULING

A. Prepare schedule indicating anticipated start dates for the following:
   1. Piping system pressure testing.
   2. Piping system flushing and cleaning.
   3. Equipment and system startups.
   4. Plumbing system orientation and inspections.
   5. Operation and maintenance manual submittals.
   6. Training sessions.

B. Schedule seasonal tests of equipment and systems during peak weather conditions to observe full-load performance.

1.10 COORDINATION

A. Notify Commissioning Authority minimum of four weeks in advance of the following:
   1. Scheduled equipment and system startups.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install additional balancing valves, access doors, test ports, and pressure and temperature taps required by Commissioning Authority.

B. Place plumbing systems and equipment into full operation and continue operation during each working day of commissioning.

END OF SECTION

SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
   2. Building service entrance piping extending to 5'-0" outside the building.
   3. Flexible connectors.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUBMITTALS

A. Product Data: For the following products:
   1. Piping.
   2. Piping fittings.
   3. Flexible connectors.

B. Coordination Drawings.

C. Field quality-control reports.

1.3 QUALITY ASSURANCE

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

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

1.4 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 no fewer than two days in advance of proposed interruption of water service.
   2. Do not proceed with interruption of water service without Architect's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L or K (ASTM B 88M, Type A or B) water tube, drawn temper.
   1. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

3. 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.
4. Copper Pressure-Seal-Joint Fittings: ASME B16.18 or ASME B16.23.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Viega; Plumbing and Heating Systems
      2) Preapproved equal
   b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
   c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
5. Copper-Tube Extruded-Tee Connections:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) T-DRILL Industries Inc.
   b. Description: Tee formed in copper tube according to ASTM F 2014.
   c. Use only for mains of 2-1/2" line size and larger with branch lines at least two pipe sizes smaller than the main.
6. Rolled Grooved-Joint Copper-Tube Appurtenances:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Victaulic Company
      2) Anvil International (Gruvlok).
   b. Copper Grooved-End Fittings: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
   c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606 - include ferrous housing sections, EPDM rubber gaskets suitable for hot and cold water and bolts and nuts.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) water tube, annealed temper.
   1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) 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, 95-5 Tin-Antimony 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.

2.4 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
   2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).

2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 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." Install tubing without joints if possible. If joints are required, they shall be brazed.

C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.

D. Install shutoff valve immediately upstream of each dielectric fitting.

E. Where water pressure exceeds 80 psig, install water-pressure-reducing valves downstream from building shutoff valve.

F. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

H. 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.

I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space. Provide space to permit insulation applications, with 1 inch clearance outside the insulation.

J. Install piping adjacent to equipment and specialties to allow service and maintenance.

K. Install piping to permit valve servicing.

L. 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.

M. Install piping free of sags and bends.

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

O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

P. Install pressure gages on suction and discharge piping from each plumbing pump.

Q. Install thermostats in hot-water circulation piping.

R. Install thermometers on inlet and outlet piping from each water heater.

3.2 JOINT CONSTRUCTION

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

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. 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."

F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

H. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.

I. 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.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

K. Provide air compression chambers equal to 12 pipe diameters, 18" maximum, on all water supply connections to fixtures and equipment, except where water hammer arresters are installed.

3.3 VALVE INSTALLATION

A. 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 (DN 50) and smaller. Use butterfly valves for piping NPS 2-1/2 (DN 65) and larger.

B. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
   1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
   2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

C. Install calibrated balancing valves in each hot-water circulation return branch of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
   2. NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.6 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge manifold connections to each domestic water booster pump.

B. Install bronze-hose flexible connectors in copper domestic water tubing.

C. Install stainless-steel-hose flexible connectors in stainless steel domestic water piping.

3.7 WATER METER INSTALLATION

A. Water meters will be furnished and installed by utility company. Coordinate all requirements with utility company.

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

B. Support piping and tubing not otherwise listed according to MSS SP-69, plumbing code, and manufacturer's written instructions.

3.9 CONNECTIONS

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

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

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code.
   3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.10 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

3.11 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.12 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entry into building.

B. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal

components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.13 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 section "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT" for identification of materials and installation.

B. Where multiple system pressures exist, label pressure piping with system operating pressure.

3.14 FIELD QUALITY CONTROL

A. 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.

B. 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 (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow standing 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.

C. Domestic water piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.15 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Adjust calibrated balancing valves in hot-water-circulation return piping to provide adequate flow or to flows indicated.
   5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.16 CLEANING

A. Clean and disinfect 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 (50 mg/L) of chlorine. Isolate with valves and allow standing for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow standing for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.17 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated. Use minimum number of joints possible in below floor piping.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

DOMESTIC WATER PIPING SERVICE DESCRIPTION	PIPING	FITTINGS

Building Service Entrance Piping NPS 3 (DN 80) and smaller	Hard Copper Tube Type K (Type A)	Wrought Copper Brazed Joints
Building Service Entrance Piping NPS 4 to NPS 8 (DN 100 to DN 200) and larger	Hard Copper Tube Type K (Type A)	Wrought Copper Brazed Joints
	Ductile-Iron	Mechanical Joint with Restrained Joints
Under-Building Slab NPS 2 (DN 50) and smaller	Soft Copper Tube Type K (Type A)	Wrought Copper Brazed Joints (only where joints are required)
Above Ground NPS 2 (DN 50) and smaller	Hard Copper Tube Type L (Type B)	Wrought Copper Soldered Joints
		Copper Pressure-Seal Pressure Sealed Joints
Above Ground NPS 2-1/2 to NPS 6 (DN 65 to DN 150)	Hard Copper Tube Type L (Type B)	Wrought Copper Soldered Joints
		Copper Pressure-Seal Pressure-Sealed Joints
		Grooved Joints
Above Ground NPS 8 (DN 200) and larger	Hard Copper Tube Type L (Type B)	Grooved Joints

3.18 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 (DN 50) and smaller. Use butterfly valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
   2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
   3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
   4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION

SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following domestic water piping specialties:
1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose bibbs.
9. Wall hydrants.
10. Ground hydrants.
11. Post hydrants.
12. Drain valves.
13. Water hammer arresters.
14. Air vents.
15. Trap-seal primer valves.

B. Related Documents:
1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

1.3 SUBMITTALS

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

B. Field quality-control test reports.

C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. NSF Compliance:
1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. FEBCO; SPX Valves & Controls.
   e. Watts Industries, Inc.; Water Products Div.
   f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze or chrome plate.
7. Operation: Anti-siphon, anti-spill, not for operation under continuous pressure.

B. Low Hazard Hose-Connection Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. MIFAB, Inc.
   d. Prier Products, Inc.
   e. Watts Industries, Inc.; Water Products Div.
   f. Woodford Manufacturing Company.
   g. Zurn Plumbing Products Group.
2. Standard: ASSE 1011.
3. Body: Bronze, non-removable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Match faucet or hydrant finish.

C. Pressure Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Accessories:
   a. Valves: Ball type, on inlet and outlet.
6. Use freeze-resistant type for outside installations.

D. Laboratory-Faucet Vacuum Breaker:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Woodford Manufacturing Company.
   d. Zurn Plumbing Products Group; Wilkins Div.
   e. Faucet Manufacturer.
2. Standard: ASSE 1035.
3. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10) matching faucet size.
4. Body: Bronze.
5. End Connections: Threaded.

6. Finish: Chrome plated.

E. Spill-Resistant Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Accessories:
   a. Valves: Ball type, on inlet and outlet.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers (RPZ):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig (83 kPa) maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.
6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
7. Configuration: Designed for horizontal, straight through flow or as indicated on the drawings.
8. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
   b. Strainer on inlet.
   c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check Backflow-Prevention Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.
6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
7. Configuration: Designed for horizontal, straight through flow, or as indicated on drawings.

8. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

C. Dual-Check-Valve Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. McDonald, A. Y. Mfg. Co.
   e. Mueller Co.; Water Products Div.
   f. Watts Industries, Inc.; Water Products Div.
   g. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.
4. Body: Bronze with union inlet.

D. High Hazard Hose Hose-Connection Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Woodford Manufacturing Company.
2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water (30-kPa) back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm (0.19-L/s) flow.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. Honeywell Water Controls.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
4. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
5. Valves for Booster Heater Water Supply: Include integral bypass.
6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

B. Water Control Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Watts Industries, Inc.; Ames Fluid Control Systems.
   b. Watts Industries, Inc.; Watts ACV.
   c. Zurn Plumbing Products Group; Wilkins Div.
2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve.

3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa) minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
   a. Pattern: Angle or globe valve design.
   b. Trim: Stainless steel.
5. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.

2.4 CALIBRATED BALANCE VALVES (MANUAL BALANCE VALVES)

A. Manufacturer: Subject to compliance with requirements, provide calibrated balance valves by one of the following:
   1. Armstrong Model CBV-S.CBV-T (1/2" through 2")
   2. Armstrong Model CBV-A/CBV-A (2 ½" through 12")
   3. MEPCO Model MBVS/MBVT (1/2" through 2")
   4. MEPCO Model MBVF (2 ½" through 12")
   5. Tour: Anderson Model STAS/STAD (1/2" through 2")
   6. Tour: Anderson Model STAG/STAF (2 ½" through 12")
   7. TACO Model ACUF-AC/ACUF-AT (1/2" through 2")
   8. TACO Model ACUF-F (2 ½" through 4")
   9. Flow Design Flow-set Model AS-S WT/AS-FPT (1/2" through 2")
   10. Flow Design Flow-set Model AG/AF (2 ½" through 14")

B. General: Provide as indicated, calibrated balance valves equipped with readout test ports to facilitate connecting of a differential pressure meter to balance valves. Equip each readout test port with integral EPT check valve designed to minimize system fluid loss during balancing process. Provide calibrated nameplate to indicate degree of closure of precision machined orifice with tamper resistant memory step. Valves shall be capable of positive shut-off with no leakage.

C. Features: Balancing Valves in sizes ½" through 2" shall be of bronze body construction with solder or NPT connections to match piping systems. Balancing valves in sizes 2 ½" through 12" shall be of cast iron body design conforming to ASME/ANSI B16.5 with brass interior parts and flanged or grooved connections to match piping systems. Construct each valve for a minimum of 125 psig working pressure at a temperature of 250 F, and supplied with a preformed insulated housing suitable for use on heating and cooling systems. Insulation shall have a flame spread not to exceed 25, fuel contributed not to exceed 50 and smoke developed rating not to exceed 50.
   1. Provide each valve with an engraved valve tag attached permanently to valve with brass chain or wire link manufactured specifically for that purpose. A valve schedule suitable for framing shall be provided referring each valve by sequenced number and indicating a minimum of valve size, model, manufacturer, piping system and unit served if applicable. A copy of the valve schedule shall be provided with balancing valve shop drawings submittals.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
   1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
   2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating for NPS 2-1/2 (DN 65) and larger.
   3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
   4. Screen: Stainless steel with round perforations, unless otherwise indicated.
   5. Perforation Size:
      a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).

b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
c. Strainers NPS 5 (DN 125) and Larger: 0.10 inch (2.54 mm).

6. Drain: Factory-installed, hose-end drain valve.

2.6 OUTLET BOXES

A. Clothes Washer Outlet Boxes:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Acorn Engineering Company.
b. Guy Gray Manufacturing Co., Inc.
c. IPS Corp.
d. Oatey.
e. Plastic Oddities
f. Sioux Chief
g. Symmons Industries, Inc.
h. Watts Industries, Inc.; Water Products Div.
i. Zurn Plumbing Products Group; Light Commercial Operation.
2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel or plastic box and faceplate.
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 (DN 15) gate, globe, or ball valves and NPS 1/2 (DN 15) copper, water tubing.
6. Drain: NPS 2 (DN 50) standpipe and P-trap for direct waste connection to drainage piping.
7. In fire rated assemblies, the installation shall be listed to maintain the fire rating.

B. Icemaker Outlet Boxes:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Acorn Engineering Company.
b. Guy Gray Manufacturing Co., Inc.
c. IPS Corp.
d. Oatey.
e. Plastic Oddities
f. Sioux Chief.
2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel or plastic box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 (DN 15) gate, globe, or ball valve and NPS 1/2 (DN 15) copper, water tubing.
6. In fire rated assemblies, the installation shall be listed to maintain the fire rating.

2.7 HOSE BIBBS

A. Hose Bibbs (HB):
1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig (860 kPa).

7. Vacuum Breaker: Integral non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.8 WALL HYDRANTS

A. Nonfreeze Wall Hydrants (WH):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company.
   b. MIFAB, Inc.
   c. Prier Products, Inc.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Woodford Manufacturing Company.
   h. Zurn Plumbing Products Group.
2. Standard: ASME A112.21.3M for concealed or exposed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig (860 kPa).
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 (DN 20 or DN 25).
7. Outlet: Concealed, with integral ASSE 1052 approved vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze or chrome plated, stainless steel, polished bronze or plain bronze as selected by the Architect.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze or chrome plated.
12. Operating Key: One with each wall hydrant.

B. Non-freeze, Hot- and Cold-Water Wall Hydrants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company.
   b. Prier Products, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, 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-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig (860 kPa).
4. Operation: Loose key.
5. Casings and Operating Rods: Of length required to match wall thickness. Include wall clamps.
6. Inlets: NPS 3/4 or NPS 1 (DN 20 or DN 25).

7. Outlet: Concealed.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze or chrome plated, stainless steel, polished bronze or plain bronze as selected by the Architect.
10. Vacuum Breaker: Non-removable, manual-drain-type, hose-connection backflow preventer complying with ASSE 1052 and with garden-hose thread complying with ASME B1.20.7 on outlet.
11. Operating Key: One with each wall hydrant.

C. Vacuum Breaker Wall Hydrants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. McDonald, A. Y. Mfg. Co.
   b. Prier Products, Inc.
   c. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Watts Industries, Inc.; Water Products Div.
   e. Woodford Manufacturing Company.
   f. Zurn Plumbing Products Group; Light Commercial Operation.
2. Standard: ASSE 1019, Type A or Type B.
3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
5. Pressure Rating: 125 psig (860 kPa).
6. Operation: Loose key.
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.9 POST HYDRANTS

A. Non-freeze, Draining-Type Post Hydrants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.
   b. Prier Products, Inc.
   c. Simmons Manufacturing Co.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Woodford Manufacturing Company.
   h. Zurn Plumbing Products Group.
2. Standard: ASME A112.21.3M.
3. Type: Nonfreeze, exposed-outlet post hydrant.
4. Operation: Loose key.
5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
6. Casing: Bronze with casing guard.
7. Inlet: NPS 3/4 (DN 20).
8. Outlet: Garden-hose thread complying with ASME B1.20.7.
9. Drain: Designed with hole to drain into ground when shut off.

B. Nonfreeze, Nondraining-Type Post Hydrants
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Murdock, Inc.
   b. Other manufacturers by prior approval.

2. Operation: Lever-piston operating mechanism and nondraining water-storage reservoir, designed without drain.
3. Length: As required for burial of valve below frost line.
4. Inlet: NPS 1 (DN 25) threaded.
5. Outlet: NPS 1 by NPS 3/4 (DN 25 by DN20) adapter with nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011; and garden-hose thread complying with ASME B1.20.7 on outlet or NPS 1 by NPS 3/4 (DN 25 by DN20) adapter with nonremovable, drainable, hose-connection backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

C. Freeze-Resistant Sanitary Yard Hydrants (YH):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hoeptner Products.
2. Standard: ASSE 1057, Type 5 for nondraining hydrants.
3. Operation: Wheel handle.
4. Head: Copper alloy, with pail hook.
5. Inlet: NPS 3/4-inch (DN20) threaded inlet and inlet nozzle, galvanized-steel riser, and venturi.
6. Canister: Plastic with atmospheric-vent device.
7. Vacuum Breaker: Removable hose-connection backflow preventer complying with ASSE 1052 with garden-hose thread complying with ASME B1.20.7 on outlet for field installation.

2.10 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4 (DN 20).
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 (DN 20) threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:
1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig (1380-kPa) minimum CWP or Class 125.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 (DN 6) side outlet with cap.

2.11 WATER HAMMER ARRESTERS

A. Water Hammer Arresters (WHA-X*):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. PPP Inc.
   b. Sioux Chief Manufacturing Company, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.
5. Water hammer arresters shown in inaccessible locations shall be approved for that application.

* P.D.I. Size

2.12 AIR VENTS

A. Bolted-Construction Automatic Air Vents:
   1. Body: Bronze.
   2. Pressure Rating: 125-psig (860-kPa) minimum pressure rating at 140 deg F (60 deg C).
   3. Float: Replaceable, corrosion-resistant metal.
   4. Mechanism and Seat: Stainless steel.
   5. Size: NPS 3/8 (DN 10) minimum inlet.
   6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:
   1. Body: Stainless steel.
   2. Pressure Rating: 150-psig (1035-kPa) minimum pressure rating.
   3. Float: Replaceable, corrosion-resistant metal.
   4. Mechanism and Seat: Stainless steel.
   5. Size: NPS 3/8 (DN 10) minimum inlet.
   6. Inlet and Vent Outlet End Connections: Threaded.

2.13 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. MIFAB, Inc.
      b. PPP Inc.
      c. Sioux Chief Manufacturing Company, Inc.
   2. Type: Pressure actuated can be installed on water lines 1 1/2" and less, requiring no adjustment.
   3. Standard: ASSE 1018.
   4. Pressure Rating: 125 psig (860 kPa) minimum.
   5. Body: Bronze or brass.
   6. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
   7. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
   8. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
   9. Provide distribution unit as required to serve multiple drains.

B. Flush-Valve, Trap-Seal Primer Valve:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Sloan
      b. Other manufacturers by prior approval only.

2. Operation: Each time the flush valve of the water closet is operated, a small amount of water is diverted from the vacuum breaker assembly of the flush valve to the floor drain.
3. Primer valve consists of elbow, water deflector, 12" tubing, wall flange and fittings. Exposed parts are chrome plated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system, unless indicated otherwise on drawings.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain, or as shown. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.
4. Install backflow preventers in the orientation (vertical up, vertical down, horizontal, etc.) for which it is approved.

C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

D. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

E. Install balancing valves in locations where they can easily be adjusted.

F. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
1. Install thermometers and water regulators as 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, and solenoid valve.

H. Install outlet boxes recessed in wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking wall reinforcement between studs.

I. Install ground hydrants with 1 cu. yd. (0.75 cu. m) of crushed gravel around drain hole. Set ground hydrants with box flush with grade.

J. Install draining-type post hydrants with 1 cu. yd. (0.75 cu. m) of crushed gravel around drain hole. Set post hydrants in concrete paving.

K. Install non-freeze, non-draining type post hydrants set in concrete or pavement.

L. Install water hammer arresters in water piping according to PDI-WH 201 and as shown on the plans.

M. Install air vents at high points of water piping. Install drain piping and discharge to floor drain or mop basin.

N. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow. Install in accessible location, and per manufacturer's instructions.

O. Install vacuum breakers per manufacturer's instructions observe critical level of vacuum breaker above outlet of water or source of possible contamination.

3.2 CONNECTIONS

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

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate valve tag or nameplate on or near each of the following:
1. Vacuum breakers.
2. Reduced-pressure-principle backflow preventers.
3. Double-check backflow-prevention assemblies.
4. Dual-check-valve backflow preventers.
5. Water pressure-reducing valves.
6. Calibrated balancing valves.
7. Primary, thermostatic, water mixing valves.
8. Manifold, thermostatic, water-mixing-valve assemblies.
9. Primary water tempering valves.
10. Supply-type, trap-seal primer valves.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
1. Test each vacuum breaker and backflow preventer 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. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION

SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 DEFINITIONS

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

B. LLDPE: Linear, low-density polyethylene plastic.

C. NBR: Acrylonitrile-butadiene rubber.

D. PE: Polyethylene plastic.

E. PVC: Polyvinyl chloride plastic.

F. TPE: Thermoplastic elastomer.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).

1.4 SUBMITTALS

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

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

C. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping and "NSF-SEWER" for plastic sewer piping.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: 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 no fewer than two days in advance of proposed interruption of sanitary waste service.

2. Do not proceed with interruption of sanitary waste service without Architect's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Charlotte Pipe
   c. Dallas Specialty & Mfg. Co.
   d. Fernco Inc.
   e. Matco-Norca, Inc.
   f. MIFAB, Inc.
   g. Mission Rubber Company; a division of MCP Industries, Inc.
   h. Stant.
   i. Tyler Pipe.
2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Charlotte Pipe
   c. Clamp-All Corp.
   d. Dallas Specialty & Mfg. Co.
   e. MIFAB, Inc.
   f. Mission Rubber Company; a division of MCP Industries, Inc.
   g. Stant.
   h. Tyler Pipe.
2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MG Piping Products Company.
   b. Other manufacturer by prior approval only.
2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.

B. Steel Pipe Pressure Fittings:
   1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
   2. 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.
   3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

C. Cast-Iron Flanges: ASME B16.1, Class 125.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.5 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.6 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.
   1. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564.
   1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Shielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cascade Waterworks Mfg. Co.
         2) Mission Rubber Company; a division of MCP Industries, Inc.

b. Standard: ASTM C 1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

4. Pressure Transition Couplings:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Cascade Waterworks Mfg. Co.
2) Dresser, Inc.
3) EBAA Iron, Inc.
4) JCM Industries, Inc.
5) Romac Industries, Inc.
6) Smith-Blair, Inc.; a Sensus company.
7) The Ford Meter Box Company, Inc.
8) Viking Johnson.
b. Standard: AWWA C219.
c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: Manufacturer's standard.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:
1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Flanges:
a. Description:
1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
3. Dielectric-Flange Insulating Kits:
a. Description:
1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig (1035 kPa).
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.
4. Dielectric Nipples:
a. Description:
1) Electroplated steel nipple complying with ASTM F 1545.
2) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
3) End Connections: Male threaded or grooved.
4) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31.

3.2 EXAMINATION

A. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

B. Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.

C. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.3 PREPARATION OF FOUNDATION FOR UNDERGROUND BUILDING DRAINS

A. Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.

B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicate invert elevation.

C. Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand backfill. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation.

3.4 PIPING INSTALLATION

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

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of

piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
   1. Horizontal Sanitary Drain Piping: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
   2. Vent Piping: Shall slope down toward vertical fixture vent.

N. 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."

O. Install steel piping according to applicable plumbing code.

P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

Q. Install aboveground PVC piping according to ASTM D 2665.

R. Install underground PVC piping according to ASTM D 2321.

S. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
   2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

U. 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."

V. Install mechanical sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for mechanical sleeve seals specified in Division 22 Section "Common Work Results for Plumbing."

W. 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."

3.5 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads 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.

D. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

E. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

G. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.6 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.
3. In Aboveground Pressure Piping: Fitting-type transition couplings.
4. In Underground Pressure Piping:
a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100: Use dielectric flanges or flange kits.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support piping and tubing not otherwise listed above according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

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

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in risers near floor and floor cleanouts with cover flush with floor.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.9 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.10 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If piping does 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 sanitary drainage and vent 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 drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
   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 required corrective action.

E. Test pressure 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 pressure 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 (345 kPa) 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.

3.11 CLEANING AND PROTECTION

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.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.12 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

Soil & Waste Piping	Above Ground	4" (DN100) and smaller	Service class, cast-iron soil pipe & fittings; gaskets; & gasketed joints.
			Hubless, cast-iron soil pipe & fittings; CISPI hubless-piping couplings; & cast-iron, hubless-piping couplings.
			Copper DWV tube, copper drainage fittings, and soldered joints
			Solid-wall PVC pipe, PVC socket fittings, & solvent-cemented joints. (a)
Soil & Waste Piping	Above Ground	5" (DN125) and larger	Service class, cast-iron soil pipe & fittings; gaskets; & gasketed joints.
			Hubless, cast-iron, soil pipe & fittings; CISPI hubless piping couplings; & cast-iron, hubless-piping couplings.
			Solid-wall PVC pipe, PVC socket fittings, & solvent-cemented joints. (a)
Vent Piping	Above Ground	4" (DN100) and smaller	Service class, cast-iron soil pipe & fittings; gaskets; & gasketed joints.
			Hubless, cast-iron, soil pipe & fittings; CISPI hubless piping couplings; & coupled joints.
			Copper DWV tube, copper drainage fittings, & soldered joints
			Solid-wall PVC pipe, PVC socket fittings, & solvent-cemented joints. (a)
Vent Piping	Above Ground	5" (DN125) and larger	Service class, cast-iron soil pipe & fittings; gaskets; & gasketed joints.
			Hubless, cast-iron, soil pipe & fittings; CISPI hubless piping couplings; & cast-iron, hubless-piping couplings.
			Solid-wall PVC pipe, PVC socket fittings, & solvent-cemented joints. (a)
Soil, Waste & Vent Piping	Underground	All Sizes	Service class, cast-iron soil piping; gaskets; & gasketed joints.
			Solid-wall PVC pipe (to NPS 12 (DN300); PVC socket fittings; & solvent-cemented joints.

Notes: (a) This piping material is not to be installed in a return air plenum.

END OF SECTION

SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:
   1. Backwater valves.
   2. Cleanouts.
   3. Floor drains.
   4. Floor sinks.
   5. Trench drains.
   6. Garage Drains.
   7. Air-admittance valves.
   8. Miscellaneous sanitary drainage piping specialties.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Division, may contain requirements that relate to this section.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

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

B. Field quality-control test reports.

C. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.5 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 size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts (CO):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, 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. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts (CO):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: If required.
7. Outlet Connection: Inside calk or spigot.
8. Closure: Brass plug with straight threads and gasket, or brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round (standard) or square where located in tile floor.
12. Top Loading Classification: Heavy duty where vehicle traffic is possible. Medium duty in all other areas.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts (WCO):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, 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. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. PVC Products are not to be utilized in return air plenums.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains (FD) or (FD-1):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Cast iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Top or Strainer Material: Nickel bronze.
10. Top of Body and Strainer Finish: Nickel bronze.
11. Top Shape: Square in tile floors, round in other applications.
12. Dimensions of Top or Strainer: 5" x 5" or 5"ø for 2" outlet, 6" x 6" or 6"ø for 3" outlet, 8" x 8" or 8"ø for 4" outlet.
13. Top Loading Classification: Light Duty.
14. Funnel: If indicated provide 4" ø x 4" high funnel.
15. Trap Material: Cast iron.
16. Trap Pattern: Deep-seal P-trap.
17. Trap Features: Trap-seal primer valve drain connection if required.

2.3 FLOOR SINKS:

A. Cast-Iron Floor Sinks (FS) or (FS-1):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Division
   e. Watts Drainage Products, Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3
3. Pattern: Sanitary drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: As required to suit project conditions.
7. Clamping Device: As required to suit project conditions.
8. Outlet: Bottom.
9. Coating on Interior Surfaces: Acid-resistant porcelain enamel.
10. Sediment Bucket: Aluminum.
11. Top of Body Finish: Nickel bronze or acid-resistant porcelain enamel.
12. Top Shape: Square.
13. Grate: Half, three quarter, or full hinged grate as indicated on drawings.
14. Dimensions: 12" x 12" top, 9" x 9" x 8" minimum deep body.

15. Trap Material: Cast iron.
16. Trap Pattern: Deep-seal P-trap.

B. Cast-Iron Floor Sinks (FS-2):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Division
   e. Watts Drainage Products, Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3
3. Pattern: Sanitary drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: As required to suit project conditions.
7. Clamping Device: As required to suit project conditions.
8. Outlet: Bottom.
9. Coating on Interior Surfaces: Acid-resistant porcelain enamel.
10. Sediment Bucket: Aluminum.
11. Top of Body Finish: Nickel bronze or acid-resistant porcelain enamel.
12. Top Shape: Square.
13. Grate: Half, three quarter, or full hinged grate as indicated on drawings.
14. Dimensions: 8" x 8" top, 7" x 7" x 6" minimum deep body.
15. Trap Material: Cast iron.
16. Trap Pattern: Deep-seal P-trap.

C. Cast-Iron Floor Sinks (FS-3):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Division
   e. Watts Drainage Products, Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3
3. Pattern: Sanitary drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: As required to suit project conditions.
7. Clamping Device: As required to suit project conditions.
8. Outlet: Bottom.
9. Coating on Interior Surfaces: Acid-resistant porcelain enamel.
10. Sediment Bucket: Aluminum.
11. Top of Body Finish: Nickel bronze or acid-resistant porcelain enamel.
12. Top Shape: Square.
13. Grate: Half, three quarter, or full hinged grate as indicated on drawings.
14. Dimensions: 12" x 12" top, 12" x 12" x 8" minimum deep body.
15. Trap Material: Cast iron.
16. Trap Pattern: Deep-seal P-trap.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains (Hub Drains):

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping.
3. Use these drains only where shown on drawings and subject to approval of local authorities.

B. Deep-Seal Traps:
1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
   a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
   b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:
1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

D. Air-Gap Fittings:
1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:
1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches (51 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stacks piping.

F. Stack Flashing Fittings:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:
1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:
1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper or galvanized steel.
2. Design: To provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:
1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

J. Trap Seal:

1. Manufacturer: "Trap Guard" as manufactured by ProSet. Similar design by "Sure Seal" is acceptable.
2. Description: Manufactured smooth, soft, flexible elastomeric PVC material molded into shape of duck's bill with closure at bottom, open ring at top.
3. Design: Allows wastewater to open and adequately discharge through its interior. Closes and return to its original molded shape after wastewater discharge is complete.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backwater valves in building drain piping where shown or required by code. For interior installation, provide cleanout cover flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) 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 (30 m).
4. Locate at base of each vertical soil and waste stack.

D. For floor cleanouts for piping below floors, install cleanout covers with top flush with finished floor.

E. For cleanouts in piping concealed in wall, install cleanout wall access covers, of types indicated, with cover flush with finished wall.

F. Install floor drains and floor sinks at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
2. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
3. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

G. Install fixture air-admittance valves on fixture drain piping. Install air-admittance valves only when allowed by code and where specifically shown on the drawings.

H. Install stack air-admittance valves at top of stack vent and vent stack piping. Install air-admittance valves only when allowed by code and where specifically shown on the drawings.

I. Install air-admittance-valve wall boxes recessed in wall. Install air-admittance valves only when allowed by code and where specifically shown on the drawings.

J. Install roof flashing assemblies or fittings on sanitary stack vents and vent stacks that extend through roof. Type shall meet roofing specification and/or detail requirements and shall meet roofing manufacturer's requirements.

K. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

L. Install through-penetration firestop assemblies in stacks at floor penetrations.

M. Assemble open drain fittings and install with top of hub 2 inches (51 mm) above floor.

N. Install deep-seal traps on floor drains and other waste outlets.

O. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: 1/2".

P. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

Q. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

R. Install vent caps on each vent pipe passing through roof.

S. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

T. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

U. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

V. Install wood-blocking reinforcement for wall-mounting-type specialties.

W. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

X. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

Y. Install trap seal in floor drains where indicated and where allowed by authorities having jurisdiction in lieu of trap primers to maintain floor drain traps.

3.2 CONNECTIONS

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

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

3.3 PROTECTION

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

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

END OF SECTION

SECTION 22 14 16
STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.

B. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 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 (30 kPa).

1.3 SUBMITTALS

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

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

B. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and shall be listed by NSF International.

C. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Storm-Drainage Service: 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 no fewer than two days in advance of proposed interruption of storm-drainage service.
   2. Do not proceed with interruption of storm-drainage service without Architect's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service classes.

B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Charlotte Pipe
      c. Dallas Specialty & Mfg. Co.
      d. Fernco Inc.
      e. Matco-Norca, Inc.
      f. MIFAB, Inc.
      g. Mission Rubber Company; a division of MCP Industries, Inc.
      h. Stant.
      i. Tyler Pipe.
   2. Standards: ASTM C 1277 and CISPI 310.
   3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight. Include square-cut-grooved or threaded ends matching joining method.

B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12 threaded.

C. Steel-Pipe Pressure Fittings:
   1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
   2. 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.
   3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Cast-Iron Flanges: ASME B16.1, Class 125.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.5 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.
   1. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564.
   1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Shielded, Non-pressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cascade Waterworks Mfg. Co.
      2) Mission Rubber Company; a division of MCP Industries, Inc.
   b. Standard: ASTM C 1460.
   c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Dielectric Fittings:
1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Flanges:
   a. Description:
      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 150 psig (1035 kPa).
      4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
3. Dielectric-Flange Insulating Kits:
   a. Description:
      1) Non-conducting materials for field assembly of companion flanges.
      2) Pressure Rating: 150 psig (1035 kPa).
      3) Gasket: Neoprene or phenolic.
      4) Bolt Sleeves: Phenolic or polyethylene.
      5) Washers: Phenolic with steel-backing washers.
4. Dielectric Nipples:
   a. Description:
      1) Electroplated steel nipple complying with ASTM F 1545.
      2) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
      3) End Connections: Male threaded or grooved.
      4) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31.

3.2 EXAMINATION

A. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.3 PREPARATION OF FOUNDATION FOR UNDERGROUND STORM DRAINS

A. Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.

B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicate invert elevation.

C. Shape bottom of trench to fit bottom of pipe for 90 degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand backfill. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pie barrel on the foundation.

3.4 PIPING INSTALLATION

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

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration Controls for Plumbing Piping and Equipment."

K. 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.

L. 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.

M. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
   1. Building Storm Drain: 1 percent downward in direction of flow.
   2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.

N. 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."

O. Install steel piping according to applicable plumbing code.

P. Install aboveground PVC piping according to ASTM D 2665.

Q. Install underground PVC piping according to ASTM D 2321.

R. Install engineered controlled-flow and siphonic drain specialties and storm drainage piping in locations indicated.

S. Install pressure piping at elevations indicated.

T. Plumbing Specialties:
   1. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Storm Drainage Piping Specialties."
   2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage pressure piping. Comply with requirements for cleanouts specified in Division 22 Section "Storm Drainage Piping Specialties."
   3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Storm Drainage Piping Specialties."

U. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

V. 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."

W. Install mechanical sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for mechanical sleeve seals specified in Division 22Section "Common Work Results for Plumbing."

X. 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."

3.5 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads 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.

D. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

E. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

F. Plastic, Non-pressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.6 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Shielded, non-pressure transition couplings.

3. In Aboveground Pressure Piping: Fitting-type transition couplings.
4. In Underground Pressure Piping:
   a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
   b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges or flange kits.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support piping and tubing not otherwise listed according to MSS SP-69 and manufacturer's written instructions.

3.8 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.
1. Install test tees (wall cleanouts) in rainleaders near floor, and floor cleanouts with cover flush with floor.
2. Comply with requirements for backwater valves, cleanouts, and drains specified in Division 22 Section "Storm Drainage Piping Specialties."

D. Connect pressure piping to the following:
1. Drainage piping where shown on the drawings.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:
1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.9 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.10 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 piping does 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 (30 kPa). From 15 minutes before inspection starts until 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 pressure 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 pressure 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 (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow standing 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.

3.11 CLEANING

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

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

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.12 PIPING SCHEDULE

SERVICE DESCRIPTION	LOCATION	SIZE	PIPING AND FITTINGS
Storm Drainage Piping (Rainleaders)	Above Ground	6" and Smaller	Service class, cast-iron soil pipe & fittings; gaskets; & gasketed joints.
			Hubless, cast-iron soil pipe & fittings; CISPI hubless-piping couplings; or heavy duty hubless-piping couplings.
		12" and Smaller	Solid-wall PVC pipe, PVC socket fittings, & solvent-cemented joints. (a)
Storm Drainage Piping (Rainleaders)	Above Ground	8" and Larger	Service class, cast-iron soil pipe & fittings; gaskets; & gasketed joints.
			Hubless, cast-iron soil pipe & fittings; heavy duty hubless-piping couplings; & cast-iron, hubless-piping couplings.
		12" and Smaller	Solid-wall PVC pipe, PVC socket fittings, & solvent-cemented joints. (a)

Storm Drainage Piping (Rainleaders)	Above Ground	18" and Larger	Galvanized -steel pipe, drainage fittings and grooved joints.
Storm Drainage Piping (Rainleaders)	Underground	All Sizes	Service class, cast-iron soil piping; gaskets; & gasketed joints.
			Solid-wall PVC pipe (to NPS 12 (DN300); PVC socket fittings; & solvent-cemented joints.

NOTES: (a) PVC piping material is not to be installed in a return air plenum

END OF SECTION

SECTION 22 14 19
STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof drains.
   2. Miscellaneous storm drainage piping specialties.
   3. Cleanouts.

B. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. NPS 6 (DN 150) and Larger Cast-Iron, Large-Sump, General-Purpose Roof Drains (RD or RD-1).
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfg. Co.
      d. Tyler Pipe. (Wade)
      e. Watts Water Technologies, Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.6.4, for general-purpose roof drains.
   3. Body Material: Cast iron.
   4. Dimension of Body: Nominal 14-inch (357-mm) diameter.
   5. Combination Flashing Ring and Gravel Stop: Required.
   6. Extension Collars: Required when roof insulation exceeds 2" at drain.
   7. Underdeck Clamp: Required.
   8. Expansion Joint: As required.
   9. Sump Receiver Plate or Bearing Pan: As required to suit project conditions.
   10. Dam: Required on overflow roof drains to elevate drain flow 2" above primary roof drain.
   11. Dome Material: Cast iron.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected downspout.
3. Finish: nickel bronze, polished bronze or plain bronze as selected by the Architect.

2.3 CLEANOUTS

A. Exposed Metal Cleanouts (CO):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, 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. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Floor Cleanouts (CO):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: If required.
7. Outlet Connection: Inside calk or spigot.
8. Closure: Brass plug with straight threads and gasket, or brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Heavy duty where vehicle traffic is possible, medium duty in all other areas.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts (WCO):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, 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. Include wall access.
3. Size: Same as connected drainage piping.

4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

D. Plastic Floor Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Oatey
   b. Plastic Oddities; a division of Diverse Corporate Technologies.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Zurn Plumbing Products Group; Light Commercial Operation.
2. Size: Same as connected branch.
3. Body: PVC.
4. Closure Plug: PVC.
5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.
6. Adjustable Housing Material: PVC with threaded brass inserts.
7. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
8. Frame and Cover Material Shape: Round (standard) or square where located in tile floor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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 Sections.
1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.
4. Overflow roof drains shall have a 2" dam or be positioned 2" higher than the location of primary roof drains.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 6 inches (152 mm) above grade. Secure to building wall.

D. Install downspout nozzles at exposed bottom of rainleaders where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
1. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 100 feet (30 m).
4. Locate cleanouts at base of each vertical rainleader.

F. For floor cleanouts for piping below floors, install cleanout covers with top flush with finished floor.

G. For cleanouts in piping concealed in walls, install cleanout wall access covers, of types indicated, with cover flush with finished wall.

H. Install horizontal backwater valves in floor with cover flush with floor.

I. Install drain-outlet backwater valves in outlet of drains where indicated.

J. Install test tees in vertical rainleaders and near floor.

K. Install wall cleanouts in vertical rainleaders. Install access door in wall if indicated.

L. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

M. Assemble trench drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

N. Install through-penetration firestop assemblies in plastic rainleaders at concrete floor penetrations.

O. Install sleeve flashing device with each rainleader passing through floors with waterproof membrane.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 PROTECTION

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

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

END OF SECTION

SECTION 22 43 00
HEALTHCARE PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following medical plumbing fixtures and related components:
   1. Faucets for lavatories, showers, and sinks.
   2. Protective shielding guards.
   3. Fixture supports.
   4. Lavatories.
   5. Clinical sinks.
   6. Surgeons' scrub sinks.
   7. Outlet boxes.

B. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 DEFINITIONS

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

B. Fitting: Device that controls the flow of water into or out of the medical plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes.

C. FRP: Fiberglass-reinforced plastic.

D. PMMA: Polymethyl methacrylate (acrylic) plastic.

1.3 SUBMITTALS

A. Product Data: For each type of medical 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 medical plumbing fixtures to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain medical 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.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public

Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

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

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

F. Select combinations fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for medical plumbing fixtures:
1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Plastic Bathtubs: ANSI Z124.1.
3. Plastic Shower Enclosures: ANSI Z124.2.
4. Slip-Resistant Bathing Surfaces: ASTM F 462.
5. Vitreous-China Fixtures: ASME A112.19.2M.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
2. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
3. Faucets: ASME A112.18.1.
4. Hose-Connection Vacuum Breakers: ASSE 1011.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
7. NSF Materials: NSF 61.
8. Pipe Threads: ASME B1.20.1.
9. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
10. Supply Fittings: ASME A112.18.1.
11. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for bathtub and 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.
3. Faucets: ASME A112.18.1.
4. Hand-Held Showers: ASSE 1014.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Manual-Control Antiscald Faucets: ASTM F 444.
8. Pipe Threads: ASME B1.20.1.
9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Flexible Water Connectors: ASME A112.18.6.
4. Manual-Operation Flushometers: ASSE 1037.
5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
6. Brass Waste Fittings: ASME A112.18.2.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Grab Bars: ASTM F 446.
2. Hose-Coupling Threads: ASME B1.20.7.
3. Off-Floor Fixture Supports: ASME A112.6.1M.
4. Pipe Threads: ASME B1.20.1.
5. Plastic Toilet Seats: ANSI Z124.5.
6. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 REFERENCES

A. See "Plumbing Fixture List" in the plumbing drawings for more precise description, including "Basis of Design" product.

B. See "Plumbing Fixture Schedule" in the plumbing drawings for sizes of runouts and connections to water, waste and vent.

2.2 LAVATORY FAUCETS

A. Lavatory Faucets:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings, or a comparable product by one of the following:
a. American Standard Companies, Inc.
b. Bradley Corporation.
c. Chicago Faucets.
d. Delta Faucet Company.
e. Eljer.
f. Elkay Manufacturing Co.
g. Just Manufacturing Company.
h. Kohler Co.
i. Sloan Valve Company.
j. Speakman Company.
k. Symmons Valve Company.
l. T & S Brass and Bronze Works, Inc.
m. Zurn Plumbing Products Group; Commercial Brass Operation.
2. Description: Faucet for lavatory-type medical plumbing fixture. Coordinate faucet inlets with supplies, connectors, and fixture holes; coordinate outlet with spout and fixture receptor.
a. Maximum Flow Rate: 2.2 gpm (8.3 L/min.).
b. Body Material: Solid brass.
c. Finish: Polished chrome plate.
d. Temperature Indicators: Color-coded for hot and cold water.
e. Faucet outlet shall be laminar-flow.

2.3 SINK FAUCETS

A. Sink Faucets:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
a. American Standard Companies, Inc.
b. Chicago Faucets.
c. Delta Faucet Company.
d. Eljer.
e. Elkay Manufacturing Co.
f. Fisher Manufacturing Co.
g. Grohe America, Inc.

h. Just Manufacturing Company.
i. Kohler Co.
j. Speakman Company.
k. T & S Brass and Bronze Works, Inc.
l. Zurn Plumbing Products Group; Commercial Brass Operation.

2. Description: Faucet for sink-type medical plumbing fixtures. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   a. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
   b. Body Material: Solid brass.
   c. Finish: Polished chrome plate.
   d. Temperature Indicators: Color-coded for hot water on left and cold water on right.
   e. Faucet outlet shall be laminar flow.

2.4 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Insul-Tect Products Co.
   b. McGuire Manufacturing Co., Inc.
   c. Plumberex Specialty Products Inc.
   d. TCI Plumbing Products, Inc.
   e. TRUEBRO, Inc.
   f. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic wraps for covering medical plumbing fixture water supply and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.5 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Lavatory Supports:
1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type medical plumbing fixture. Include steel uprights with feet.
2. Carrier must be able to fit within standard stud walls.

C. Sink Supports:
1. Description: As required for sink-type medical plumbing fixture. Include steel uprights with feet.

2.6 LAVATORIES

A. Wall-Mounting Lavatories:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. American Standard Companies, Inc.
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Kohler Co.
   d. Sloan Valve Company

e. Toto
f. Zurn

2. Description: Accessible, wall-mounting, vitreous-china medical plumbing fixture.
   a. Color: White.
   b. Faucet: Lavatory as indicated.
   c. Supplies: NPS 3/8 (DN 10) chrome-plated copper tubes with stops.
   d. Drain: Grid strainer with offset tailpiece as required.
   e. Drain Piping: Chrome plated cast brass 'P' trap, 0.045-inch (1.1 mm) thick tubular brass waste to wall; and wall escutcheon.
   f. Protective Shielding Guard(s): as indicated.
   g. Fixture Support: Concealed arm.

B. Counter-Mounting Lavatories:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. American Standard Companies, Inc.
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Kohler Co.
   d. Sloan Valve Company
   e. Toto.
   f. Zurn Plumbing Products.
2. Description: Counter-mounting, vitreous-china, medical plumbing fixture.
   a. Type: Self-rimming.
   b. Faucet Hole Location: Top.
   c. Color: White.
   d. Faucet: Lavatory as indicated.
   e. Supplies: NPS 3/8 (DN 10) chrome-plated copper tubes with stops.
   f. Drain: Grid strainer with offset tailpiece as required.
   g. Drain Piping: Chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.
   h. Protective Shielding Guard(s): as indicated.

C. Lavatories:
1. Description: Accessible countertop with integral bowl fixtures furnished and installed by others.
   a. Faucet(s): Lavatory with separate drain for each bowl.
   b. Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.
   c. Drain Piping: NPS 1-1/4 (DN 32) chrome-plated, cast-brass P-trap; NPS 1-1/4 (DN 32) 0.045-inch- (1.1-mm-) thick tubular brass waste to wall; and wall escutcheon.
   d. Protective Shielding Guards: For bowls as indicated.

2.7 MOP BASINS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Acorn Engineering Company.
2. Crane Plumbing, L.L.C./Fiat Products.
3. Florestone Products Co., Inc.
4. Stern-Williams Co., Inc.

2.8 CLINICAL SINKS

A. Wall-Mounting Clinical Sinks:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. American Standard Companies, Inc.
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Kohler Co.

d. Zurn Industries, LLC

2. Description: Wall-mounting, back-outlet, vitreous-china, flushing-rim, service-sink-type medical plumbing fixture.
   a. Color: White.
   b. Rim Guard: Stainless steel on front and also on sides if flat rim.
   c. Faucet: Sink as indicated.
   d. Flushometer: as indicated.
   e. Bedpan Washer: as indicated.
   f. Fixture Support: Sink.

B. Floor-Mounting Clinical Sinks:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. American Standard Companies, Inc.
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Kohler Co.
   d. Zurn Industries, LLC
2. Description: Floor-mounting, bottom-outlet, vitreous-china, flushing-rim, service-sink-type medical plumbing fixture. Include bolt caps.
   a. Color: White.
   b. Rim Guards: Stainless steel on front and sides.
   c. Sink Base: Set on sink base by General Contractor.
   d. Faucet: Sink as indicated.
   e. Flushometer: as indicated.
   f. Bedpan Washer: as indicated.

2.9 SURGEONS' SCRUB SINKS

A. Stainless-Steel Surgeons' Scrub Sinks:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Elkay Manufacturing Co.
   b. Just Manufacturing Company.
   c. Sloan Valve Company
   d. Whitehall Manufacturing; a division of Acorn Engineering Company.
2. Description: Wall-mounting, sink-type medical plumbing fixture.
   a. Faucet: Chrome-plated-brass, gooseneck type matching fixture.
   b. Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes with stops.
   c. Drain: Grid, NPS 1-1/2 (DN 40).
   d. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.
   e. Fixture Support: as indicated.
   f. See Plumbing Fixture Schedule on drawings for additional information.

2.10 OUTLET BOXES

A. Dialysis Equipment Outlet Boxes:
1. Manufacturers: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
   a. Acorn Engineering Company.
   b. Bradley Corporation.
   c. Metcraft Industries Inc.
   d. Whitehall Manufacturing; a division of Acorn Manufacturing Company.
2. Description: Recessed-mounting outlet box with water supply and drain connections.
   a. Box and Faceplate: Stainless steel.
   b. Drain: NPS 2 (DN 50) standpipe, P-trap, and direct waste connection to drainage piping.

3. Reinforcement: 2-by-4-inch (50-by-100-mm) fire-retardant-treated-wood blocking between studs. Fire-retardant-treated wood blocking is specified in Division 06.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for medical plumbing fixtures to verify actual locations of piping connections before 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 medical 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.

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 counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to roughing-in drawings.

H. Install water-supply piping with stop on each supply to each fixture to be connected to domestic water 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, gate, or globe valve if stops are not specified with fixture.

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install flushometer valves for accessible water closets with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install toilet seats on water closets.

L. 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.

M. Install shower flow-control fittings with specified maximum flow rates in shower arms.

N. Install traps on fixture outlets.
1. Exception: Omit trap on fixtures with integral traps.

O. Install escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.

P. Set showers in leveling bed of cement grout.

Q. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

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 water supplies from domestic water piping to medical plumbing fixtures.

C. Connect drain piping from medical plumbing fixtures to sanitary waste and vent piping.

D. Ground equipment according to Division 26.

E. Connect wiring according to Division 26.

3.4 FIELD QUALITY CONTROL

A. Verify that installed medical plumbing fixtures are categories and types specified for locations where installed.

B. Check that medical plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed medical 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 medical plumbing fixtures, fittings, and controls.

B. Adjust water pressure at faucets, shower valves and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean medical plumbing 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 medical plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 61 13
COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Medical air piping and specialties designated "medical air," operating at 50 to 55 psig (345 to 380 kPa).

B. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

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, dental air and medical laboratory air piping systems.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Compressed-air tubes and fittings.
   2. Compressed-air valves and valve boxes.
   3. Medical compressed-air outlets.
   4. Medical compressed-air pressure control panels.
   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 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 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 compressed-air outlets of same type and from same manufacturer as outlets provided for in Division 22 Sections.

D. 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."

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. ASME Compliance:
1. Comply with ASME B31.1, "Power Piping," for laboratory compressed-air piping operating at more than 150 psig (1035 kPa).
2. Comply with ASME B31.9, "Building Services Piping," for laboratory compressed-air piping operating at 150 psig (1035 kPa) or less.

G. Comply with NFPA 99, "Health Care Facilities," for medical compressed-air system materials and installation in healthcare facilities.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Laboratory and Medical Compressed-Air Service(s): Do not interrupt laboratory or 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 Owner no fewer than seven days in advance of proposed interruption of laboratory and medical compressed-air service(s).
2. Do not proceed with interruption of laboratory and medical compressed-air service(s) without Owner's written permission.

1.6 COORDINATION

A. Coordinate medical compressed-air outlets with other outlets. Medical vacuum service terminals and medical gas outlets are specified in other Division 22 sections.

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.
3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
4. Copper Water Tube: ASTM B 88, Type M (ASTM B 88M, Type C), seamless, drawn temper.
5. Copper Fittings: ASME B16.18, cast-copper or ASME B16.22, wrought-copper, solder-joint pressure type.

2.2 JOINING MATERIALS

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

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

C. Threaded-Joint Tape: PTFE.

2.3 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Healthcare Products, Inc.
   b. Amico Corporation.
   c. BeaconMedaes.
   d. Conbraco Industries, Inc.
   e. NIBCO INC.
   f. Ohio Medical Co.
   g. Powerex.
   h. Tri-Tech Medical.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device where indicated.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Check Valves: In-line pattern, bronze.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Healthcare Products, Inc.
   b. Amico Corporation.
   c. BeaconMedaes.
   d. Conbraco Industries, Inc.
   e. Ohio Medical Co.
   f. Powerex.
   g. Tri-Tech Medical.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Operation: Spring loaded.
4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Healthcare Products, Inc.
   b. Amico Corporation.
   c. BeaconMedaes.
   d. Ohio Medical Co.
   e. Powerex.
   f. Tri-Tech Medical.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever.
6. Stem: Blowout proof with PTFE or TFE seal.

7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
8. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Allied Healthcare Products, Inc.
b. Amico Corporation.
c. BeaconMedaes.
d. Ohio Medical Co.
e. Powerex.
f. Tri-Tech Medical.
2. Interior Finish: Factory-applied white enamel.
3. Cover Plate: Aluminum or extruded-anodized aluminum, Satin-chrome finish steel or Stainless steel with NAAMM AMP 503, No. 4 finish with frangible or removable windows.
4. 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 (1725-kPa) minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.

H. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate.

2.4 MEDICAL COMPRESSED-AIR OUTLETS

A. Manufacturers: Match existing.

B. 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.
2. ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
3. Finishing Assembly:
a. Brass housing with primary check valve.
b. Double seals that will prevent air leakage.
c. Cover plate with gas-service label.
4. Quick-Coupler Service Connections: 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.
5. D.I.S.S. Service Connections: 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 Air Outlets: CGA V-5, D.I.S.S. No. 1160.

b. Instrument Air Outlets: CGA V-5, D.I.S.S. No. 1160.

6. Cover Plates: One-piece, stainless steel, with NAAMM AMP 503, No. 4 finish, metal, with chrome-plated finish or anodized aluminum and permanent, color-coded, identifying label matching corresponding service.

2.5 MEDICAL COMPRESSED-AIR PRESSURE CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Match existing Hospital Equipment.

B. 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.
1. Minimum Working Pressure: 200 psig (1380 kPa).
2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
3. Pressure Gages: 0- to 300-psig (0- to 2070-kPa) range.
4. Service Connection: CGA V-5, D.I.S.S. No. 1160, instrument air outlet.
5. Before final assembly, provide temporary dust shield and U-tube for testing.
6. Label cover plate "Air Pressure Control."

2.6 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Match existing Hospital Equipment.

B. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.

C. 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.
1. 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 (4 deg C) at 55 psig (380 kPa).

D. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
1. Low-Pressure Operating Range: 0- to 100-psig (0- to 690-kPa).
2. High-Pressure Operating Range: Up to 250-psig (1725-kPa).

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- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) 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:

2. Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa), dew point rises above 39 deg F (4 deg C) at 55 psig (380 kPa), carbon monoxide level rises above 10 ppm, and high water level is reached in receiver for liquid-ring, medical air compressor systems.
3. Dental Air: Pressure drops below 65 psig (450 kPa) or rises above 110 psig (760 kPa), backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa), dew point rises above 50 deg F (10 deg C) at 125 psig (860 kPa), and carbon monoxide level rises above 10 ppm.
4. Medical Laboratory Air: Pressure drops below 90 psig (630 kPa) or rises above 110 psig (760 kPa).

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 condition exists:
2. Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).

I. Dental-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:
2. Dental Air: Pressure drops below 65 psig (450 kPa) or rises above 110 psig (760 kPa), backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa), dew point rises above 50 deg F (10 deg C) at 125 psig (860 kPa), and carbon monoxide level rises above 10 ppm.

J. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
1. Include alarm signals when the following condition exists:
2. Medical Laboratory Air: Pressure drops below 90 psig (630 kPa) or rises above 110 psig (760 kPa).

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 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 20 alarm signals.

2.8 FLEXIBLE PIPE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Hyspan Precision Products, Inc.
4. Mercer Rubber Co.
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.
1. Working-Pressure Rating: 200 psig (1380 kPa) minimum.
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.

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 certified installer 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 (0.453 kg) of chemical to 3 gal. (11.3 L) of water.
      a. Scrub to ensure complete cleaning.
      b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

A. Laboratory Air Piping: Use the following piping materials for each size range:
   1. NPS 4 (DN 100) and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
   2. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

B. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

C. Dental Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

D. Medical Laboratory Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

E. Drain Piping: Use the following piping materials:
   1. Copper water tube, cast- or wrought-copper fittings, and soldered 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 air and drain piping with 1 percent slope downward in direction of flow.

H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.

I. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver.

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

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

O. Install medical compressed-air piping to medical compressed-air outlets specified in this Section, and to equipment specified in other Sections requiring medical compressed-air service.

P. Install seismic restraints on compressed-air piping if required.

Q. Install compressed-air outlets recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

R. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.

S. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

T. Install sleeves for piping penetrations of walls, ceilings, and floors.

U. Install sleeve seals for piping penetrations of concrete walls and slabs.

V. Install escutcheons for piping penetrations of walls, ceilings, and floors.

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 and in inlet air piping from remote air-inlet filter 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. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

3.6 COMPRESSED-AIR SERVICE COMPONENT INSTALLATION

A. Install compressed-air pressure control panel in walls. Attach 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 HANGER AND SUPPORT INSTALLATION

A. Vertical Piping: MSS Type 8 or 42, clamps.

B. Individual, Straight, Horizontal Piping Runs:
1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

C. Base of Vertical Piping: MSS Type 52, spring hangers.
1. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
2. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
5. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
6. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
7. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
8. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
9. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
10. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
11. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
12. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
13. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
14. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.
15. Install supports for vertical copper tubing every 10 feet (3 m).

3.9 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties.

B. 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. Dental Air: Black letters on yellow-and-white diagonal stripe background.
   3. Instrument Air: White letters on red background.
   4. Medical Laboratory Air: Black letters on yellow-and-white checkerboard background.

3.10 FIELD QUALITY CONTROL FOR COMPRESSED-AIR PIPING IN NONMEDICAL LABORATORY FACILITIES

A. Perform tests and inspections of compressed-air piping in nonmedical laboratory facilities and prepare test reports.

B. Tests and Inspections:
   1. Piping Leak Tests for Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
   2. Repair leaks and retest until no leaks exist.
   3. Inspect filters and pressure regulators for proper operation.

3.11 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. 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.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.12 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain medical compressed-air alarm systems. Refer to Division 01.

END OF SECTION

SECTION 22 62 13
VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Medical surgical vacuum piping and specialties designated "medical vacuum" operating at 20 inches mercury (510 mm mercury or 67.7 kPa vacuum).
   2. Waste anesthetic gas disposal piping and specialties designated "WAGD evacuation" operating at 14 inches mercury (355 mm mercury or 47.2 kPa vacuum).

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

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 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 service connections 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.
   2. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.

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 terminal connections of same type and from same manufacture as outlets provided for in other Division 22 sections.

D. 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."

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with ASME B31.9, "Building Services Piping," for vacuum piping in laboratory facilities.

G. NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Laboratory and Medical Vacuum Service(s): Do not interrupt laboratory or 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 Owner no fewer than seven days in advance of proposed interruption of laboratory and medical vacuum service(s).
   2. Do not proceed with interruption of laboratory and medical vacuum service(s) without Owner's written permission.

1.6 COORDINATION

A. Coordinate medical vacuum service terminals with other service outlets. Medical compressed-air outlets and medical gas outlets are specified in other Division 22 sections.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Type L or K, 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.
   3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

B. Copper Water Tube: ASTM B 88, Type M (ASTM B 88M, Type C), seamless, drawn temper.
   1. Cast-Copper Fittings: ASME B16.18, solder-joint pressure type.
   2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
   3. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.

4. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

C. Extruded-Tee Outlets: ASTM F 2014 procedure for making branch outlets in copper tube.
1. Manufacturers: Subject to compliance with requirements, provide procedure according to one of the following:
a. T-DRILL Industries Inc.

D. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
1. PVC Pressure Fittings: ASTM D 2466, Schedule 40 and ASTM D 2467, Schedule 80; socket type.

2.2 JOINING MATERIALS

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

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

C. Threaded-Joint Tape: PTFE.

D. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, full-face type.

E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

F. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.
1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
1. Exception: Factory cleaning and bagging are not required for valves for WAGD service.

B. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Allied Healthcare Products, Inc.
b. Amico Corporation.
c. BeaconMedaes.
d. Conbraco Industries, Inc.
e. NIBCO INC.
f. Ohio Medical Co.
g. Powerex.
h. Tri-Tech Medical.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device where indicated.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Bronze Check Valves: In-line pattern.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Healthcare Products, Inc.
b. Amico Corporation.
c. BeaconMedaes.
d. Conbraco Industries, Inc.
e. Ohio Medical Co.
f. Powerex.
g. Tri-Tech Medical.

2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Operation: Spring loaded.
4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Match existing Hospital equipment.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
8. Vacuum 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 vacuum gages and in sizes required to permit manual operation of valves.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Match existing Hospital Equipment.
2. Interior Finish: Factory-applied white enamel.
3. Cover Plate: Aluminum or extruded-anodized aluminum, satin-chrome finish steel, or stainless steel with NAAMM AMP 503, No. 4 finish with frangible or removable windows.
4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

F. PVC Ball Valves: MSS SP-122, with union ends and 150-psig (1035-kPa) minimum working-pressure rating and suitable for vacuum service.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Asahi/America.
c. Colonial Valve; a div. of Colonial Engineering, Inc.
d. George Fischer Inc.
e. Hayward Industrial Products, Inc.
f. IPEX Inc.
g. Jomar International Ltd.
h. NIBCO INC.
i. Plast-O-Matic Valves, Inc.
j. Sloane, George Fischer, Inc.
k. Spears Manufacturing Co.
l. Thermoplastic Valves Inc.

G. PVC Butterfly Valves: Lug type with lever handle and 150-psig (1035-kPa) minimum working-pressure rating and suitable for vacuum service.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.

b. Asahi/America.
c. Colonial Valve; a div. of Colonial Engineering, Inc.
d. George Fisher Inc.
e. Hayward Industrial Products, Inc.
f. IPEX Inc.
g. NIBCO INC.
h. Sloane, George Fischer, Inc.
i. Spears Manufacturing Co.
j. Thermoplastic Valves Inc.

H. PVC Check Valves: Ball-, in-line-, piston-, or swing-check design with flanged or union ends and 100-psig (690-kPa) minimum working-pressure rating and suitable for vacuum service.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Asahi/America.
c. Colonial Valve; a div. of Colonial Engineering, Inc.
d. George Fisher Inc.
e. NIBCO INC.
f. Sloane, George Fischer, Inc.
g. Spears Manufacturing Co.
h. Thermoplastic Valves Inc.

I. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.

J. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate.

2.4 MEDICAL VACUUM SERVICE INLET TERMINALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Match existing Hospital Equipment.

B. Inlet Terminals: 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 (DN 10) 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 Service Inlet Terminals: Suction inlets for medical vacuum and WAGD evacuation inlet terminals 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. Service Inlet Terminals: 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.
a. Medical Vacuum Service Connections: CGA V-5, D.I.S.S. No. 1220.

b. WAGD Evacuation Service Connections: CGA V-5, D.I.S.S. No. 2220.

5. Vacuum Bottle Brackets: 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, or anodized aluminum and permanent, color-coded, identifying label matching corresponding service.

2.5 MEDICAL VACUUM PIPING ALARM SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Match existing Hospital equipment.

B. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.

C. 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.

D. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Vacuum Operating Range: 0- to 30-in. Hg (0- to 101-kPa vacuum).

E. 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- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.

F. 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 (40 kPa vacuum) and backup vacuum pump is in operation.
      b. WAGD Evacuation: Vacuum drops below 12-in. Hg (40 kPa vacuum).
      c. Dental Vacuum: Vacuum drops below 6-in. Hg (20 kPa vacuum) and backup vacuum producer is in operation.
      d. HVE: 4-in. Hg (13 kPa vacuum) and backup vacuum producer is in operation.
      e. Medical Laboratory Vacuum: Vacuum drops below 10-in. Hg (34 kPa vacuum).

G. Anesthetizing-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 (40 kPa vacuum).
      b. WAGD Evacuation: Vacuum drops below 12-in. Hg (40 kPa vacuum).

H. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   1. Include alarm signals when the following condition exists:
      a. Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum).

I. Dental 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. Dental Vacuum: Vacuum drops below 6-in. Hg (20 kPa vacuum) and backup vacuum producer is in operation.

b. HVE: 4-in. Hg (13 kPa vacuum) and backup vacuum producer is in operation.

J. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
1. Include alarm signals when the following condition exists:
a. Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum).

2.6 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 20 alarm signals.

2.7 FLEXIBLE PIPE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Hyspan Precision Products, Inc.
4. Mercer Rubber Co.
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.
1. Working-Pressure Rating: 200 psig (1380 kPa) minimum.
2. End Connections: Threaded copper pipe or plain-end copper tube.

2.8 NITROGEN

A. Description: Comply with USP 28 – NF 23 for oil-free dry nitrogen.

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 certified installer 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 (0.453 kg) of chemical to 3 gal. (11.3 L) of water.
a. Scrub to ensure complete cleaning.
b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

A. Nonhealthcare Laboratory Low Vacuum Piping: Use the following piping materials for each size range:
1. NPS 4 (DN 100) and Smaller: Type L, copper or M (C) copper water tube; wrought-copper fittings; and brazed or soldered joints.

2. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper or M (C) copper water tube; wrought-copper fittings; and brazed or soldered joints.

B. Nonhealthcare Laboratory High Vacuum Piping: Use the following piping materials for each size range:
1. NPS 4 (DN 100) and Smaller: Type L, copper or M (C) copper water tube; wrought-copper fittings; and brazed or soldered joints.
2. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper or M (C) copper water tube; wrought-copper fittings; and brazed or soldered joints.

C. Medical Vacuum Piping: Use the following piping materials for each size range:
1. NPS 4 (DN 100) and Smaller: Type L or K, copper medical gas tube; wrought-copper fittings; and brazed joints.
2. NPS 5 to NPS 8 (DN 125 to DN 200): Type L or K, copper medical gas tube; wrought-copper fittings; and brazed joints.

D. WAGD Evacuation Piping: Use the following piping materials for each size range:
1. NPS 4 (DN 100) and Smaller: Type L or K, copper medical gas tube; wrought-copper fittings; and brazed joints.
2. NPS 5 to NPS 8 (DN 125 to DN 200): Type L or K, copper medical gas tube; wrought-copper fittings; and brazed joints.

E. Dental Vacuum Piping: Use the following piping materials for each size range:
1. NPS 4 (DN 100) and Smaller: Type L, copper medical gas or M (C) copper water tube; wrought-copper fittings; and brazed or soldered joints.
2. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas or M (C) copper water tube; wrought-copper fittings; and brazed or soldered joints.

F. HVE Piping: Use the following piping materials for each size range:
1. NPS 4 (DN 100) and Smaller: Type L, copper medical gas or M (C) copper water tube; wrought-copper fittings; and brazed or soldered joints.
2. NPS 4 (DN 100) and Smaller: Schedule 40 PVC pipe, Schedule 40 or Schedule 80 PVC pipe, Schedule 80 PVC fittings, and solvent-cemented joints.
3. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas or M (C) copper water tube; wrought-copper fittings; and brazed or soldered joints.
4. NPS 5 to NPS 8 (DN 125 to DN 200): Schedule 40 PVC pipe, Schedule 40, or Schedule 80 PVC pipe, Schedule 80 PVC fittings, and solvent-cemented joints.

G. Medical Laboratory Vacuum Piping: Use the following piping materials for each size range:
1. NPS 4 (DN 100) and Smaller: Type L or K, copper medical gas tube; wrought-copper fittings; and brazed joints.
2. NPS 5 to NPS 8 (DN 125 to DN 200): Type L or K, copper medical gas tube; wrought-copper fittings; and brazed joints.

H. Drain Piping: Use one of the following piping materials:
1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.
2. 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 vacuum and drain piping with 1 percent slope downward in direction of flow.

H. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.

I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator.

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.

O. Install medical vacuum piping to medical vacuum service inlet terminal specified in this Section and to equipment specified in other Sections requiring medical vacuum service.

P. Install seismic restraints on vacuum piping as indicated or required.

Q. Install medical vacuum service inlet terminals recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

R. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet where indicated.

S. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.

T. Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

U. Install unions, in PVC vacuum piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

V. Install flanges, in PVC vacuum piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment, machine, and specialty.

W. Install sleeves for piping penetrations of walls, ceilings, and floors.

X. Install sleeve seals for piping penetrations of concrete walls and slabs.

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 VALVE APPLICATIONS

A. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.

B. Valves for PVC Vacuum Piping:
   1. NPS 4 (DN 100) and Smaller: Use copper alloy ball and bronze or PVC ball, butterfly, and check types.
   2. NPS 5 (DN 125) and Larger: Use PVC butterfly and check types.

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. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

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

D. Threaded Joints: Apply appropriate tape to external pipe threads.

E. 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.

F. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

G. Extruded-Tee Outlets: Form branches in copper tube according to ASTM F 2014, with tools recommended by procedure manufacture.

H. 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.
   2. PVC Piping: Install PVC flange on PVC pipes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

I. 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 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in other Division 22 sections for pipe hanger and support devices.

B. Vertical Piping: MSS Type 8 or 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:
1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

D. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

E. Base of Vertical Piping: MSS Type 52, spring hangers.

F. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
5. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
6. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
7. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
8. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
9. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
10. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
11. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
12. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
13. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
14. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.

I. Install supports for vertical copper tubing every 10 feet (3 m).

J. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 (DN 25) and Smaller: 30 inches (760 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): 36 inches (900 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches (1150 mm) with 1/2-inch (13-mm) rod.
4. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1220 mm) with 1/2-inch (13-mm) rod.
5. NPS 6 and NPS 8 (DN 150 and DN 200): 54 inches (1350 mm) with 5/8-inch (16-mm) rod.

K. Install supports for vertical PVC piping every 48 inches (1220 mm).

3.9 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties.

B. 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. Dental Vacuum: Black boxed letters on white-and-black diagonal stripe background.
   4. HVE: Black boxed letters on white-and-black diagonal stripe background.
   5. Medical Laboratory Vacuum: Black boxed letters on white-and-black checkerboard background.

3.10 FIELD QUALITY CONTROL FOR LABORATORY FACILITY NONMEDICAL VACUUM PIPING

A. Perform tests and inspections of vacuum piping in nonmedical laboratory facilities.

B. Tests and Inspections:
   1. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
      a. Test Pressure for Copper Tubing: 100 psig (690 kPa).
      b. Test Pressure for PVC Piping: 100 psig (690 kPa).
   2. Repair leaks and retest until no leaks exist.
   3. Inspect filters for proper operation.

C. Prepare test reports.

3.11 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. 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.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.12 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems. Refer to Division 01.

END OF SECTION

SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following items which apply to all Division 23 sections:
1. Submittals.
2. Coordination drawings.
3. Record documents.
4. Maintenance manuals.
5. Piping materials and installation instructions common to most piping systems.
6. Transition fittings.
7. Dielectric fittings.
8. Mechanical sleeve seals.
9. Sleeves.
10. Escutcheons.
11. Grout.
12. Flashing.
13. Through penetration firestop assemblies.
14. HVAC demolition.
15. Equipment installation requirements common to equipment sections.
16. Painting and finishing.
17. Concrete bases.
18. Supports and anchorages.

B. Related Documents:
1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

H. Firestopping (Through-Penetration Protection System): Sealing of stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.3 SUBMITTALS

A. Product Data for each kind of product indicated.

B. Welding certificates.

C. Firestopping Schedules: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

D. Submittal of shop drawings, product data, and samples will be accepted only when signed and submitted by this Contractor and the General Contractor. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed.

E. Shop drawings submitted without this Contractor's signature or approval and verification will not be approved. Quantities will not be checked or verified. It is the Contractor's responsibility to provide the proper quantities required to complete the job.

F. Portions of the work requiring a shop drawing submittal shall not begin until the shop drawing has been approved by the Engineer.

G. Submit wiring diagrams for all equipment requiring field wiring clearly showing all required connections. This Contractor will send one copy of Engineer approved shop drawings to the Electrical Contractor with a transmittal letter. Forward one copy of the transmittal letter to the Engineer's office.

H. Where catalog cuts are used, mark them to indicate equipment, capacities, controls, fittings, valves, sizes, etc.

I. Reference each item to applicable specification paragraph number and plan sheet number. Reference items not appearing in base specification to applicable alternate numbers, change order numbers, letters of authorization, etc.

J. Engineers acceptance of Compliance Submittals will not relieve Contractor from his responsibility for any deviations from the requirements of the Contract Documents unless Contractor has in writing called Engineer's attention to such deviation at the time of submission and Engineer has given written approval to the specific deviation, nor shall any acceptance by Engineer relieve Contractor from responsibility for errors or omissions in Compliance Submittals.

1.4 GENERAL WORK REQUIREMENTS

A. Permits:
1. Obtain and pay for all licenses and permits, fees, inspection and certificates required for the execution of this work.
2. Pay fees and charges for connection to outside services and use of property.
3. Deliver permits and certificates to the Architect to be transmitted to the Owner.

B. Utility Services:
1. This Contractor shall pay for all expenses, deposits, reimbursements, etc., required by the local rules and codes for the service to the buildings, complete and ready for use. See plot plan.
2. Consult gas, water and sewer utility for their requirements and for coordinating with their installation. Contractor shall provide any work thus required beyond that indicated by the drawings and specifications. He shall bear all expense involved

for the complete installation of the gas service (both temporary and permanent) to the building ready for operation, including utility service charges, except as specifically excluded on the plans.

3. This Contractor shall consult all local departments to verify requirements and bid installation for service in accordance with local codes and Utility company rules and regulations.

1.5 RESPONSIBILITY

A. This Contractor will be held responsible for any and all damage to any part of the building or to the work of other contractors, as may be caused through his operation.

B. The operation and maintenance of the Mechanical Plant during construction shall be the responsibility of this contractor until the acceptance of the building by the Owner.

C. The General Contractor shall pay for all fuel cost for operation of the plant until the acceptance of the building by the Owner.

D. This contractor shall make all provisions for entry of equipment, installed under this contract, to the installed location. This contractor shall provide openings in existing construction if necessary. This contractor shall do all repair necessary to restore the building to the original condition. During the period of entry of equipment and removal of trash, no disruption of the Owner's normal business shall occur.

1.6 QUALITY ASSURANCE

A. Execute work in compliance with all applicable Federal. State and Municipal laws, codes, ordinances, and local customs regarding the trade to perform the work. The Contractor is required to verify that all installations comply with applicable codes. The codes applicable to this specific project may be listed on the Architect's code compliance sheet. If not, it is the Contractor's responsibility to determine which codes apply to the installations. Where code requirements conflict with those shown on the drawings and specifications, the code requirements shall take precedence. The Contractor shall notify the Architect immediately of any discrepancies between the applicable code requirements and the documents. Changes made to comply with the applicable requirements shall not justify an additional cost.

B. Inspect the existing site and conditions and check the drawings and specifications to be fully informed of the requirements for completion of the work. Lack of such information shall not justify an extra to the contract price.

C. The HVAC Work shall include labor, materials, and equipment to install systems and place in proper working order, as shown on plans and hereinafter specified. The installation shall include all labor, materials, tools, transportation, equipment, services and facilities, required for the complete, proper and substantial installation of all mechanical work shown on the plans, and/or outlined in these specifications. The installation shall include all materials, appliances, and apparatus not specifically mentioned herein or noted on the drawings but which are necessary to make a complete working installation of all mechanical systems.

D. Material and equipment shall be new, of best quality and design and free from defects. A manufacturer's nameplate affixed in a conspicuous place will be required on each major component of equipment stating manufacturer's name, address and catalog number.

E. Furnish testing equipment and test all piping systems under methods and conditions as specified.

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

G. 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.

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

I. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 and ASTM E814 with 0.10 inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
   a. Floor Penetrations within Wall Cavities: T-Rating is not required.

J. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

K. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

L. Fire Resistant Joints between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

M. Surface Burning Characteristics: 25/50 flame spread/smoke developed index when tested in accordance with ASTM E84.

1.7 DELIVERY, STORAGE, AND HANDLING

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

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

1.8 WORKMANSHIP AND COORDINATION

A. Make installation substantially as shown on plans.

B. Pipe and duct routing and equipment location shown on the drawings are schematic in nature. Make alterations in location of apparatus or piping as may be required to conform to building construction without extra charge.

C. Equipment service clearances, per equipment manufacturer's specifications, shall be maintained from general construction. No pipe shall be installed within these clearances. No piping shall be installed above electrical panels, starters or switchgear, or in elevator equipment rooms.

D. Cooperate with other contractors in their installation of work.

E. The ductwork shall take precedence over all pipe work except where it is necessary to maintain an even grade on the piping.

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

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

H. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces.

I. Use only experienced mechanics.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not apply sealants, caulking, or mastic materials outside the range of the manufacturer's installation instructions.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F (15 degrees C).

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

D. Provide ventilation in areas to receive solvent cured materials.

1.10 ELECTRONIC DOCUMENT REQUESTS

A. The Contractor may request the use of the bidding documents in electronic format (CAD, BIM, PDF etc.) for use in preparation of shop drawings and coordination drawings.

B. Professional Engineering Consultants, P.A. (PEC) reserves the right to refuse requests for electronic files at its sole discretion. The format of the files will be at PEC's sole discretion.

C. All electronic documents provided are provided on an as-is basis and are utilized by the Contractor at his own risk. All files provided by the Engineer are subject to PEC's standard "CADD/Electronic File Disclaimer". This disclaimer can be provided upon request.

D. At PEC's sole discretion, per sheet fee of up to $50 may be required to cover the costs of preparing the electronic files for transmission.

E. By obtaining the bid document CAD or BIM files, the Contractor is not relieved from his duty to create construction, shop and coordination drawings.

1.11 HVAC COORDINATION DRAWINGS

A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of HVAC equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of piping, equipment, hangers, and materials. Include the following:
    a. Clearances for installing and maintaining insulation.
    b. Clearances for servicing and maintain equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
    c. Equipment connections and support details.
    d. Exterior wall and foundation penetrations.
    e. Fire-rated wall and floor penetrations.
    f. Underground piping.
    g. Sizes and locations of required concrete pads and bases.
    h. Numbered valve location diagrams.
    i. Valve stem movement.
    j. Pipe expansion loops.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Submit drawing to Architect to review for completeness. These drawings will be reviewed and returned with comments. They will not be approved as a shop drawing.

1.12 RECORD DOCUMENTS

A. Prepare record documents in accordance with Division 1. These drawings shall reflect the actual "As-Built" condition including any change orders, of the mechanical systems and installation. In addition to the requirements specified in Division 1, indicate the following installed conditions:
   1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Identification Section. Indicate actual inverts and horizontal locations of underground piping.
   2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
   3. Approved substitutions, contract modifications, and actual equipment and materials installed.

1.13 MAINTENANCE MANUALS

A. Prepare Maintenance Manuals in accordance with Division 1 Sections. In addition to the requirements specified in Division 1, include the following information for equipment items:
   1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control stopping, shutdown, and emergency instructions.
   3. Maintenance procedures for routing preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
   4. Approved shop drawing submittals.
   5. Servicing instructions and lubrication charts and schedules.
   6. Copy of valve tag chart.

1.14 FINAL ELECTRONIC SUBMITTAL

A. In addition to the hard-copy record documents above, provide a set of electronic documents in PDF formats on CD-ROM media. The electronic shall include the following:
   1. Floor plans, O&M manuals, approved shop drawings, and valve tag schedules.
   2. The floor plans shall contain labels and links for each piece of equipment specified in this Division. The equipment links shall open the O&M manual for the respective piece of equipment with a single mouse click. Valve tag links shall open the appropriate portion of the valve tag schedule.
   3. It is anticipated that there will be separate PDF floor plan documents for each class of equipment, and separate PDF valve tag floor plan(s) for each unique system. The exact format and quantity of PDF documents shall be submitted to the Owner for approval prior to creation of the comprehensive final submittal.

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. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified or pre-approved equals.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

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

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials.

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 Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

D. 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 (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

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

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

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

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

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

G. Molded PE: Reusable, PE, tapered-cup shaped and smooth-outer surface with nailing flange for attaching to wooden forms.

2.7 ESCUTCHEONS

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

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

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated and rough brass.

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

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

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

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

2.8 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.9 FLASHING

A. Metal Flashing: 26 gage (0.5 mm) thick galvanized steel.

B. Metal Counterflashing: 22 gage (0.8 mm) thick galvanized steel.

C. Lead Flashing:
   1. Waterproofing: 5 lb./sq. ft (24.5 kg/sq m) sheet lead.
   2. Soundproofing: 1 lb./sq. ft (5 kg/sq m) sheet lead.

D. Flexible Flashing: 47 mil (1.2 mm) thick sheet of material compatible with roofing. Coordinate with Architectural roofing specifications.

E. Caps: Steel, 22 gage (0.8 mm) minimum; 16 gage (1.5 mm) at fire resistant elements.

2.10 FIRESTOPPING

A. Manufacturers:
   1. Hilti Corp.
   2. 3M fire Protection Products

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
   1. Silicone Firestopping Elastomeric Firestopping: Single or multiple component silicone elastomeric compound and compatible silicone sealant.
   2. Foam Firestopping Compounds: Single or multiple component foam compound.
   3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
   4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
   5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
   6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
   7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: As selected from manufacturer's full range of colors.

D. Coordinate the above requirements with Division 7.

2.11 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

C. General:
   1. Furnish UL listed products.
   2. Select products with rating not less than rating of wall or floor being penetrated.

D. Non-Rated Surfaces:
   1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
   2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

2.12 ACCESS DOORS

A. If specified in Division 7 that section shall apply. Where not specified in Division 7 provide access doors as follows.

B. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

C. Frames: 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
   1. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
   2. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
   3. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

D. Flush Panel Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
   1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

E. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks individually keyed; provide 2 keys.

F. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bar-Co., Inc.
2. J.L. Industries.
3. Karp Associates, Inc.
4. Milcor Div. Inryco, Inc.
5. Nystrom, Inc.

2.13 DRIP PANS

A. Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top, either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drainline connections.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION REQUIREMENTS

A. The existing areas surrounding the remodel area are fully occupied and shall remain operational throughout the duration of this project.

B. This contractor shall closely coordinate with the Owner and/or his representative the timing and schedule for any temporary cutoffs of any mechanical systems. The valve location and scheduled shutdown shall be closely coordinated with the Owner. It is recognized that temporary shutdown of systems will be required. These shall be scheduled in advance with Owner's representatives and restored to full service at the end of the work period.

C. 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.

D. 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.

E. Contractor shall provide protective plastic drop cloths to protect the existing occupied areas and equipment from dust and debris during the construction work and shall clean the areas of all construction dirt daily, and upon completion of the work.

F. Connection to existing piping for HVAC, medical gas, fire sprinkler or domestic water will require temporary shutdown of those mains to accomplish the new tie-ins. Closely coordinate and schedule this work with the Owner. Perform such work on weekends or nights as required by Owner's use and schedule.

G. All drained piping risers and mains shall be refilled with fluid and properly vented by this Contractor.

H. Coordinate with General Contractor the removal and replacement of all existing ceilings, walls, etc. as required for mechanical demolition work.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

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

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or stamped steel type with polished chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type or stamped steel with polished chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw.
      g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
      h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
   2. Existing Piping: Use the following:
      a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
      b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass or stamped steel type with chrome-plated finish.

d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass or stamped steel type with chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

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

N. 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 (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) 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 (DN 150).
b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) 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 (50 mm) above finished floor level. Refer to Division 07 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 Sections for materials and installation.

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) 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.

P. 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 (25-mm) 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.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.3 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. The Contractor shall field verify all existing conditions and dimensions. The Contractor shall make field adjustments as required to accommodate the new work.

B. Verify final equipment locations for roughing-in.

C. 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 23 Sections specifying piping systems.

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

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

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

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

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

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

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

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

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

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 using manufacturer certified mechanics and tools.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.5 PIPING CONNECTIONS

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

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric nipples and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

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

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

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

3.7 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
1. Coordinate mechanical systems, equipment, and materials installation with other building components, including the structure, fire sprinklers, and the electrical lights and equipment.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install access panel or doors where units are concealed behind finished surfaces.
11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope, or systems requiring a fixed access clearance.
12. The Mechanical Contractor shall locate and mark the location of all holes and openings which require blocking out, cutting or core drilling.

13. All square openings through precast concrete shall be blocked out by precast manufacturer. All openings 6" dia. or larger shall be blocked out by precast manufacturer. All holes less than 6" dia. may be core drilled.
14. Contractor shall review with Owner location, accessibility, and method of operating all HVAC shut-off valves located in plumbing chases, ceiling cavity and mechanical rooms.
15. This Contractor shall assist with and provide supervised start-up of the steam, condensate return, hot water and chilled water systems, involving air venting, drainage, etc. Monitor the air venting until all air has been eliminated from the building system and the lines within the buildings are completely filled with fluid, or steam as applicable.
16. The ceiling cavity space is limited. Therefore, the ductwork and piping locations shall be closely coordinated with each other as well as the lights, ceiling height, electrical conduit and fire sprinkler piping.
17. It is the intent, where possible, to locate the domestic water piping, medical gas piping, fire sprinkler piping, and HVAC piping above the ductwork and tight to the existing steel and concrete structure. The steam condensate return piping shall, in most cases, be located to run below the ductwork.
18. Selected pipe and duct elevations are shown on the plans as an aid to the contractor in their installation. Where necessary, due to conflicts, these items may be changed as long as conflict with other items does not occur.
19. Ductwork and piping shall rise into the joist or beam space and run between joists or beams where shown on the drawings and as may be required, whether specifically shown or not, to avoid conflict with other trades.
20. This Contractor shall be responsible for coordination with the fire sprinkler subcontractor, plumbing contractor, and the Electrical Contractor as required to avoid and or resolve conflicts. Conflicts between piping, ducts, electrical, sprinklers, etc. shall be resolved with no additional cost or change to the contract amount.
21. Where new work conflicts with existing ductwork or piping (plumbing, HVAC, fire protection, medical gas etc.) this contractor shall relocate those items as required to make way for new work without additional charges.

3.8 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1. In addition to the requirements specified in Division 1, the following requirements apply:
   1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
   1. Uncover work to provide for installation of ill-timed work.
   2. Remove and replace defective work.
   3. Remove and replace work not conforming to requirements of the Contract Documents.
   4. Remove samples of installed work as specified for testing.
   5. Install equipment and materials in existing structures.
   6. Upon written instructions from the Architect, uncover and restore work to provide for Architect/Engineer observation of concealed work.

3.9 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in other divisions.

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

3.10 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100mm) larger in both directions than supported units.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi (20.7MPa) 38-day compressive-strength concrete and reinforcement. Refer to architectural and structural for additional requirements.

3.11 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.

3.12 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.

3.13 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.

3.14 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs. Refer to Division 7.

3.15 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating. Install per manufacturer's instructions to comply with appropriate listing.

D. Fire Rated Surface:
   1. Seal openings as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
      b. Size sleeve allowing minimum of 1 inch (25 mm) void between sleeve and building element.
      c. Pack void with backing material.
      d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

E. Non-Rated Surfaces:
   1. Seal openings, where required by code, through non-fire rated openings as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
      b. Size sleeve allowing minimum of 1 inch (25 mm) void between sleeve and building element.
      c. Install type of firestopping material recommended by manufacturer.
   2. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
   3. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms, and data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and pipe.

F. Inspect installed firestopping for compliance with specifications and submitted schedule.

G. Clean adjacent surfaces of firestopping materials.

3.16 INSTALLATION OF ACCESS DOORS

A. Provide access doors in construction wherever access is required for valves, dampers, equipment, etc.

B. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

C. Adjust hardware and panels after installation for proper operation.

3.17 INSTALLATION OF DRIP PANS

A. Locate drip pans under piping passing within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection and run to nearest drain or elsewhere as indicated.

3.18 CLEANING

A. Refer to Division 1 for general requirements for final cleaning.

B. Contractor shall clean work area of all construction dirt and debris at the end of each workday.

3.19 WARRANTIES

A. Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.

B. Compile and assemble the warranties as specified into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. This Contractor shall warrant all material and equipment installed by him for a period of one year after completion of the project.

END OF SECTION

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes single- and three-phase motors for application on equipment provided under other sections and for motors furnished loose to Project.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.
   3. Refer to Division 26 for starters, disconnects, fuses, and variable speed drives.

1.2 REFERENCES

A. American Bearing Manufacturers Association:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.

C. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

B. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

B. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

C. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Class B.

H. Insulation: Class F.

I. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. 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 shall be coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. All motors driven by a variable frequency PWM drive shall include a factory installed maintenance free, circumferential, conductive microfiber or carbon brush shaft grounding ring to discharge shaft currents to ground. The conductive microfibers shall redirect shaft currents and provide a reliable, very low impedance path from shaft to motor frame by-passing motor bearings entirely. For vertical turbine pump motors, the upper shaft shall be provided with a coating to isolate the shaft from the bearings and the shaft grounding ring shall be installed within the motor casing. This information shall be provided with the shop drawing submittal for verification of method of installation and to ensure they are to be supplied.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Electronically Commutated Motor
   1. Motor Enclosure: Open Type.
   2. Motor shall be an electronically commutated, permanent magnet, brushless DC type motor (ECM) specifically designed for HVAC applications.
   3. Motors shall be permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
   4. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
   5. Motor shall be speed controllable down to 20% of full speed (minimum 80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
   6. Motor shall be a minimum of 85% efficient at all speeds.

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.

2.6 MOTOR CONNECTIONS

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

2.7 POWER FACTOR CORRECTION

A. Each motor, 10 horsepower and larger, except for motors with variable frequency drives, supplied for use within this project shall be supplied with capacitors as required to correct the power - factor of the individual motor to 95% lagging $\pm$ 3%. The Mechanical Contractor shall secure performance data on each individual motor and condenser. Provide operating current values on the condenser, and on the motor, and total line current for the combination. Provide voltage reading at time of disconnecting motor.

B. In no event shall the capacitor current exceed the "no-load" values of the motor current. Heating element ratings shall be adjusted if, and as necessary, to provide thermal protection to the motor. In the event the voltage reading at the time of disconnecting the unit exceeds a safe value, the capacitor rating shall be changed to provide safe voltages, as well as providing a power factor within the specified limit. All capacitor shall be rated for operation on the system voltage specified and furnished by the equipment manufacturer.

C. Each capacitor shall be suitable for energizing at temperatures as low as -10°F. and for continuous operation in ambient temperatures not exceeding 115°F. when installed and unrestricted ventilation and energized up to 100 percent of rated voltage.

D. Power factor correction capacitors shall be of the unit cell type. Individual capacitor cells shall be factory assembled and wired in a metallic, moisture-resistant enclosure. All power factor correction capacitors shall be UL listed. Capacitors shall be switched on and off with the motor and shall be installed and wired by the Electrical Contractor.

E. Individual capacitor cells shall utilize polypropylene film as the dielectric with vacuum deposited aluminum layers as the electrodes. Each capacitor cell shall be furnished with replaceable fuses with a current limiting interrupting capacity of 100,000 Amps and filled with a completely biodegradable fluid.

F. Discharge resistors shall be provided to reduce the residual voltage to 50 volts or less within one minute after the capacitor has been removed from the line. Resistors shall be mounted external to the capacitor cells to minimize the dielectric operating temperature.

G. Enclosures shall be fabricated from sheet metal having a minimum thickness of 0.026", suitable for indoor or outdoor installations, designed to prevent accidental contact with live conducting parts, finished with gray enamel and provided with integral mounting brackets for wall or floor mounting.

H. Nameplate shall contain name of manufacturer, rated voltage, frequency, kilovar rating, number of poles and amount of combustible fluid in gallons. Nameplate shall be externally attached to the enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install securely on firm foundation. Properly align motor with driven machine.

B. Install engraved plastic nameplates.

C. Ground and bond motors.

D. Furnish capacitors to Electrical Contractor for installation.

END OF SECTION

SECTION 23 05 19
METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Filled-system thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.
6. Test-plug kits.
7. Sight flow indicators.
8. Orifice flow meters.

B. Related Documents:
1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUBMITTALS

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

B. Wiring Diagrams: For power, signal, and control wiring.

C. Product Certificates: For each type of meter and gage, from manufacturer.

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

PART 2 - PRODUCTS

2.1 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ashcroft Inc.
   b. Marsh Bellofram.
   c. Miljoco Corporation.
   d. Palmer Wahl Instrumentation Group.
   e. Trerice, H. O. Co.
   f. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum or drawn; 4-1/2-inch (114-mm) nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Pointer: Dark-colored metal.
8. Window: Glass.

9. Ring: Stainless steel.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
12. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Miljoco Corporation.
    b. Palmer Wahl Instrumentation Group.
    c. Trerice, H. O. Co.
    d. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 7-inch (178-mm) nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.4 THERMOWELLS

A. Thermowells:
1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material: Brass or 304 stainless steel.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
6. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
7. Bore: Diameter required matching thermometer bulb or stemming.
8. Insertion Length: Length required matching thermometer bulb or stemming.
9. Lagging Extension: 2" minimum or longer as required for insulated piping and tubing.
10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
11. Provide cap nut with chain fastened permanently to thermometer well.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.5 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMETEK, Inc.; U.S. Gauge.
      b. Ashcroft Inc.
      c. Marsh Bellofram.
      d. Miljoco Corporation.
      e. Palmer Wahl Instrumentation Group.
      f. Trerice, H. O. Co.
      g. Weiss Instruments, Inc.
      h. WIKA Instrument Corporation - USA.
   2. Standard: ASME B40.100.
   3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Nonreflective or coated aluminum with permanently etched scale markings graduated in psi (kPa) and feet of water (for water use).
   8. Pointer: Dark-colored metal.
   9. Window: Glass.
   10. Ring: Brass or stainless steel.
   11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.6 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping. Select disc material for fluid served and pressure rating.

B. Siphons: Loop-shaped section of steel pipe with NPS 1/4 or NPS 1/2 (DN 8 or DN 15) pipe threads.

C. Valves: Brass ball, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads.

2.7 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flow Design, Inc.
   2. Miljoco Corporation.
   3. Peterson Equipment Co., Inc.
   4. Sisco Manufacturing Company, Inc.
   5. Trerice, H. O. Co.
   6. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber suitable for inserting 1/8" O.D. probe assembly from dial type insertion pressure gage or temperature gage.

2.8 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Archon Industries, Inc.
   2. Dwyer Instruments, Inc.
   3. Emerson Process Management; Brooks Instrument.
   4. Ernst Co., John C., Inc.
   5. Ernst Flow Industries.
   6. OPW Engineered Systems; a Dover company.
   7. Penberthy; A Brand of Tyco Valves & Controls - Prophetstown.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 125 psig (860 kPa).

E. Minimum Temperature Rating: 200 deg F (93 deg C).

F. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

G. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

2.9 FLOWMETERS

A. Orifice Flow meters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Griswold
      b. Bell & Gossett; ITT Industries.
      c. Flow Design
      d. S. A. Armstrong Limited; Armstrong Pumps Inc.
   2. Description: Flow meter with sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
   3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
   4. Sensor: Wafer-orifice-type, calibrated, flow-measuring element; for installation between pipe flanges.
      a. Design: Differential-pressure-type measurement for water.
      b. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated stainless steel nameplate. Nameplate shall be installed with a stainless steel chain to allow for insulation.
      c. Minimum Pressure Rating: 300 psig (2070 kPa).
      d. Minimum Temperature Rating: 250 deg F (121 deg C).
   5. Operating Instructions: Include complete instructions and flow rate data with each flow meter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

I. Install remote-mounted pressure gages on panel.

J. Install valve and snubber in piping for each pressure gage for fluids (except steam).

K. Install valve and syphon fitting in piping for each pressure gage for steam.

L. Install flow indicators in piping systems in accessible positions for easy viewing.

M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flow meters according to manufacturer's written instructions.

N. Install flow meter elements in accessible positions in piping systems.

O. Install wafer-orifice flow meter elements between pipe flanges. Chain mounted stainless steel nameplate shall be secured to the valve outside of the insulation.

P. Install differential-pressure-type flow meter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

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

R. Install thermometers in the following locations:
1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Inlet and outlet of each chiller.
4. Inlet and outlet of each hydronic heat exchanger.
5. Inlet and outlet of each thermal-storage tank.
6. Elsewhere as indicated on the drawings.

S. Install pressure gages in the following locations:
1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.
4. Elsewhere as indicated on the drawings.

T. Install test plugs in the following locations:
1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Inlet and outlet of each chiller.
4. Inlet and outlet of each hydronic coil.
5. Inlet and outlet of each hydronic heat exchanger.
6. Inlet and outlet of each thermal-storage tank.
7. Elsewhere as indicated on drawings.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

C. Thermometer stems shall be of length to match thermowell insertion length.

3.4 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.

B. Scale Range for Condenser-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.

C. Scale Range for Heating, Hot-Water Piping: 40 to 240 deg F and 0 to 150 deg C.

D. Scale Range for Steam and Steam-Condensate Piping: 50 to 400 deg F and 0 to 200 deg C.

E. Scale Range for Air Ducts: Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 psi and 0 to 600 kPa.

B. Scale Range for Condenser-Water Piping: 0 to 100 psi and 0 to 600 kPa.

C. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi and 0 to 600 kPa.

D. Scale Range for Low Pressure Steam Piping: 0 to 30 psi and 0 to 240 kPa.

E. Scale Range for High Pressure Steam Piping0 to 200 psi and 0 to 1400 kPa.

END OF SECTION

SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Bronze ball valves.
2. Iron ball valves.
3. Iron butterfly valves.
4. Iron, grooved-end butterfly valves.
5. Brass, grooved-end butterfly valves.
6. High-performance butterfly valves.
7. Bronze lift check valves.
8. Bronze swing check valves.
9. Iron swing check valves.
10. Iron swing check valves with closure control.
11. Iron, grooved-end spring-assisted check valves.
12. Bronze gate valves.
13. Iron gate valves.
14. Bronze globe valves.
15. Iron globe valves.
16. Lubricated plug valves.

B. Related Sections:
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

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

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooved ends, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

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

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

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: 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 5 plug valves, for each size square plug-valve head.
   5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions to match specified insulation thickness and the following features:
   1. Gate Valves: With rising stem.
   2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   3. Butterfly Valves: With extended neck.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Threaded: With threads according to ASME B1.20.1.
   3. Grooved: With grooved ends according (or similar) to AWWA C606.

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

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.; Apollo Valves.

b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

B. Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Regular.

2.3 IRON BALL VALVES

A. Class 150, Iron Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Kitz Corporation.
d. Sure Flow Equipment Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-72.
b. CWP Rating: 200 psig.
c. Body Design: Split body.
d. Body Material: ASTM A 126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE or TFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

2.4 IRON, BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.; Apollo Valves.
      b. Cooper Cameron Valves; a division of Cooper Cameron Corp.
      c. Crane Co.; Crane Valve Group.
      d. Hammond Valve.
      e. Kitz Corporation.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-67, Type I.
      b. CWP Rating: 150 psig.
      c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      e. Seat: EPDM.
      f. Stem: One- or two-piece stainless steel.
      g. Disc: Stainless steel.

B. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.; Apollo Valves.
      b. Cooper Cameron Valves; a division of Cooper Cameron Corp.
      c. Crane Co.; Crane Valve Group; Jenkins Valves.
      d. Hammond Valve.
      e. Kitz Corporation.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-67, Type I.
      b. CWP Rating: 200 psig.
      c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      e. Seat: EPDM.
      f. Stem: One- or two-piece stainless steel.
      g. Disc: Stainless steel.

2.5 IRON, GROOVED-END BUTTERFLY VALVES

A. 150 CWP, Iron, Grooved-End Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Victaulic Company
      b. Kennedy Valve; a division of McWane, Inc.
      c. Tyco Fire Products LP; Grinnell Mechanical Products
      d. Or approved substitution.
   2. Description:
      a. Standard: MSS SP-67, Type I.
      b. CWP Rating: 150 psig (1032 kPa).
      c. Body Material: Coated, ductile iron.
      d. Stem: Two-piece stainless steel, offset from the disc centerline to provide complete 360-degree circumferential seating.

e. Disc: Aluminum-bronze.
f. Seat: EPDM, pressure responsive in sizes through NPS 12.

2.6 BRASS, GROOVED-END BUTTERFLY VALVES

A. 150 CWP, Brass, Grooved-End Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by the following
a. Victaulic Company
b. Kennedy Valve; a division of McWane, Inc.
c. Tyco Fire Products LP; Grinnell Mechanical Products
d. Or approved substitution.
2. Description:
a. CWP Rating: 150 psig (1032 kPa).
b. Body Material: Cast brass to UNS C87850.
c. Stem: Stainless steel, offset from the disc centerline to provide complete 360-degree circumferential seating.
d. Disc: Aluminum-bronze.
e. Seat: Fluoroelastomer.

2.7 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by Zwick, no substitutions permitted.
2. Description:
a. Standard: ANSI B16.10.
b. CWP Rating: 720 psig at 100 deg F.
c. Body Design: Flange type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: Carbon steel.
e. Seat: Reinforced stainless steel.
f. Stem: One-piece stainless steel; offset from seat plane.
g. Disc: Carbon steel.
h. Service: Bidirectional.
i. Packing: Graphite.

2.8 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.
b. Jenkins Valves.
c. Stockham.
2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.9 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Valve, Inc.
b. Crane Co.; Crane Valve Group.

c. Jenkins Valves.
d. Stockham.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.

2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.10 IRON SWING CHECK VALVES

A. Class 250, Iron Swing Check Valves with Metal Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Jenkins Valves.
c. Stockham.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

2.11 IRON, GROOVED-END SPRING-ASSISTED CHECK VALVES

A. Ductile Iron Spring-Assisted Check Valve for Vertical or Horizontal Installation.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Victaulic Company.
b. Kennedy Valve; a division of McWane, Inc.
c. Tyco Fire Products LP; Grinnell Mechanical Products
d. Or approved substitution.
2. Description:
a. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
b. NPS 14 to NPS 24, CWP Rating: 230 psig.
c. Body Material: ASTM A 536, ductile iron.
d. Ends: Grooved.
e. Trim: Stainless steel.
f. Disc / Seat / Seal:
1) Stainless steel disc with elastomer seat.
2) Elastomer coated ductile iron disc with welded-in nickel seat.
g. Installation: Vertical or horizontal.

2.12 BRONZE GATE VALVES

A. Class 150, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Stockham.
   c. Hammond Valve.
   d. Kitz Corporation.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Powell Valves.
   h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 300 psig.
   c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron.

2.13 IRON GATE VALVES

A. Class 300, NRS, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Stockham Division.
   c. NIBCO INC.
   d. Vogt
2. Description:
   a. Standard: MSS SP-70, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig at 300 degrees F.
   c. NPS 14 to NPS 24, CWP Rating: 300 psig at 300 degrees F.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Disc: Solid wedge.
   h. Packing and Gasket: Asbestos free, graphite.

B. Class 300, OS&Y, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Hammond Valve.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Powell Valves.
   g. Vogt.
2. Description:
   a. Standard: MSS SP-70, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig at 300 degrees F.
   c. NPS 14 to NPS 24, CWP Rating: 300 psig at 300 degrees F.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.

g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos free, graphite.

C. Class 800, OS&Y, Iron Gate Valves:
1. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
a. Milwaukee
b. Vogt
2. Description:
a. Standard: MSS SP-70, Type 1.
b. CWP Rating: 1745 PSIG at 300 degrees F.
c. Body Material: ASTM A 105 carbon steel with bolted bonnet.
d. Ends: Threaded or flanged.
e. Disc: Solid wedge.
f. Seat: Hard faced.
g. Packing and Gasket: Asbestos free, spiral wound gasket, graphite packing.

2.14 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Stockham Division.
c. Hammond Valve.
d. Kitz Corporation.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Powell Valves.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron.

2.15 IRON GLOBE VALVES

A. Class 300, Iron Globe Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Jenkins Valves.
c. Stockham Division.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Vogt.
2. Description:
a. Standard: MSS SP-85, Type I.
b. CWP Rating: 500 psig at 300 degrees F.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.

f. Packing and Gasket: Asbestos free, graphite.

B. Class 800, Iron Globe Valve:
1. Manufacturers: Subject to compliance with the requirements, provide products of one of the following:
a. Milwaukee.
b. Vogt.
2. Description:
a. Standard: MSS SP-70, Type 1.
b. CWP Rating: 1745 psig at 300 degrees F.
c. Body material: ASTM A 105 carbon steel with bolted bonnet.
d. Ends: Threaded or flanged.
e. Disc: Solid wedge.
f. Seat: Hard faced.
g. Packing and Gasket: Asbestos free, spiral wound gaskets, graphite packing.

2.16 LUBRICATED PLUG VALVES

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Nordstrom Valves, Inc.
2. Description:
a. Standard: MSS SP-78, Type II.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
e. Pattern: Venturi.
f. Plug: Cast iron or bronze with sealant groove.

B. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Nordstrom Valves, Inc.
2. Description:
a. Standard: MSS SP-78, Type II.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
e. Pattern: Venturi.
f. Plug: Cast iron or bronze with sealant groove.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

D. Examine grooved ends for form and cleanliness. Ends shall be clean and free from indentations and projections in the area from valve end to (and including) the groove.

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 INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.

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

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

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

E. Install gear operators on all non-quarter turn valves over 6" size.

F. 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.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly, or gate valves.
   2. Throttling Service except Steam: Globe valves.
   3. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
      b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.

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

C. Select valves, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 and Larger: Flanged ends.
   7. Grooved end valves may be used in lieu of flanged valves on applicable piping systems.

3.5 CHILLED-WATER AND HEATING WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two-piece, full port, bronze with stainless-steel trim.
   3. Bronze Swing Check Valves: Class 150, bronze disc.

4. Bronze Gate Valves: Class 150, NRS, bronze.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
1. Iron, Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, stainless-steel disc.
2. Iron, Grooved-End Butterfly Valves, NPS 2 to NPS 24: 150 psi CWP, EPDM seat / seal.
3. Iron Swing Check Valves: Class 125, metal seats.
4. Grooved-End, Spring-Assisted Iron Check Valves: 150-psi CWP.
5. Iron Gate Valves: Class 125, NRS.
6. Iron Globe Valves: Class 125.
7. Lubricated Plug Valves: Class 125, regular gland, flanged.

3.6 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:
1. Bronze Swing Check Valves: Class 150, bronze disc.
2. Bronze Gate Valves: Class 150, NRS.
3. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
1. High-Performance Butterfly Valves: Class 150, double flange.
2. Iron Swing Check Valves: Class 150, metal seats.
3. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 150, lever and spring.
4. Iron Gate Valves: Class 150, OS&Y.
5. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 150.

3.7 HIGH AND MEDIUM PRESSURE STEAM VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Iron Globe Valves: Class 300.
2. Iron Gate Valves: Class 300.
3. Iron Swing Check Valves: Class 250.

B. Pipe Sizes NPS 2-1/2 and Larger:
1. High-Performance Butterfly Valves: Class 300, single flange, with gear operator.
2. Iron Swing Check Valves: Class 250, metal seats.
3. Iron Gate Valves: Class 300, OS&Y, flanged.
4. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 300.

3.8 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Iron Swing Check Valves: Class 250, bronze disc.
2. Iron Gate Valves: Class 300, RS.
3. Iron Globe Valves: Class 300, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
1. High-Performance Butterfly Valves: Class 150, single flange.
2. Iron Swing Check Valves: Class 250, metal seats.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
4. Iron Gate Valves: Class 300, OS&Y.
5. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 300.

END OF SECTION

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Building attachments.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.
11. Miscellaneous equipment.

B. Related Documents:
1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment where required.

1.4 SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following: Include Product Data for components:
1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers
1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless steel.

B. Strap-Type, Fiberglass Pipe Hangers:
1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous thread rod, washer, and nuts made of stainless steel.

2.4 METAL FRAMING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Tube & Conduit.
2. Cooper B-Line, Inc.
3. Unistrut Corporation; Tyco International, Ltd.

B. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

C. Standard: MFMA-4.

D. Channels: Continuous slotted steel channel with inturned lips.

E. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

F. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

G. Metallic Coating: Hot-dipped galvanized.

H. Paint Coating: Epoxy.

I. Plastic Coating: Polyurethane.

2.5 FIBERGLASS STRUT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Tube & Conduit
2. Champion Fiberglass, Inc.
3. Cooper B-Line, Inc.
4. SEASAFE, INC.; a Gibraltar Industries Company.

B. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.
1. Channels: Continuous slotted fiberglass channel with inturned lips.
2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.6 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) or ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength.

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

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

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.7 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated, provide factory- fabricated building attachments comply with MSS SP-58, of one of the following MSS types listed, selected by Installer to

suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Attachment materials to building structure shall be approved by the Structural Engineer.

B. Where concrete structure occurs hang piping using 1/2" diameter Phillips red head wedge anchors or equal by Hilti.
   1. Concrete Inserts: MSS Type 18.
   2. Top Beam C-Clamps: MSS Type 19.
   3. Side Beam or Channel Clamps: MSS Type 20.
   4. Center Beam Clamps: MSS Type 21.
   5. Welded Beam Attachments: MSS Type 22.
   6. C-Clamps: MSS Type 23.
   7. Top Beam Clamps: MSS Type 25.
   8. Side Beam Clamps: MSS Type 27.
   9. Steel Beam Clamps with Eye Nut: MSS Type 28.
   10. Linked Steel Clamps with Eye Nut: MSS Type 29.
   11. Malleable Beam Clamps: MSS Type 30.
   12. Steel Brackets: One of the following for indicated loading:
      a. Light Duty: MSS Type 31.
      b. Medium Duty: MSS Type 32.
      c. Heavy Duty: MSS Type 33.
   13. Side Beam Brackets: MSS Type 34.
   14. Plate Lugs: MSS Type 57.
   15. Horizontal Travelers: MSS Type 58.

2.8 PIPE STANDS

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

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

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

D. High-Type, Single-Pipe Stand:
   1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. Base: 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:
   1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   2. Bases: One or more; plastic.
   3. Vertical Members: Two or more protective-coated-steel channels.
   4. Horizontal Member: Protective-coated-steel channel.
   5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

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

2.9 PIPE POSITIONING SYSTEMS

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

2.10 EQUIPMENT SUPPORTS

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

2.11 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

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

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

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

G. Installation of Building Attachments:
   1. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.
   2. Use power driven anchors or expansion anchors at concrete structure.
   3. Install supplementary steel angles, fastened or welded to building structure as required to support pipe and accessories. Use 3" x 3" x 1/4" steel angle with long leg vertical, or heavier if required.

H. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Sections for how system interfaces with roofing system.

I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each HVAC fixture. See Division 23 HVAC fixture Sections for requirements for pipe positioning systems for HVAC fixtures.

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

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

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

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

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

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

P. Insulated Piping:
1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) 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 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

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

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

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

3.3 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 PAINTING

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

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

3.6 INSTALLATION - PIPE HANGER AND SUPPORT

A. Install in accordance with ASME B31.9, MSS SP 58, MSS SP69, and MSS SP 89.

B. Support horizontal and vertical piping as scheduled.

C. Install hangers with minimum 1/2 inch (13 mm) space between finished covering and adjacent work.

D. Provide clearance in hangers and from structure and other equipment for installation of insulation.

E. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment.

F. Design hangers for pipe movement without disengagement of supported pipe

G. Comply with MSS SP-69 for pipe-hanger selections and applications that are not otherwise specified.

H. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

I. Use stainless-steel pipe hangers, fiberglass pipe hangers, fiberglass strut systems and stainless-steel or corrosion-resistant attachments for outdoors and/or hostile environment applications.

J. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing. Use vinyl-coated hangers and attachments for PEX, PVC, and CPVC piping. Use stainless steel hangers and stainless steel attachments on stainless steel pipes.

K. Use padded hangers for piping that is subject to scratching, including plastic pressure piping and all glass piping.

L. Use thermal-hanger shield inserts for insulated piping and tubing.

M. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified elsewhere, 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 (DN 15 to DN 750).
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), 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 (DN 20 to DN 200).
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
   12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
   13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
   16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
   17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
   18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
   19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
   20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

N. Vertical-Piping Clamps: Unless otherwise indicated and except as specified elsewhere, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

O. Hanger-Rod Attachments: Unless otherwise indicated and except as specified elsewhere, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) 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 (49 to 232 deg C) piping installations.

P. Building Attachments: Unless otherwise indicated and except as specified elsewhere, 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 (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
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.

Q. Saddles and Shields: Unless otherwise indicated and except as specified elsewhere, 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.

R. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions: (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary, to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.

S. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not otherwise specified.

T. Comply with MFMA-103 for metal framing system selections and applications that are not otherwise specified.

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

3.7 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

3.8 SCHEDULES

HORIZONTAL PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING Feet (m)	HANGER ROD DIAMETER Inches (mm)
CPVC, 1 inch (25 mm) and smaller	3 (0.9)	1/2 (13)
CPVC, 1-1/4 inch (32 mm) to 3 inch (75)	4 (1.2)	1/2 (13)
CPVC, 4 inch (100) to 8 inch (200)	4 (1.2)	7/8 (22)
Copper Tube, 1-1/4 inch (32 mm) and smaller	5 (1.5)	3/8 (10)

Copper Tube, 1-1/2 inch (38 mm) to 5 inches (DN125)	8 (2.4)	1/2 (13)
Copper Tube 6 inch (DN150)	10 (3)	5/8 (16)
Copper Tube 8 inch (DN200)	10 (3)	3/4 (19)
Fiberglass up to 4 inch (100 mm)	10 (3)	5/8 (16)
Polypropylene/Polyethylene 3 inches (75 mm) and smaller	3 (.9)	1/2 (13)
Polypropylene/Polyethylene 4 inches (100 mm) to 8 inches (200 mm)	4 (1.2)	7/8 (22)
PVC 3 inches (75 mm) and smaller	4 (1.2)	1/2 (13)
PVC 4 inches (100 mm) to 8 inch (100 mm)	4 (1.2)	7/8 (22)
Stainless Steel or Steel, 3 inches (75 mm) and smaller	12 (3.7)	1/2 (13)
Stainless Steel or Steel, 4 inches (100 mm) to 6 inch (150 mm)	12 (3.7)	3/4 (19)
Stainless Steel or Steel, 8 inches (200 mm) and larger	12 (3.7)	7/8 (22)

NOTE:
1. Where code requirements for hangers are more stringent than above, code requirements shall apply.
2. Place hangers within 12 inches (300 mm) of each horizontal elbow, fitting, valve and coupling.
3. Support horizontal cast iron pipe adjacent to each hub.
4. Rod diameters may be reduced one size for double-rod hangers, with 3/8 inch (10mm) minimum rods.

VERTICAL PIPE SUPPORT SPACING	
PIPE MATERIAL	MAXIMUM SUPPORT SPACING Feet (m)
CPVC 1 inch (25 mm) and smaller	5 (1.5)
CPVC 1-1/4 inch (32mm) and larger	6 (1.8)
Copper Tube	10 (3)
Fiberglass	12 (3.7)
Polypropylene/Polyethylene	5 (1.5)
PVC	4 (1.2)
Steel or Stainless Steel	15 (4.5)

NOTE:
1. Where not otherwise indicated, support vertical piping at each floor.
2. Support cast iron at hubs.
3. Support riser piping independently of connected horizontal piping.

END OF SECTION

SECTION 23 05 48
VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Isolation pads.
   2. Isolation mounts.
   3. Restrained elastomeric isolation mounts.
   4. Freestanding and restrained spring isolators.
   5. Housed spring mounts.
   6. Elastomeric hangers.
   7. Spring hangers.
   8. Spring hangers with vertical limit stops.
   9. Pipe riser resilient supports.
   10. Resilient pipe guides.
   11. Restrained vibration isolation roof-curb rails.
   12. Restraining braces and cables.
   13. Steel and inertia, vibration isolation equipment bases.

1.3 PERFORMANCE REQUIREMENTS

A. Wind-Restraint:
   1. Basic Wind Speed: 90 mph (145 km/hr)
   2. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) 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, or higher as required by local code.

1.4 ACTION SUBMITTALS

A. 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.

B. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

E. Field quality-control test reports.

1.6 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 Building Code 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."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control.
2. Mason Industries.
3. Vibration Mountings & Controls, Inc.

B. Pads (Type I): Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene, rubber, or hermetically sealed compressed fiberglass.

C. Mounts (Type 2): Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

D. Restrained Mounts (Type 2): All-directional mountings with seismic restraint.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

E. Spring Isolators (Type 3): 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. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 150 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).

6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators (Type 4): Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 150 percent of rated load, fully compressed, without deformation or failure.

G. Housed Spring Mounts (Type 4): Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch (6-mm) travel up or down before contacting a resilient collar.

H. Elastomeric Hangers (Type 2): 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.

I. Spring Hangers (Type 3): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop (Type 3): 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. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
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.

K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) 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 (3.45 MPa) and for equal resistance in all directions.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS (TYPE D)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Thybar Corporation.
5. Vibration Mountings & Controls, Inc.

B. 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.

C. 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 (50 mm) of rigid, glass-fiber insulation on inside of assembly.

D. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- (6-mm-) 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. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
2. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   a. Resilient Material: Oil- and water-resistant [standard neoprene] [natural rubber] [hermetically sealed compressed fiberglass].

E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch (6 mm) thick.

F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.3 VIBRATION ISOLATION EQUIPMENT BASES

A. Steel Base (Type B): Factory-fabricated, welded, structural-steel bases and rails.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) 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.

B. Inertia Base (Type C): Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
      a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
   4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.4 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 galvanized 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. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND DEVICE INSTALLATION

A. Comply with requirements in Division 07 for installation of roof curbs, equipment supports, and roof penetrations.

B. 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 (3.2 mm).

C. Piping Restraints:
1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet (12 m) o. c., and longitudinal supports a maximum of 80 feet (24 m) o. c.
3. Brace a change of direction longer than 12 feet (3.7 m).

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

G. 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.

H. 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.

I. 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 prestressed 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 MOTION

A. Install flexible connections in piping where they cross building 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.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 HVAC VIBRATION-CONTROL DEVICE SCHEDULE

			Equipment Location											
			Slab on Grade			Floor Span								
						Up to 20 ft			20 to 30 ft			30 to 40 ft		
Equipment Type	Horsepower and Other	RPM	Base Type	Isolator Type	Min. Defl., in.	Base Type	Isolator Type	Min. Defl., in.	Base Type	Isolator Type	Min. Defl., in.	Base Type	Isolator Type	Min. Defl., in.
Equipment Machines and Chillers														
Reciprocating	All	All	A	2	0.25	A	4	0.75	A	4	1.50	A	4	2.50
Centrifugal, screw	All	All	A	1	0.25	A	4	0.75	A	4	1.50	A	4	1.50
Open centrifugal	All	All	C	1	0.25	C	4	0.75	C	4	1.50	C	4	1.50
Absorption	All	All	A	1	0.25	A	4	0.75	A	4	1.50	A	4	1.50
Air Compressors and Vacuum Pumps														
Tank mounted Horiz	≤10	All	A	3	0.75	A	3	0.75	A	3	1.50	A	3	1.50
	≥15	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50
Tank mounted vert.	All	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50
Base mounted	All	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50
Large reciprocating	All	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50
Pumps														
Close coupled	≤7.5	All	B	2	0.25	C	3	0.75	C	3	0.75	C	3	0.75
	≥10	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50
Large inline	5 to 25	All	A	3	0.75	A	3	1.50	A	3	1.50	A	3	1.50
	≥30	All	A	3	1.50	A	3	1.50	A	3	1.50	A	3	2.50
End suction and split	≤40	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	1.50
case	50 to 125	All	C	3	0.75	C	3	0.75	C	3	1.50	C	3	2.50
	≥150	All	C	3	0.75	C	3	1.50	C	3	2.50	C	3	3.50
Cooling Towers	All	Up to 300	A	1	0.25	A	4	3.50	A	4	3.50	A	4	3.50
		301 to 500	A	1	0.25	A	4	2.50	A	4	2.50	A	4	2.50
		500 and up	A	1	0.25	A	4	0.75	A	4	0.75	A	4	1.50
Boilers (fire-tube)	All	All	A	1	0.25	B	4	0.75	B	4	1.50	B	4	2.50
Axial Fans, Fan Heads, Cabinet Fans, Fan Sections														
Up to 22 in. diameter	All	All	A	2	0.25	A	3	0.75	A	3	0.75	C	3	0.75
24 in. diameter and up	≤2 in SP	Up to 300	B	3	2.50	C	3	3.50	C	3	3.50	C	3	3.50
		300 to 500	B	3	0.75	B	3	1.50	C	3	2.50	C	3	2.50
		501 and up	B	3	0.75	B	3	1.50	B	3	1.50	B	3	1.50
	≥2.1 in SP	Up to 300	C	3	2.50	C	3	3.50	C	3	3.50	C	3	3.50
		300 to 500	C	3	1.50	C	3	1.50	C	3	2.50	C	3	2.50
		501 and up	C	3	0.75	C	3	1.50	C	3	1.50	C	3	2.50
Centrifugal Fans														
Up to 22 in. diameter	All	All	B	2	0.25	B	3	0.75	B	3	0.75	C	3	1.50
24 in. diameter and up	≤40	Up to 300	B	3	2.50	B	3	3.50	B	3	3.50	B	3	3.50
		300 to 500	B	3	1.50	B	3	1.50	B	3	2.50	B	3	2.50
		501 and up	B	3	0.75	B	3	0.75	B	3	0.75	B	3	1.50
	≥50	Up to 300	C	3	2.50	C	3	3.50	C	3	3.50	C	3	3.50
		300 to 500	C	3	1.50	C	3	1.50	C	3	2.50	C	3	2.50
		501 and up	C	3	1.00	C	3	1.50	C	3	1.50	C	3	2.50
Propeller Fans														

Wall mounted	All	All	A	1	0.25	A	1	0.25	A	1	0.25	A	1	0.25
Roof mounted	All	All	A	1	0.25	A	1	0.25	B	4	1.50	D	4	1.50
Heat Pumps	All	All	A	3	0.75	A	3	0.75	A	3	0.75	A/D	3	1.50
Condensing Units	All	All	A	1	0.25	A	4	0.75	A	4	1.50	A/D	4	1.50
Packaged AH, AC, H and V Units														
All	10	All	A	3	0.75	A	3	0.75	A	3	0.75	A	3	0.75
	≤15	Up to 300	A	3	0.75	A	3	3.50	A	3	3.50	C	3	3.50
	≤4 in. SP	301 to 500	A	3	0.75	A	3	2.50	A	3	2.50	A	3	2.50
		501 and up	A	3	0.75	A	3	1.50	A	3	1.50	A	3	1.50
	≤15	Up to 300	B	3	0.75	C	3	3.50	C	3	3.50	C	3	3.50
	≤4 in. SP	301 to 500	B	3	0.75	C	3	1.50	C	3	2.50	C	3	2.50
		501 and up	B	3	0.75	C	3	1.50	C	3	1.50	C	3	2.50
Packaged Rooftop	All	All	A/D	1	0.25	D	3	0.75	←		See Drawings		→	
Equipment ≥ 7.5 tons														
Ducted Rotating Equipment														
Small fans, fan	≤600 cfm	All	A	3	0.50	A	3	0.50	A	3	0.50	A	3	0.50
powered boxes	≥601 cfm	All	A	3	0.75	A	3	0.75	A	3	0.75	A	3	0.75
Engine Driven Generators	All	All	A	3	0.75	C	3	1.50	C	3	2.50	C	3	3.50

Base Types:
A. No base, isolators attached directly to equipment.
B. Structural steel rails or base.
C. Concrete inertia base.
D. Curb mounted base.

Isolator Types:
1. Pad, rubber, or glass fiber.
2. Rubber floor isolator or hanger.
3. Spring floor isolator or hanger.
4. Restrained spring isolator.
5. Thrust restraint.

Table adapted from the Chapter 48 of the 2011 ASHRAE HVAC Applications Handbook

END OF SECTION

SECTION 23 05 53
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. Valve tags.
   5. Warning tags.
   6. Duct labels.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

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 including color scheme, wording, symbols, and letter size.

D. Valve numbering scheme including color scheme, wording, symbols, and letter size.

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

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. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032-inch (0.8-mm); Stainless steel, 0.025-inch (0.64-mm); Aluminum, 0.032-inch (0.8-mm); or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
   3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches

(1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
2. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
3. 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).
4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

C. 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).

D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

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

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

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

2.3 PIPE LABELS

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

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

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

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

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

C. 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).

D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

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

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

G. 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. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
   1. Tag Material: Multilayer, multicolored plastic, 0.0625 inch (1.6mm); Brass, 0.032-inch (0.8-mm); Stainless steel, 0.025-inch (0.64-mm); Aluminum, 0.032-inch (0.8-mm); or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches (100 by 178 mm).
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Yellow background with black lettering.

2.7 PLASTIC UNDERGROUND PIPE MARKERS

A. Brightly colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; mechanical 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. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings.
   8. There shall be a minimum of one label for each system per room.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
   1. Blue: For cold-air supply ducts.
   2. Yellow: For hot-air supply ducts.
   3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
   4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; 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.

3.6 WARNING-TAG INSTALLATION

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

3.7 UNDERGROUND PIPE MARKERS

A. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finish grade, directly above buried pipe.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Testing, adjusting, and balancing of air systems.
   2. Testing, adjusting, and balancing of hydronic systems.
   3. Measurement of final operating condition of HVAC systems.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 REFERENCES

A. National Environmental Balancing Bureau:
   1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

1.3 SUBMITTALS

A. Prior to commencing Work, submit proof of latest calibration date of each instrument.

B. Test Reports: Indicate data on NEBB approved Report forms.

C. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

D. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and Copy of NEBB Certificate of Conformance Certification.

E. Submit draft copies of report for review prior to final acceptance of Project.

F. Furnish reports complete with table of contents page and indexing tabs, with cover identification. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report for inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

B. Prior to commencing Work, calibrate each instrument to be used.

1.6 QUALIFICATIONS

A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum ten years documented experience Certified by NEBB.

B. Perform Work under supervision of NEBB Certified Testing, Balancing and Adjusting Supervisor. Supervisor shall be a registered professional engineer experienced in performance of this Work and licensed at place where Project is located.

1.7 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.8 SEQUENCING

A. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.9 DESCRIPTION OF WORK:

A. Extent of testing, adjusting, and balancing work required by this section shall include a preliminary balance of Air and Water systems together with preparation of the systems for, and cooperation with, the independent Air and Water Balance Contractor. This work by the Mechanical Contractor shall include the following:

1. Carefully check all piping during installation to make certain that water system is installed free from foreign material (stones, sand etc.).
2. Clean the water in the piping system, remove strainer covers and clean basket, and place all associated equipment in operation.
3. Bleed all air from the hydronic system.
4. Provide Pete's Plug gage ports with screw on caps at the inlet and outlet of each piece of equipment attached to the water heating, cooling and piping systems. (Coils, pumps, connectors, airtrol fittings, etc.).
5. Make water system modifications as required by the balancing engineer.
6. Clean air filters, ductwork, coils, fans, etc. in the air system to remove all construction dust and debris.
7. Start, lubricate and balance all fans. Change and/or adjust drive pulleys on fans to give required RPM.
8. Supply and install balancing dampers as required for final balancing as determined by the balancing engineer.
9. Furnish workmen familiar with this project and of the proper trade to assist the balancing engineer in the air and water balancing. Also make available subject to request by the balancing engineer trained servicemen of the control, and other equipment suppliers to assist as needed during the testing of their portion of the project.
10. Furnish plans, operating manuals, and shop drawings of all equipment installed for use by the Air and Water Balancing Agency.
11. Have all systems in full operation a minimum of 72 hours before Balance Contractor arrives on job.

PART 2 - PRODUCTS

2.1 TESTING AND BALANCING

A. The Mechanical Contractor shall procure the services of an engineer pre-approved independent test and balance agency to test water and air moving equipment and air distribution and exhaust systems and to supervise the balance and adjustment of these systems. All work shall be done under direct supervision of a qualified and licensed Heating and Ventilating Engineer. The Contractor shall provide access as required, including any necessary scaffolding, and shall cooperate with testing laboratory personnel. All instruments used in this work shall be accurately calibrated within the 9 months prior to initiating work and maintained in good working order. If requested the tests shall be

conducted in the presence of the Mechanical Engineer responsible for the project and/or his representative. Air balance and testing shall not begin until the system has been completed and is in full working order. The Contractor shall award the test and balance contract upon receipt of his contract to proceed with the air conditioning installation, to allow the Air Balance and Testing Engineer to schedule his work in cooperation with other trades involved and comply with completion date. Upon completion of the air conditioning system installation, the Air Balance and Testing Engineer shall perform the following tests, supervise adjustments and system modifications, and compile the test data as required for evaluation and approval.

B. The independent test and balance agency shall be a full member in good standing of NEBB. All work shall be performed in accordance with the standards set forth by NEBB.

C. Submit a prebalance check list of items to be performed by the Mechanical Contractor prior to balance.

D. Submit a test and balance agenda outlining methods, procedures and instrumentation to be used during balancing. This agenda shall be submitted within 3 months after award of the building contract.

E. Perform an opposite season check-out of the HVAC system (Air and Water) approximately 6 months after original balance to verify that all systems are operating properly and adjust as required. Submit report.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify systems are complete and operable before commencing work. Verify the following:
1. Systems are started and operating in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire, smoke, and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed, and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled with the final fluid, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place or in normal position.
15. Service and balancing valves are open.

3.2 PREPARATION

A. Furnish instruments required for testing, adjusting, and balancing operations.

B. Make instruments available to Project/Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.

B. Air Outlets and Inlets: Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 ADJUSTING

A. Verify recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.

D. Report defects and deficiencies noted during performance of services, preventing system balance.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

F. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

A. Bring all fans to design RPM.

B. Bring air volume in each air handling system to the design air volume using pitot tube transverse method.

C. Test and record fan motor data.

D. Test and record static pressure and air volume in high velocity duct extremities.

E. Measure, record and adjust air diffusers and registers to design CFM.

F. Make recommendations for system modifications and adjustments required to facilitate proper system balancing as determined by preceding test.

G. Retest and readjust all system segments affected by system modifications.

H. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.

I. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

J. Vary total system air quantities by adjustment of fan speeds or adjustable sheaves. Coordinate required sheave drive changes with Mechanical Contractor. Vary branch air quantities by damper regulation.

K. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

L. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

M. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

N. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

O. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.

P. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure where indicated on the drawings.

Q. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

R. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.

S. On fan powered VAV boxes, adjust airflow switches for proper operation.

T. Perform duct leakage tests as specified in Section 233113.

3.6 WATER SYSTEM PROCEDURE

A. Review systems, automatic fill valve and strainer, expansion tank level, water cleanliness, pump strainers, air vent location and pressure tap locations.

B. Inform Mechanical Contractor if there is additional work required by the contractor prior to balancing.

C. Measures circulating pump capacities using calibrated flow meter. Record differential pressure and dead head measurements, amperage and voltages. Position all automatic valves, hand valves and balancing cocks for full flow through coils, converters, etc., during pump adjustment. Use only calibrated test gages for pump adjustment, the use of pressure gages installed with the system will not be allowed.

D. Coordinate the setting of controls to maintain coil water inlet design temperatures with coil valves positioned for full flow through coil during adjustment. Balance individual water coils at full flow to maintain temperature differential specified.

E. Test all equipment on the water system (coils, pumps, converters, etc.) for design flow.

F. Mark settings of all balancing cocks at required positions.

G. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system and note all conditions on the Balance Report.

H. Adjust systems to obtain specified flows through heat transfer elements prior to thermal testing.

I. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.

J. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

K. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.7 DATA FILE:

A. Prepare complete balance report, and data file on all equipment and devices tested indicating name plate data, design requirements and final operating conditions. Prepare drawing showing final CFM adjacent to each supply, return, and exhaust device. Submit seven (7) copies of the final balance report to be distributed as follows:

1. General Contractor - 1 copy
2. Mechanical Contractor - 1 copy
3. Architect - 1 copy
4. Engineer - 1 copy
5. Remaining three (3) copies to be included in the operation and maintenance manuals presented to the Owner.

B. Final report shall include stamp and/or seal of NEBB certified member.

3.8 RETESTING

A. Perform all necessary retesting and rebalancing required to bring all systems into compliance with design parameters of ±10% on airflow and ±5% on water flow at the pump, and ± 10% on water flow at the terminal device.

B. Perform all retesting necessary after contractor's rework to bring non-conforming systems into compliance.

C. Perform all retesting and readjusting as requested by project engineer after review of test report and submit revised report as required.

3.9 INSTRUCTION:

A. At the completion of the balancing, review the operating and maintenance brochures as supplied by the Mechanical Contractor and supplement these instructions as determined through balancing experience. Meet with owner's personnel and with Mechanical Contractor and controls subcontractor to review proper operating procedures.

B. Warranty that the system is set in accordance with values as established by the plans and specifications.

END OF SECTION

SECTION 23 07 00
HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. HVAC piping insulation, jackets and accessories.
   2. HVAC equipment insulation, jackets and accessories.
   3. HVAC ductwork insulation, jackets, and accessories.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Division, may contain requirements that relate to this section.

1.2 REFERENCES

A. Sheet Metal and Air Conditioning Contractors':
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

B. National Fire Protection Association:
   1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

C. Underwriters Laboratories Inc.:
   1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
   2. UL 1978 - Standard for Safety for Grease Ducts.

1.3 SUBMITTALS

A. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

B. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84, UL 723, and NFPA 255. All items exposed in return air plenums must not exceed 25/50 for flame and smoke.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

D. Perform Work in accordance with applicable local and state codes.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years experience.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

B. Maintain temperature before, during, and after installation for minimum period recommended by manufacturer.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
1. CertainTeed.
2. Knauf.
3. Johns Manville.
4. Owens-Corning.

B. Manufacturers for Closed Cell Elastomeric Insulation Products:
1. Aeroflex. Aerocell.
2. Armacell, LLC. Armaflex.
3. Nomaco. K-flex.

C. Manufacturers for Polyisocyanurate Foam Insulation Products:
1. Dow Chemical Company.

D. Manufacturers for Extruded Polystyrene Insulation Products:
1. Dow Chemical Company.

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
1. Thermal Conductivity: 0.23 at 75 degrees F (0.034 at 24 degrees C).
2. Operating Temperature Range: 0 to 850 degrees F (minus 18 to 454 degrees C).
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F (minus 29 to 66 degrees C).

B. TYPE P-2: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
1. Thermal Conductivity: 0.23 at 75 degrees F (0.034 at 24 degrees C).
2. Operating Temperature Range: 0 to 850 degrees F (minus 18 to 454 degrees C).

C. TYPE P-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket. Conform to ASTM C795 for application on Austenitic stainless steel.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.040 at 24 degrees C).
2. Operating Temperature Range: 0 to 650 degrees F (minus 18 to 343 degrees C).

3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F (minus 29 to 66 degrees C).

D. TYPE P-4: ASTM C612; semi-rigid, fibrous glass board noncombustible. Conform to ASTM C795 for application on Austenitic stainless steel.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.040 at 24 degrees C).
2. Operating Temperature Range: 0 to 650 degrees F (minus 18 to 343 degrees C).

E. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 25 degrees C).
2. Operating Temperature Range: Range: Minus 70 to 180 degrees F (minus 57 to 82 degrees C).

F. TYPE P-6: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.30 at 75 degrees F (0.043 at 24 degrees C).
2. Maximum Service Temperature: 300 degrees F (149 degrees C).
3. Operating Temperature Range: Range: Minus 58 to 300 degrees F (minus 50 to 149 degrees C).

G. TYPE P-7: ASTM C534, Type I, flexible, nonhalogen, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
2. Maximum Service Temperature: 250 degrees F (120 degrees C).
3. Operating Temperature Range: Range: Minus 58 to 250 degrees F (minus 50 to 120 degrees C).

H. TYPE P-8: ASTM C547, Type I or II, mineral fiber preformed pipe insulation, noncombustible.
1. Thermal Conductivity: 0.23 at 75 degrees F (0.034 at 24 degrees C).
2. Maximum Service Temperature: 1200 degrees F (649 degrees C).
3. Canvas Jacket: UL listed, 6 oz/sq yd (220 g/sq m), plain weave cotton fabric treated with fire retardant lagging adhesive.

I. TYPE P-9: ASTM C591, Type IV, polyisocyanurate foam insulation, formed into shapes for use as pipe insulation.
1. Density: 2.0 pounds per cubic foot (32 kg per cubic meter).
2. Thermal Conductivity: 180 day aged value of 0.19 at 75 degrees F (0.027 at 24 degrees C).
3. Operating Temperature Range: Range: Minus 297 to 300 degrees F (minus 183 to 149 degrees C).
4. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of 4 mils (0.1 mm) thickness and water vapor permeance of 0.02 perms.

J. TYPE P-10: ASTM C578, Type XIII, extruded polystyrene insulation, formed into shapes for use as pipe insulation.
1. Thermal Conductivity: 180 day aged value of 0.259 at 75 degrees F (0.037 at 24 degrees C).
2. Operating Temperature Range: Range: Minus 297 to 165 degrees F (minus 183 to 74 degrees C).
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of 4 mils (0.1 mm) thickness and water vapor permeance of 0.02 perms.

K. TYPE P-11: ASTM C533; Type I, hydrous calcium silicate pipe insulation, rigid molded white; asbestos free.
1. Thermal Conductivity: 0.45 at 200 degrees F (0.0650 at 93 degrees C).
2. Operating Temperature Range: 140 to 1200 degrees F (60 to 649 degrees C).

2.3 PIPE INSULATION JACKETS

A. PVC Plastic Pipe Jacket:

1. Product Description: ASTM D1784, one-piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 30 mil (0.76 mm).
3. Connections: Brush on welding adhesive.

B. ABS Plastic Pipe Jacket:
1. Jacket: One-piece molded type fitting covers and sheet material, off-white color.
2. Minimum service temperature: -40 degrees F (-40 degrees C).
3. Maximum service temperature of 180 degrees F (82 degrees C).
4. Moisture vapor transmission: ASTM E96; 0.012 perm-inches.
5. Thickness: 30 mil (0.76 mm).
6. Connections: Brush on welding adhesive.

C. Aluminum Pipe Jacket:
1. ASTM B209.
2. Thickness: 0.032 inch (0.80 mm) thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
5. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.020 inch (0.50 mm) thick stainless steel.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches (40 mm) diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches (50 mm) diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches (150 mm) long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with [aluminum] [stainless steel jacket] single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.
1. Thermal Conductivity: 0.24 at 75 degrees F (0.035 at 24 degrees C).
2. Operating Temperature Range: 0 to 450 degrees F (minus 18 to 232 degrees C).
3. Density: 1.5 pound per cubic foot (24 kilogram per cubic meter).

B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied foil scrim craft jacket.
1. Thermal Conductivity: 0.24 at 75 degrees F (0.035 at 24 degrees C).
2. Operating Temperature Range: 0 to 450 degrees F (minus 18 to 232 degrees C).
3. Density: 3.0 pound per cubic foot (48 kilogram per cubic meter).
4. Jacket Temperature Limit: minus 20 to 150 degrees F (minus 29 to 66 degrees C).

C. TYPE E-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket.
   1. Thermal Conductivity: 0.27 at 75 degrees F (0.040 at 24 degrees C).
   2. Operating Temperature Range: 0 to 650 degrees F (minus 18 to 343 degrees C).
   3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F (minus 29 to 66 degrees C).

D. TYPE E-4: ASTM C612; semi-rigid, fibrous glass board noncombustible.
   1. Thermal Conductivity: 0.27 at 75 degrees F (0.040 at 24 degrees C).
   2. Operating Temperature Range: 0 to 650 degrees F (minus 18 to 343 degrees C).

E. TYPE E-5: ASTM C612; glass fiber, semi-rigid board, noncombustible.
   1. Thermal Conductivity: 0.23 at 75 degrees F (0.033 at 24 degrees C).
   2. Maximum Operating Temperature: 850 degrees F (450 degrees C).
   3. Density: 3.0 pound per cubic foot (48 kilogram per cubic meter).

F. TYPE E-6: ASTM C553; mineral fiber blanket, Type I.
   1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
   2. Maximum Operating Temperature: 1000 degrees F (538 degrees C).
   3. Density: 1.0 pound per cubic foot (16 kilogram per cubic meter).

G. TYPE E-7: ASTM C533; Type II, hydrous calcium silicate block insulation, asbestos free.
   1. Thermal Conductivity: 0.45 at 200 degrees F (0.0650 at 93 degrees C).
   2. Operating Temperature Range: 140 to 1200 degrees F (60 to 649 degrees C).

H. TYPE E-8: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
   1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 25 degrees C).
   2. Operating Temperature Range: Range: Minus 70 to 220 degrees F (minus 57 to 105 degrees C).

I. TYPE E-9: ASTM C612, manmade mineral fiber, noncombustible, Classes 1-4.
   1. Thermal Conductivity: 0.25 at 100 degrees F (0.037 at 38 degrees C).
   2. Maximum Service Temperature: 1200 degrees F (650 degrees C).
   3. Density: 4 pound per cubic foot (64 kilogram per cubic meter).

2.6 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:
   1. Product Description: ASTM D1784, sheet material, off-white color.
   2. Minimum Service Temperature: -40 degrees F (-40 degrees C).
   3. Maximum Service Temperature: 150 degrees F (66 degrees C).
   4. Moisture Vapor Transmission: ASTM E96; 0.002 perm-inches.
   5. Thickness: 30 mil (0.75 mm).
   6. Connections: Brush on welding adhesive.

B. Aluminum Equipment Jacket:
   1. ASTM B209.
   2. Thickness: 0.040 inch (1.00 mm) thick sheet.
   3. Finish: Smooth.
   4. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
   5. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
   6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.

C. Canvas Equipment Jacket: UL listed, 6 oz/sq yd (220 g/sq m), plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.

D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

E. Adhesives: Compatible with insulation.

2.8 DUCTWORK INSULATION

A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied foil scrim craft jacket meeting ASTM C1136, Type II.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
2. Maximum Operating Temperature: 250 degrees F (121 degrees C).
3. Density: 0.75 pound per cubic foot (12 kilogram per cubic meter).

B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied paintable all service facing meeting ASTM C1136, Type II.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
2. Density: 3.0 pound per cubic foot (48 kilogram per cubic meter).

C. TYPE D-3: ASTM C612, Type IA or IB, rigid glass fiber, no facing.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
2. Density: 3.0 pound per cubic foot (48 kilogram per cubic meter).

D. TYPE D-4: ASTM C1071, Type I, flexible, glass fiber duct liner with coated air side.
1. Thermal Conductivity: 0.26 at 75 degrees F (0.038 at 24 degrees C).
2. Density: 2.0 pound per cubic foot (32 kilogram per cubic meter).
3. Maximum Operating Temperature: 250 degrees F (121 degrees C).
4. Maximum Air Velocity: 6,000 feet per minute (30.5 meter per second).

E. TYPE D-5: ASTM C1071, Type II, rigid, glass fiber duct liner with coated air side.
1. Thermal Conductivity: 0.23 at 75 degrees F (0.033 at 24 degrees C).
2. Density: 3.0 pound per cubic foot (48 kilogram per cubic meter).
3. Maximum Operating Temperature: 250 degrees F (121 degrees C).
4. Maximum Air Velocity: 4,000 feet per minute (20.3 meter per second).

F. TYPE D-6: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
2. Service Temperature Range: Range: Minus 58 to 180 degrees F (minus 50 to 82 degrees C).

G. TYPE D-7: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet laminated with white thermoplastic rubber membrane.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
2. Service Temperature Range: Range: Minus 58 to 180 degrees F (minus 50 to 82 degrees C).

H. TYPE D-8: Inorganic blanket encapsulated with scrim reinforced foil meeting UL 1978.
1. Thermal Conductivity: 0.42 at 500 degrees F (0.060 at 260 degrees C).
2. Weight: 1.4 pound per square foot (6.73 kilogram per square meter).
3. Flame spread rating of 0 and smoke developed rating of 0 in accordance with ASTM E84.

2.9 DUCTWORK INSULATION JACKETS

A. Aluminum Duct Jacket:
1. ASTM B209.
2. Thickness: 0.032 inch (0.80 mm) thick sheet.
3. Finish: Smooth.
4. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.

5. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.

B. Vapor Retarder Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with pressure sensitive tape.

C. Canvas Duct Jacket: UL listed, 6 oz/sq yd (220 g/sq m), plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

D. Membrane Duct Jacket: ASTM D4637; Type I, EPDM; non-reinforced, 0.060 inch (1.5 mm) thick, 48 inch (1220 mm) wide roll; white color.

2.10 DUCTWORK INSULATION ACCESSORIES

A. Vapor Retarder Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Adhesive: Waterproof, ASTM E162 fire-retardant type.

D. Liner Fasteners: Galvanized steel, self-adhesive pad, impact applied, or welded with integral or press-on head.

E. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.

F. Lagging Adhesive: Fire resistive to ASTM E84, NFPA 255, and UL 723.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Adhesives: Compatible with insulation.

I. Membrane Adhesives: As recommended by membrane manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify piping, equipment and ductwork has been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Division 07 for penetrations of assemblies with fire resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature:
1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:
1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Polyisocyanurate Foam Insulation and Extruded Polystyrene Insulation:
1. Wrap elbows and fitting with vapor retarder tape.
2. Seal butt joints with vapor retarder tape.

F. Hot Piping Systems less than 140 degrees F (60 degrees C):
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

G. Hot Piping Systems greater than 140 degrees F (60 degrees C):
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

H. Inserts and Shields:
1. Piping 1-1/2 inches (40 mm) Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches (50 mm) Diameter and Larger: Install insert between support shield and piping and under finish jacket.
    a. Insert Configuration: Minimum 6 inches (150 mm) long, of thickness and contour matching adjoining insulation; may be factory fabricated.
    b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

I. Insulation Terminating Points:
1. Coil Branch Piping 1 inch (25 mm) and Smaller: Terminate hot water piping at union upstream of the coil control valve. On VAV, CV, and FTU terminal units, insulate heating water piping and components up to coil connections.
2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
3. Cooling Coil Condensate Piping: Insulate entire piping system and components to prevent condensation.

J. Closed Cell Elastomeric Insulation:

1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer's recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

K. High Temperature Pipe Insulation:
1. Install in multiple layers to meet thickness scheduled.
2. Attach each layer with bands. Secure first layer with bands before installing next layer.
3. Stagger joints between layers.
4. Finish with canvas jacket sized for finish painting.

****** [OR] ******

5. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

L. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet (3 meters) above finished floor): Finish with PVC jacket and fitting covers.

M. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

N. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.

O. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

P. Prepare pipe insulation for finish painting. Refer to Division 09.

3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:
1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F (60 degrees C) Or Less:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment Containing Fluids Over 140 degrees F (60 degrees C):
1. Insulate flanges and unions with removable sections and jackets.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

G. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting or with aluminum jacket.

H. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

I. Cover cellular glass, hydrous calcium silicate, and cellular foam insulation with aluminum jacket.

J. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

K. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

L. Prepare equipment insulation for finish painting. Refer to Division 09.

3.4 INSTALLATION - DUCTWORK SYSTEMS

A. Duct dimensions indicated on Drawings are finished inside dimensions. Increase duct dimension where internal duct liner is specified.

B. Insulated ductwork conveying air below ambient temperature:
1. Provide insulation with vapor retarder jackets.
2. Finish with tape and vapor retarder jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ductwork conveying air above ambient temperature:
1. Provide with or without standard vapor retarder jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. External Glass Fiber Duct Insulation:
1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

E. External Elastomeric Duct Insulation:
1. Adhere to clean oil-free surfaces with full coverage of adhesive.
2. Seal seams and butt joints with manufacturer's recommended adhesive.
3. When application requires multiple layers, apply with joints staggered.
4. Insulate standing metal duct seams with insulation of like material and thickness as adjacent duct surface. Apply adhesive at joints with flat duct surfaces.
5. Lift ductwork off trapeze hangers and insert spacers.

F. Kitchen Exhaust Ductwork:

1. Cover duct by wrapping with insulation per listing.
2. Overlap seams of each method by 3 inches (76 mm).
3. Attach insulation using steel banding or by welded pins and clips.
4. Install insulation without sag on underside of ductwork. Use additional fasteners to prevent sagging.

G. Ducts Exterior to Building:
1. Install insulation according to insulation schedule.
2. Provide external insulation with vapor retarder jacket. Cover with membrane duct jacket.
3. Finish with aluminum duct jacket.
4. Calk seams at flanges and joints. Located major longitudinal seams on bottom side of horizontal duct sections.
5. Prepare duct insulation for finish painting. Refer to Division 09.

3.5 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPES	PIPE SIZE	INSULATION THICKNESS inches (mm)
Chilled Water Supply and Return [40 to 60 degrees F]	P-1[b]	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) inch to 4" (100mm) 6 inches (150mm) and larger	0.5 (13) 1.0 (25) 1.5 (40)
Chilled Water Supply and Return [less than 40 degrees F]	P-1[b]	3/4 inch (20 mm) and smaller 1 inch (25 mm) to 6 inches (150 mm) 8 inches (200 mm) and larger	0.5 (13) 1.0 (25) 1.5 (40)
Glycol Supply and Return [40 to 60 degrees F]	P-1[b]	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) inch and larger	0.5 (13) 1.0 (25)
Condensate Piping from Cooling Coils	P-5	All sizes	0.5 (13)
Refrigerant Suction	P-5	3/4inches (20mm) and smaller 1 inch (25mm to 8 inches (200mm)	0.5 (13) 1.0 (25)
Refrigerant Hot Gas	P-5	All sizes	0.5 (13)

Notes:
a. Not all insulation types listed are allowed in return air plenums. Insulation in air plenums must have a flame and smoke rating of 25/50 or less per ASTM E84.
b. Insulation type P-5, P-9, or P-10 may be used for piping installed outdoors. Install longitudinal seams on the bottom of the pipe to allow moisture to drain.

B. Heating Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPES	PIPE SIZE	INSULATION THICKNESS inches (mm)
Heating Water Supply and Return [105 to 140 degrees F (40 to 60 degrees C)]	P-1	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) and larger	1.0 (13) 1.5 (25)
Heating Water Supply and Return [141 to 200 degrees F (61 to 93 degrees C)]	P-1	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) and larger	1.5 (25) 2.0 (40)
Heating Water Supply and Return [201 to 250 degrees F (94 to 121 degrees C)]	P-1	3 inches (76 mm) and smaller 4 inches (100 mm) and larger	2.5 (40) 3.0 (50)
Low Pressure Steam Supply up to 15 psi (103 kPa) [up to 250 degrees F (121 degrees C)]	P-1	3 inches (76 mm) and smaller 4 inches (100 mm) and larger	2.5 (40) 3.0 (50)
Medium Pressure Steam Supply greater than 15 up to 150 psi (greater than 110 up to 1034 kPa) [251 to 366 degrees F (122 to 186 degrees C)]	P-1, P-8, P-11	3/4 inch (20 mm) and smaller 1 inch (25 mm) to 1-1/4 inches (32 mm) 1-1/2 inches (40 mm) and larger	3.0 (40) 4.0 (65) 4.5 (76)
High Pressure Steam Supply greater than 150 psi (1034 kPa) [366 degrees F (186 degrees C)]	P-8, P-11	3/4 inch (20 mm) and smaller 1 inch (25 mm) and larger	4.5 (65) 5 (76)
Low Pressure and Gravity Steam Condensate Return	P-1	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) and larger	1.5 (40) 2 (50)
Medium Pressure Condensate greater than 15 up to 150 psi (greater than 110 to 1034 kPa) [251 to 366 degrees F (122 to 186 degrees C)]	P-1, P-8, P-11	3/4 inch (20 mm) and smaller 1 inch (25 mm) to 1-1/4 inches (32 mm) 1-1/2 inches (40 mm) and larger	3.0 (40) 4.0 (65) 4.5 (76)
High Pressure Steam Condensate Return	P-1, P-8	3/4 inch (20 mm) and smaller 1 inch (25 mm) and larger	4.5 (40) 5 (65)
Pumped Steam Condensate Return	P-1	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) and larger	1.5 (40) 2 (50)
Boiler Feed Water	P-1	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) and larger	1.5 (40) 2 (50)
Humidifier Supply Piping	P-1	1-1/4 inches (32 mm) and smaller 1-1/2 inches (40 mm) and larger	1.5 (40) 2 (50)
Humidifier Drain Piping	P-1	All sizes	1 (25)

C. Dual Temperature Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPES	PIPE SIZE	INSULATION THICKNESS inches
VRF Liquid Line Outdoor Unit to Branch Selector	P-1[b], P-5	1 3/8 inches and smaller 1 1/2 inches and larger	1.0 1.5
VRF Hot Gas/Suction Line Outdoor Unit to Branch Selector	P-1[b], P-5	1 3/8 inches and smaller 1 1/2 inches and larger	1.5 2.0
VRF Dual Temperature Line Outdoor Unit to Branch Selector	P-1[b], P-5	1 3/8 inches and smaller 1 1/2 inches and larger	1.5 2.0
VRF Liquid Line Branch Selector to Indoor Unit	P-1[b], P-5	1 3/8 inches and smaller	1.0
VRF Suction Line Branch Selector to Indoor Unit	P-1[b], P-5	1 3/8 inches and smaller	0.5

Notes:

a. Not all insulation types listed are allowed in return air plenums. Insulation in air plenums must have a flame and smoke rating of 25/50 or less per ASTM E84.
b. Insulation type P-5, P-9, or P-10 may be used for piping installed outdoors. Install longitudinal seams on the bottom of the pipe to allow moisture to drain.
c. Insulation may be reduced to 1" thickness where located inside a partition that is interior to the building.

D. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPES	INSULATION THICKNESS inches (mm)
Steam-to-Water Heat Exchanger	E-2, E-3, E-7	1.5 (40)
Water-to-Water Heat Exchangers	E-2, E-3	1.5 (40)
Hot Thermal Storage Tanks	E-2, E-3, E-5	1.5 (40)
Boiler and Feed Water Storage Tanks	E-2, E-3, E-5	1.5 (40)
Steam Condensate Receivers	E-2, E-3, E-5	1.5 (40)
Condensate Tanks	E-2, E-3, E-5	1.5 (40)
Deaerators	E-2, E-3, E-5	1.5 (40)
Boiler Flue, Boiler Breeching which are not factory insulated.	E-5	1.5 (40)
Chilled Water Pump Bodies	E-8	0.5 (13)
Chilled Water Air Separators	E-8	0.5 (13)
Chilled Water Expansion Tanks	E-8	0.5 (13)
Chiller Cold Surfaces (Not Factory Insulated)	E-8	1.0 (25)
Absorption Chiller Hot Surfaces (Not Factory Insulated)	E-2, E-3, E-5	1.0 (25)

Cold Thermal Storage Tanks	E-8	1.0 (25)
Generator Exhaust Piping	E-3, E-4, E-7, E-9	2.0 (50)
Generator Exhaust Muffler	E-7,-E9	2.0 (50)

E. Ductwork Insulation Schedule:

DUCTWORK SYSTEM	INSULATION TYPE(S)[c,d]	INSULATION THICKNESS inches (mm)
Low-Velocity Rectangular Supply Ducts in Non-Hospital Applications (internally insulated)[a]	D-4	1.0 (25)
Low-Velocity Round and Oval Supply in Non-Hospital Applications (externally insulated)	D-1	1.5 (40)
Low-Velocity Rectangular Return Ducts in Non-Hospital Applications (internally insulated)[a]	D-4	0.5 (13)
Round, Rectangular and Oval Medium and High Velocity Supply Ducts in Non-Hospital Applications (externally insulated)	D-1[e]	1.5 (40)
Rectangular Supply and Return Ducts Exposed to Outdoor Air[d] or Exterior to Building[b] in Non-Hospital Applications (combined internal and external insulation)	D-4 plus D-1[e]	1.0 (25) plus 2.0 (50)
Round Supply and Return Exposed to Outdoor Air[d] or Exterior to Building[b] in Non-Hospital Applications.	D-1	3.0 (76)
All Supply Ducts in Hospital Applications (externally insulated)[f]	D-1[e]	1.5 (40)
Return Ducts in Hospital Applications (Note: Special situations, such as low-temperature operating rooms, will require insulation similar to that for supply ductwork)	None	None
All Supply and Return Ducts Exposed to Outdoor Air[d] or Exterior to Building[b] in Hospital Applications	D- 1[e]	3.0 (76)
Exhaust Fan Discharge Ducts Between the Backdraft/Isolation Damper and the Exterior Opening	D-1[e]	1.5 (40)
Rectangular Exhaust Ducts for Last 15 Feet Before Fan In all Directions[a]	D-4	0.5 (13)
Exhaust Ducts Exposed to Outdoor Air[d] or Exterior to Building[b]	D-1[e]	2.0 (50)
Kitchen Grease Exhaust Duct (2 layers of 1-1/2 inch (40 mm) each)	D-8	3.0 (76)
Rectangular Transfer Air Ducts (internally insulated)[a]	D-4	1.0 (25)
Duct Coils and Heating Coils on VAV, CV and FTU Terminal Units (Entire coil must be insulated, including casing, header and return bends)	D-1	1.5 (40)
Combustion Air	D-1[e]	2 (50)
Outside Air Intake	D-1[e]	2 (50)
Supply Duct from Energy Recovery Ventilators	D-1	1.5 (40)

Supply Duct from Energy Recovery Ventilators Exposed to Outdoor Air[e] or Exterior to Building[b]	D-1	3.0 (76)

Notes:

a. Line exhaust ductwork only in clean air exhaust applications. In applications containing fumes, grease, dirt or water vapor, the internal liner shall be omitted.
b. For ductwork installed exterior to building, furnish and install weatherproof jacket.
c. Factory-insulated dual-wall ductwork is not required to be field insulated.
d. Examples of spaces exposed to outdoor air include ventilated attics, mechanical rooms with louvered openings directly to the outdoors, etc.
e. Where rectangular ducts are exposed to view (including mechanical rooms), substitute D-2 for D-1.
f. Internal duct liner is not allowed in the supply or return ductwork in hospital applications.

END OF SECTION 230700

SECTION 23 08 00
COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. HVAC commissioning description.
   2. HVAC commissioning responsibilities.

B. Related Sections:
   1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Division, may contain requirements that relate to this section.

1.2 REFERENCES

A. Associated Air Balance Council:
   1. AABC - AABC Commissioning Guideline.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE Guideline 1 - The HVAC Commissioning Process.

C. National Environmental Balancing Bureau:
   1. NEBB - Procedural Standards for Building Systems Commissioning.

1.3 COMMISSIONING DESCRIPTION

A. HVAC commissioning process includes the following tasks:
   1. Testing and startup of HVAC equipment and systems.
   2. Equipment and system verification checks.
   3. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.
   4. Provide qualified personnel to assist in commissioning tests, including seasonal testing.
   5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
   6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
   7. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.
   8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
   9. Provide training for systems specified in this Section with coordination by Commissioning Authority.

B. Equipment and Systems to Be Commissioned:
   1. Piping systems.
   2. Ductwork.
   3. Variable frequency drives.
   4. Packaged roof top air conditioning units.
   5. Split system air conditioning units.
   6. Humidifiers.
   7. Air handling units.

8. Condensing units.
9. Hot water terminal heating equipment.
10. Unit heaters.
11. Computer room units.
12. Constant volume terminal units.
13. Variable volume terminal units.
14. Fans.
15. Fire dampers.
16. Smoke dampers.
17. Indoor air quality.
18. Equipment sound control.
19. Equipment vibration control.

C. Perform seasonal function performance tests for equipment and systems.

1.4 COMMISSIONING SUBMITTALS

A. Draft Forms: Submit draft of system verification form and functional performance test checklist.

B. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified. Use AABC forms as guidelines.

C. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.

B. Operation and Maintenance Data: Submit revisions to operation and maintenance manuals when necessary revisions are discovered during commissioning.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with AABC.

1.7 COMMISSIONING RESPONSIBILITIES

A. Equipment or System Installer Commissioning Responsibilities:
1. Attend commissioning meetings.
2. Ensure temperature controls installer performs assigned commissioning responsibilities as specified below.
3. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified.
4. Provide instructions and demonstrations for Owner's personnel.
5. Ensure subcontractors perform assigned commissioning responsibilities.
6. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
7. Develop startup and initial checkout plan using manufacturer's startup procedures and functional performance checklists for equipment and systems to be commissioned.
8. During verification check and startup process, execute HVAC related portions of checklists for equipment and systems to be commissioned.
9. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
10. Provide manufacturer's representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
11. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.

12. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
13. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
14. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
15. Provide factory supervised startup services for equipment and systems specified. Coordinate work with manufacturer and Commissioning Authority.
16. Perform verification checks and startup on equipment and systems as specified.
17. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
18. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
19. Conduct HVAC system orientation and inspection.

B. Temperature Controls Installer Commissioning Responsibilities:
1. Attend commissioning meetings.
2. Review design for ability of systems to be controlled including the following:
    a. Confirm proper hardware requirements exists to perform functional performance testing.
    b. Confirm proper safeties and interlocks are included in design.
    c. Confirm proper sizing of system control valves and actuators and control valve operation will result capacity control identified in Contract Documents.
    d. Confirm proper sizing of system control dampers and actuators and damper operation will result in proper damper positioning.
    e. Confirm sensors selected are within device ranges.
    f. Review sequences of operation and obtain clarification from Architect/Engineer.
    g. Indicate delineation of control between packaged controls and building automation system, listing BAS monitor points and BAS adjustable control points.
    h. Provide written sequences of operation for packaged controlled equipment. Equipment manufacturers' stock sequences may be included, when accompanied by additional narrative to reflect Project conditions.
3. Inspect, check, and confirm proper operation and performance of control hardware and software provided in other HVAC sections.
4. Submit proposed procedures for performing automatic temperature control system point-to-point checks to Commissioning Authority and Architect/Engineer.
5. Inspect check and confirm correct installation and operation of automatic temperature control system input and output device operation through point-to-point checks.
6. Perform training sessions to instruct Owner's personnel in hardware operation, software operation, programming, and application in accordance with commissioning plan.
7. Demonstrate system performance and operation to Commissioning Authority during functional performance tests including each mode of operation.
8. Provide control system technician to assist during Commissioning Authority verification check and functional performance testing.
9. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.

10. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

C. Testing, Adjusting, and Balancing Agency Commissioning Responsibilities:
1. Attend commissioning meetings.
2. Participate in verification of testing, adjusting, and balancing report for verification or diagnostic purposes. Repeat sample of 10 percent of measurements contained in testing, adjusting, and balancing report as indicated in commissioning plan.
3. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

1.8 COMMISSIONING MEETINGS

A. Attend initial commissioning meeting and progress commissioning meetings as required by Commissioning Authority.

1.9 SCHEDULING

A. Prepare schedule indicating anticipated start dates for the following:
1. Piping system pressure testing.
2. Piping system flushing and cleaning.
3. Ductwork cleaning.
4. Ductwork pressure testing.
5. Equipment and system startups.
6. Automatic temperature control system checkout.
7. Testing, adjusting, and balancing.
8. HVAC system orientation and inspections.
9. Operation and maintenance manual submittals.
10. Training sessions.

B. Schedule seasonal tests of equipment and systems during peak weather conditions to observe full-load performance.

C. Schedule occupancy sensitive tests of equipment and systems during conditions of both minimum and maximum occupancy or use.

1.10 COORDINATION

A. Notify Commissioning Authority minimum of four weeks in advance of the following:
1. Scheduled equipment and system startups.
2. Scheduled automatic temperature control system checkout.
3. Scheduled start of testing, adjusting, and balancing work.

B. Coordinate programming of automatic temperature control system with construction and commissioning schedules.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install additional balancing dampers, balancing valves, access doors, test ports, and pressure and temperature taps required by commissioning plan.

B. Place HVAC systems and equipment into full operation and continue operation during each working day of commissioning.

C. Install replacement sheaves and belts to obtain system performance, as requested by Commissioning Authority.

D. Install test holes in ductwork and plenums as requested by Commissioning Authority for taking air measurements.

E. Prior to start of functional performance test, install replacement filters in equipment.

3.2 COMMISSIONING

A. Seasonal Sensitive Functional Performance Tests:
   1. Test heating equipment at winter design temperatures.
   2. Test cooling equipment at summer design temperatures with fully occupied building.
   3. Participate in testing delayed beyond Final Completion to test performance at peak seasonal conditions.

B. Be responsible to participate in initial and alternate peak season test of systems required to demonstrate performance.

C. Occupancy Sensitive Functional Performance Tests:
   1. Test equipment and systems affected by occupancy variations at minimum and peak loads to observe system performance.
   2. Participate in testing delayed beyond Final Completion to test performance with actual occupancy conditions.

END OF SECTION

SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

A. Extent of temperature control systems work required by this section is indicated by drawings and schedules, and by requirements of this section.
   1. Control sequences are Specified on contract drawings.

B. Refer to other Division 23 sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not work of this section.

C. Refer to Division 26 sections for the following work; not work of this section.
   1. Power supply wiring from power source to power connection on controls and/or unit control panels. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
   2. Interlock wiring between electrically operated equipment units; and between equipment and field-installed control devices.
      a. Interlock wiring specified as factory-installed is work of this section.

D. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:
   1. Low voltage control/FMS system wiring between field-installed controls, indicating devices, and unit control panels.

1.3 QUALITY ASSURANCE:

A. Manufacturer's: Temperature controls shall be manufactured and installed by:
   1. Johnson's Controls

B. Installer's Qualifications: Firms specializing and experienced in control system installations for not less than 5 years.

C. Codes and Standards:
   1. Electrical Standards: Provide electrical components of pneumatic control systems which have been UL-listed and labeled and comply with NEMA standards.
   2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for pneumatic control systems.
   3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's specifications for each control device and compressed air station furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes, also include installation and start-up instructions.

B. Shop Drawings: Submit shop drawings for each pneumatic/electric control system, containing the following information:
   1. Schematic flow diagram of system showing chillers, fans, pumps, coils, dampers, valves, and control devices.
   2. Label each control device with setting or adjustable range of control.

3. Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed. Include a ladder diagram.
4. Provide details of faces of control panels, including controls, instruments, and labeling.
5. Include verbal description of sequence of operation.

C. Maintenance Data: Submit maintenance instructions and spare parts lists for each type of control device, and compressed air stations. Include that type data, product data and shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Provide factory shipping cartons for each piece of equipment and control device. Maintain cartons while shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

1.6 DDC TEMPERATURE CONTROLS CONTRACTOR (TCC) BALANCER COORDINATION

A. First Day: The TCC shall have a technical representative present with the Balancer on the first day of balancing for a minimum of 4 hours of active balancing - temperature controls coordination.

B. Remainder of Balancing: The TCC shall either:
1. Have a technical representative continuously present at each step of the continuation of the balancing OR
2. Furnish the Balancer with the latest DDC software any required interface device for the duration of the balancing process. This option includes instructing the Balancer in the use of the software until the Balancer is proficient in the use of the software. Software and interface device shall be returned to TCC when balance report has been accepted. There shall be no charge to the owner or to the Balancer for the use of the software, OR
3. Furnish the Balancer with the latest DDC software and any required interface device, and a portable computer for the duration of the balancing process. This option includes instructing the Balancer in the use of the portable computer and the software until the Balancer is proficient in the use of the software. Portable computer, interface device, and software shall be returned to the TCC when balance report has been accepted. There shall be no charge to the Owner or to the Balancer for the use of the software or portable computer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide electronic control of one of the following:
1. Johnson Controls

2.2 MATERIALS AND EQUIPMENT:

A. General: Provide control products in sizes and capacities indicated consisting of valves, dampers, thermostats, clocks, sensors, controllers, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated. Provide control systems with the following functional and construction features:

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:
   1. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
   2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
   3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
      a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
      b. Double-Seated valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
   4. Sizing: 5-psig (35-kPa) maximum pressure drop at design flow rate r the following:
      a. Two Position: Line Size.
      b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
      c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
   5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
   6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve o r 100 percent of total system (pump) head.

D. Steam system globe vales shall have the following characteristics:
   1. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
   2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
   3. Internal Construction: Replaceable plugs and stainless-steel seats.
      a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
      b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
   4. Sizing: For pressure drop based on the following services:
      a. Two Position: 20 percent of inlet pressure.
      b. Modulating 15-psig (103-kPa) Steam: 80 percent of inlet steam pressure.
      c. Modulating: 16-psig to 50-psig (110- to 350-kPa) Steam: 50 percent of inlet steam pressure.
      d. Modulating more than 50-psig (350-kPa) Steam: As indicated.
   5. Flow Characteristics: Modified linear characteristics.
   6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of operating (inlet) pressure.

E. Pressure independent control valves for Chilled water coils.
   1. Manufacturers:
      a. Belimo Aircontrols (USA) Inc.
      b. Flow Control Industries
   2. Control Valves: Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
   3. Pressure Independent Characterized Control Valves (PCCV): Forged brass body rated at no less than 600 psi, chrome plated brass ball and stem, female, NPT union ends.
      a. The modulating control valves shall be pressure independent.

b. The control valve shall accurately control the flow from 0% to 200% full rated flow with an equal percentage flow characteristic. The flow shall not vary more than +/-5% due to system pressure fluctuations across the valve with a minimum of 5 psid across the valve.
c. Combination of actuator and valve shall provide a minimum close-off pressure rating of 200 psi.
d. The control valve shall require no maintenance and shall not include replaceable cartridges.
e. The actuator shall be directly coupled to the valve at the factory.
f. Actuators shall be Multi-Function Technology as manufactured by Belimo Aircontrols (USA), Inc. or approved equal. Multi-turn actuators are not acceptable. Running time shall be 100 seconds independent of the flow setting while rotating a maximum of 90 degrees.
g. The control valve manufacturer shall provide written guarantee that the heating and cooling coils will meet or exceed maximum delta T performance at all load conditions as projected by an ARI certified coil program at time of commissioning. The valve manufacturer will reimburse the full purchase price of the valve(s) if this performance level cannot be met.
h. The control valve manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
i. .

F. Dampers: Provide automatic control dampers as indicated, with damper frames not less than formed 13 gauge galvanized steel. Provide mounting holes for enclosed duct mounting. Provide damper blades not less than formed 16 gauge galvanized steel, with maximum blade width of 8".
1. Secure blades to 1/2" diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of each blade. Construct blade linkage hardware of zinc-plated steel and brass. Submit leakage and flow characteristics plus size schedule for controlled dampers.
2. Operating Temperature Range: From -20 to 200 deg F (-29 to 93 deg C).
3. For standard applications as indicated, provide parallel or opposed blade design (as selected by the manufacturer's sizing techniques) with closed-cell neoprene edging.
4. For low leakage applications as indicated, provide parallel or opposed blade design (as selected by manufacturer's sizing techniques) with inflatable steel blade edging, or replaceable rubber seals, rated for leakage less than 10 CFM/sq. ft. of damper area, at differential pressure of 4" w.g. when damper is being held by torque of 50 inch-pounds.

G. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 550 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.
1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
2. Selector Switch: Integral, manual on-off-auto.

H. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.

3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

I. Room Thermostats: Provide room thermostats of 2-pipe fully proportional with adjustable throttling range and tamper-proof locking settings. Provide single or dual temperature, direct acting or reverse acting thermostats as specified for sequence of operations.
1. Provide automatic change-over on dual temperature thermostats.
2. Provide thermostat in return air duct with remote adjustable setpoint where indicated on drawing.

J. Temperature Sensors: Provide temperature sensors of the following types:
1. Provide master space-temperature sensors and other space-temperature indicating sensors of linear output type, 50 to 100 deg. F (10 to 38 deg C) range, with tank locking covers.
2. Provide room return air sensors designed to be mounted in duct of linear output type with bi-metal sensing element and corrosion proof construction on 50 to 100 deg F (10 to 28 deg C) range.
3. Provide duct-mounted or immersion type sensors with 50-100-200 deg F (10-38-93 deg. C) range, as required for 3 to 15 PSIG pressure change.
4. Provide averaging-element sensors with minimum of 8' total capillary element, with either single or multiple-unit elements.
5. Provide temperature sensors of rigid-stem type using bi-metallic sensing elements except where averaging is required.
6. Provide corrosion resistant construction, tamper-proof sensors suitable for mounting on vibrating surface. For capillary type sensors, provide exposed capillary with temperature-compensated, armor or protective tubing.
7. Provide water pipe mounted sensing elements of rod-and-tube type for linear output, furnished complete with separable protecting wells filed with heat conductive compound, factory calibrated and tamper-proof. Locate adjustable controllers inside metal enclosures with cylinder lock and key to prevent unauthorized setting.

K. Pressure Sensors: Provide static pressure sensors, of linear output type, with range of 0 to 6" w.g., adjustable in 2" spans.
1. Where indicated, provide static pressure controllers incorporated in same case as static pressure sensor, of direct or reverse-acting type, with adjustable throttling range from 0.02 to 0.5" w.g., and capable of controlling static pressures within tolerance of 0.01" w.g.

L. Low Limit Controllers: Provide unit-mounted low limit controllers, of rod-and-tube type, with adjustable proportional band.

M. Space Temperature Sensors:
1. Space temperature sensor shall have accuracy of +/- 0.7 deg f at 70 deg. f.
2. Sensor shall have integral 6-pin diagnostic jack accessible through a tamper resistant door.
3. Sensor shall have concealed setpoint adjustment without thermometer.
4. Where indicated, sensor shall be provided with a momentary push button override to allow override of night mode.
5. Sensors shall be furnished with guards where indicated. Guard shall allow operation of sensor push button without removal.

6. Sensor wiring from DDC Controller (and VAV box, FTU/'s DDC Controller DDC Alt.), shall be terminated via a 8-pin jack located on the back of the sensor.

N. Duct Sensor
1. Duct sensor shall be of the averaging or insertion type as indicated.
2. Averaging type shall be thoroughly secured to prevent element damage.
3. Accuracy shall be +/- 0.0% at 70 deg. f.

O. Immersion Sensor
1. Immersion sensor shall have an accuracy of +/- 1.0% at 70 deg. f.
2. Separate well shall be furnished.

P. Static Pressure Transmitters:
1. Static Pressure Transmitter shall sense differential pressures and convert this pressure to a proportional analog electrical signal of 0 to 5 volts, 0 to 10 volts, or 4 to 20 milliamps. The operation range shall be as indicated, or required by application, with an accuracy of 1% of full scale. The output shall be compatible with the DDC controller.

Q. Water Diff. Pressure Switch:
1. Water diff. pres. sw. shall be SPDT flow switch equal to PENN P74FAS.

R. Thermostats:
1. Low Limit Thermostats:
a. Low limit thermostats shall be of the manual reset type, with setpoint adjustment. The sensing element shall be 20 foot minimum and shall be installed completely across the coil. When any one foot of the element senses a temperature as low as the setpoint, the thermostat contact shall open.

2.3 FACILITIES MANAGEMENT SYSTEM

A. The Facility Management System shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving.

B. The facility management system (FMS) shall consist of the following:
1. Standalone DDC panels
2. Standalone application specific controllers (ASCs)

C. System Architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

D. Standalone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device. Standalone DDC panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

2.4 NETWORKING/COMMUNICATIONS

A. The design of the FMS shall network operator workstations and Standalone DDC Panels as shown on the drawings. Inherent in the system's design shall be the ability to expand or modify the network either via the local area network, or auto-dial telephone line modem connections, or via a combination of the two networking schemes.

B. COMMUNICATIONS MUST BE OVER A HIGH SPEED LAN NETWORK. THE LAN NETWORK MUST USE INDUSTRY STANDARD NETWORKS (NON PROPRIETARY)

THAT ALLOW OTHER COMPUTER EQUIPMENT THE OWNER MAY INSTALL AT A FUTURE DATE TO PEACEFULLY COEXIST ON THE SAME NETWORK.

C. FMS system networks that do not meet this requirement shall be bid only as a voluntary alternate and shall state that the system bid does not comply with this requirement.

D. Local Area Network
1. Workstation/DDC Panel Support: Operator workstations and DDC panels shall directly reside on a local area network such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.
2. Dynamic Data Access: All operator devices, either network resident, or connected via dia-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.
   a. Access to system data shall not be restricted by the hardware configuration of the facility management system. The hardware configuration of the FMS network shall be totally transparent to the user when accessing data or developing control programs.
3. General Network Design: Network design shall include the following provisions:
   a. High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, and upload/download efficiency between network devices. The minimum baud rate shall be 1 Megabaud.
   b. Support of any combination of controllers and operator workstations directly connected to the local area network. A minimum of 50 devices shall be supported on a single local area network.
   c. Detection and accommodation of single or multiple failures of either workstations, DDC panels or the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
   d. Message and alarm buffering to prevent information from being lost.
   e. Error detection, correction, and retransmission to guarantee data integrity.
   f. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
   g. Commonly available, multiple sourced, networking components and protocols shall be used.
   h. Use of an industry standard IEEE 802.x protocol. Communications must be of a deterministic nature to assure calculable performance under worst-case network loading.
   i. Synchronization of the real-time clocks in all DDC panels shall be provided.

2.5 STANDALONE DDC PANELS

A. General: Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.

B. Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including:
1. Control processes
2. Energy Management Applications
3. Alarm Management

4. Historical/Trend Data for all points
5. Maintenance Support Applications
6. Custom Processes
7. Operator I/O
8. Dial-Up Communications
9. Manual Override Monitoring

C. Point types: Each DDC panel shall support the following types of point inputs and outputs:
1. Digital Inputs for status/alarm contacts
2. Digital Outputs for on/off equipment control
3. Analog Inputs for temperature, pressure, humidity, flow, and position measurements
4. Analog Outputs for valve and damper position control, and capacity control of primary equipment
5. Pulse Inputs for pulsed contact monitoring

D. Expandability: The system shall be modular in nature and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators.
1. The system architecture shall support 100% expansion capacity of all types of DDC panels, and all point types included in the initial installation.
2. All DDC controllers shall have 10% spare capacity.

E. Serial Communication Ports: Standalone DDC panels shall provide at least two RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, PC workstations, and panel mounted or portable DDC panel Operator's Terminals. Standalone DDC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.

F. Hardware Override Switches: Where indicated in the plans or schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC panel via local, point discrete, onboard hand/off/auto operator override switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not.

G. Hardware Override Monitoring: DDC panels shall monitor the status or position of all overrides and include this information in logs and summaries to inform the operator that automatic control has been inhibited. DDC panels shall also collect override activity information for daily and monthly reports.

H. Local Status Indicator Lamps: The DDC panel shall provide local status indication for each binary input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

I. Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel and shall not require the connection of an operator I/O device.

J. Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

K. Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system

software. Non-Volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

1. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.
2. Should DDC panel memory be lost for any reason, the user shall have the capability of reloading the DDC panel via the local area network, via the local RS-232C port.

L. Standalone DDC panel Local or Portable Operator's Terminal: Each DDC panel shall be capable of supporting an operator's terminal for local command entry, instantaneous and historical data display, and program additions and modifications.

1. The DDC panel Operator Terminal shall simultaneously display a minimum of 6 points with full English identification to allow an operator to view single screen dynamic displays depicting entire mechanical systems.
2. The operator functions provided by the DDC panel Operator Terminal shall include, but not be limited to, the following:
   a. Start and Stop Points
   b. Modify Setpoints
   c. Modify PID Loop Setpoints
   d. Override PID Control
   e. Change Time/Date
   f. Add/Modify Start/Stop Weekly Scheduling
   g. Add/Modify Setpoint Weekly Scheduling
   h. Enter Temporary Override Schedules
   i. Define Holiday Schedules
      1) View Analog Limits
   j. Enter/Modify Analog Warning Limits
   k. Enter/Modify Analog Alarm Limits
   l. Enter/Modify Analog Differentials
   m. View Point History Files
3. The DDC panel Operator Terminal shall provide access to all real or calculated points in the controller to which it is connected, or any other controller in the network. This capability shall not be restricted to a subset of predefined "global points" but shall provide totally open exchange of data between the operator terminal and any DDC panel in the network.
4. Operator access at all DDC panel Operator Terminals shall be identical to each other, as well as identical to the PC or Laptop Operator Workstations. Any password changes shall automatically be downloaded to all controllers on the network.
5. The DDC panel operator terminal shall provide English language prompting to eliminate the need for the user to remember command formats or point names. Prompting shall be provided consistent with a user's password clearance and the types of points being displayed, to eliminate the possibility of operator error.
6. A multi-function touch pad shall be provided for point and command selection, as well as parameter entry. To minimize the possibility of operator error, the DDC panel Operator Terminal shall change and limit touch pad functions based upon an operator's password clearance, the function being performed, and types of points being displayed. Screen displays shall clearly indicate only valid touch pad functions.
7. Context-Sensitive Help: On-line, interactive user's "Help" manuals and tutorials shall be provided. Based upon operator request, the "help" function shall provide general system operating instructions, and specific descriptions of commands available in the currently displayed menus.
8. Identification for all real or calculated points shall be consistent for all network devices. The same English language names used at PC workstations shall be

used to access points at the DDC panel Operator's Terminal to eliminate cross-reference or look-up tables.

9. In addition to instantaneous summaries, the DDC panel Operator's Terminal shall allow a user to view a Point History file for system points. Point History files shall provide a record of value of analog points over the last 24 hours, at 30-minute intervals, or a record of the last ten status changes for binary type points. DDC system shall utilize Siemens Info Suite or Trane ES software packages to manage and archive data.

2.6 SYSTEM SOFTWARE FEATURES

A. General
   1. All necessary software to form a complete operating system as described in this specification shall be provided.
   2. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher-level computer for execution.

B. Control Software Description: The following software must be provided with no exceptions whether it is used initially or not.
   1. Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms:
      a. Two Position Control
      b. Proportional Control
      c. Proportional plus Integral Control
      d. Proportional, Integral, plus Derivative Control
      e. Automatic Control Loop Tuning
   2. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
   3. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
   4. Powerfail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

C. Energy Management Applications: DDC Panels shall have the ability to perform any or all of the following energy management routines:
   1. Time of Day Scheduling
   2. Calendar Based Scheduling
   3. Holiday Scheduling
   4. Temporary Schedule Overrides
   5. Optimal Start
   6. Optimal Stop
   7. Night Setback Control
   8. Enthalpy Switchover (Economizer)
   9. Peak Demand Limiting
   10. Temperature Compensated Load Rolling
   11. Fan Speed/CFM Control
   12. Heating/Cooling Interlock
   13. Cold Deck Reset
   14. Hot Deck Reset
   15. Hot Water Reset
   16. Chilled Water Reset
   17. Condenser Water Reset
   18. Chiller Sequencing

19. All programs shall be executed automatically without the need for operator intervention and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Execution portion of this specification.

D. Custom Process Programming Capability: DDC panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
   1. Process Inputs and Variables: It shall be possible to use any of the following in a custom process:
      a. Any system-measured point data or status
      b. Any calculated data
      c. Any results from other processes
      d. User-Defined Constants
      e. Arithmetic functions (+,-,*,/, square root, exp, etc.)
      f. Boolean logic operators (and, or, exclusive or, etc.)
      g. On-delay/Off-delay/One-shot timers
   2. Process Triggers: Custom processes may be triggered based on any combination of the following:
      a. Time interval
      b. Time of day
      c. Date
      d. Other processes
      e. Time programming
      f. Events (e.g., point alarms)
   3. Dynamic Data Access: A single process shall be able to incorporate measured or calculated data from any and all other DDC panels on the local area network.
      a. In addition, a single process shall be able to issue commands to points in any and all other DDC panels on the local area network.
   4. Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.
   5. Custom Process Documentation: The custom control programming feature shall be self-documenting. All interrelationships defined by this feature shall be documented via graphical flowcharts and English language descriptors.

E. Alarm Management: 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, minimize network traffic, and 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.
   1. 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.
   2. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
      a. 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.
   3. 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.

4. Alarm Messages: 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.
   a. Each standalone DDC panel shall be capable of storing a library of at least 250 Alarm Messages. Each message may be assignable to any number of points in the panel.
5. 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, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.

F. Historical Data and Trend Analysis: A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.
   1. Continuous Point Histories: Standalone DDC panels shall store Point History Files for all analog and binary inputs and outputs.
      a. The Point History routine shall continuously and automatically sample the value of all analog inputs at half hour intervals. Samples for all points shall be stored for the past 24 hours to allow the user to immediately analyze equipment performance and all problem-related events for the past day. Point History Files for binary input or output points and analog output points shall include a continuous record of the last ten status changes or commands for each point.
   2. Control Loop Performance Trends: Standalone DDC panels shall also provide high resolution sampling capability with an operator-adjustable resolution of 10-300 seconds in one-second increments for verification of control loop performance.
   3. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of 1 minute to 2 hours, in one-minute intervals, shall be provided. Each standalone DDC panel shall have a dedicated buffer for trend data and shall be capable of storing a minimum of 5000 data samples.
   4. Data Storage and Archiving: Trend data shall be stored at the Standalone DDC panels and uploaded to hard disk storage when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in 3rd Party personal computer applications.

G. Runtime Totalization: Standalone DDC panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.
   1. The Totalization routine shall have a sampling resolution of one minute or less.
   2. The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.

H. Analog/Pulse Totalization: Standalone DDC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
   1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, gallons, KBTU, tons. etc.).
   2. The Totalization routine shall have a sampling resolution of one minute or less.
   3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

I. Event Totalization: Standalone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.
   1. The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.
   2. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.7 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS

A. Each Standalone DDC Panel shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASCs).

B. Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

C. Each ASC shall have sufficient memory to support its own operating system and data bases including:
   1. Control Processes
   2. Energy Management Applications
   3. Operator I/O (Portable Service Terminal)

D. The operator interface to any ASC point data or programs shall be through any network-resident PC workstation, or any PC or portable operator's terminal connected to any DDC panel in the network.

E. Application Specific Controllers shall directly support the temporary use of a portable service terminal. The capabilities of the portable service terminal shall include but not be limited to the following:
   1. Display temperatures
   2. Display status
   3. Display setpoints
   4. Display control parameters
   5. Override binary output control
   6. Override analog setpoints
   7. Modification of gain and offset constants

F. Powerfail Protection: All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.

G. Application Descriptions:
   1. AHU Controllers
      a. AHU Controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in the Execution portion of this specification, and for future expansion:
         1) Large Air Handling Units
         2) Mixed Air-Single Path
         3) Mixed Air-Dual Path
         4) 100% Single Path
         5) 100% Dual Path
      b. AHU Controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally standalone fashion.
      c. AHU controllers shall have a library of control routines and program logic to perform the sequence of operation as specified in the Execution portion of this specification.
      d. Occupancy-Based Standby/Comfort Mode Control: Each AHU Controller shall have a provision for occupancy sensing overrides. Based upon the contact status of either a manual wall switch or an occupancy sensing

device, the AHU Controller shall automatically select either Standby or Comfort mode to minimize the heating and cooling requirements while satisfying comfort conditions.

e. Continuous Zone Temperature Histories: Each AHU Controller shall automatically and continuously, maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.

f. Alarm Management: Each AHU Controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

g. Each AHU controller shall have a battery backed clock.

h. Each AHU controller shall have a LCD display. The display will allow simultaneous display of three values (analog inputs/outputs, setpoints, plus binary status/mode points. Setpoints, actual temperatures and controlled outputs can be viewed at once.

i. Function keys allow adjustment of control setpoints, etc.

j. Alarm light advises of system alarm condition.

k. Each AHU DDC controller shall have as minimum: 32 Total input and output points AI, BI, AO, BO, as required to meet job requirements.

2. VAV Terminal Unit Controllers:

a. VAV Terminal Unit Controllers shall support, but not be limited to, the control of the following configurations of VAV boxes to address current requirements as described in the Execution portion of this specification, and for future expansion:

1) Single Duct Only (Cooling Only, or Cooling with Reheat
2) Fan Powered (Parallel/Side Pocket, Series/On-Off Logic)
3) Dual Duct (Constant Volume, Variable Volume)
4) Supply/Exhaust

b. VAV Terminal Unit Controllers shall support the following types of point inputs and outputs:

1) Proportional Cooling Outputs
2) Box and Baseboard Heating Outputs (Proportional, or 1 to 3 Stages)
3) Fan Control Output (On/Off Logic, or Proportional Series Fan Logic)

c. The modes of operation supported by the VAV Terminal Unit Controllers shall minimally include, but not be limited to, the following:

1) Day/Weekly Schedules
2) Comfort/Occupancy Mode
3) Economy Mode (Standby Mode, Unoccupied, etc.)
4) Temporary Override Mode

d. Occupancy-Based Standby/Comfort Mode Control: Each VAV Terminal Unit Controller shall have a provision for occupancy sensing overrides. Based upon the contact status of either a manual wall switch or an occupancy sensing device, the VAV Terminal Unit Controller shall automatically select either Standby or Comfort mode to minimize the heating and cooling requirements while satisfying comfort conditions.

e. Continuous Zone Temperature Histories: Each VAV Terminal Unit Controller shall automatically and continuously maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.

f. Alarm Management: Each VAV Terminal Unit Controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

3. Unitary Controllers:
   a. Unitary Controllers shall support, but not be limited to, the following types of systems to address specific applications described in the Execution portion of this specification, and for future expansion:
      1) Unit Vents (ASHRAE Cycle I, II, III, or W)
      2) Heat Pumps Air-to-Air, Water-to-Air)
      3) Packaged Rooftops
      4) Fan Coils (Two-Pipe, Four-Pipe)
      5) Point Multiplexer
   b. Unitary Controllers shall support the following types of point inputs and outputs:
      1) Economizer Switchover Inputs - Drybulb; Outdoor Air Enthalpy, Differential Temperature; Binary Input from a separate controller
      2) Economizer Outputs - Integrated Analog with minimum position; Binary output to enable self-contained economizer actuator
      3) Heating and Cooling Outputs - 1 to 3 Stages; Analog Output with two-pipe logic; Reversing valve logic for Heat Pumps
      4) Fan Output - On/Off Logic Control
      5) Analog Input-Binary I/O Functions
   c. Unitary controllers shall support the following library of control strategies to address the requirements of the sequences described in the Execution portion of this specification, and for future expansion:
      1) Daily/Weekly Schedules
      2) Comfort/Occupancy Mode
      3) Economy Mode - Standby Mode/Economizer Available; Unoccupied/Economizer Not Available Shutdown; Lighting Logic Interlock to Economy Mode
      4) Temporary Override Mode - Temporary Comfort Mode (Occupancy-Based Control); Boost (Occupant Warmer/Cooler Control
   d. Occupancy-Based Standby/Comfort Mode Control: Each Unitary Controller shall have a provision for occupancy sensing overrides. Based upon the contact status of either a manual wall switch or an occupancy sensing device, the Unitary Controller shall automatically select either Standby or comfort mode to minimize the heating and cooling requirements while satisfying comfort conditions.
   e. Occupancy-Based Zone Lighting Control: Unitary Controllers shall provide an auxiliary binary output to serve as the interface to an associated lighting relay. Based upon the status of either an occupancy sensing device, or manual wall switch, the Unitary Controller shall provide a contact output to automatically adjust the lighting level to accommodate occupant requirements while reducing electrical consumption. Standby/Comfort (described in the previous section) and Lighting overrides shall be served by the same occupancy override input.
   f. Continuous Zone Temperature Histories: Each Unitary Controller shall automatically and continuously, maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.
   g. Alarm Management: Each Unitary Controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.
   h. DDC system shall have the ability to generate daily reports showing log-in ID, time, date, and code edits. System shall also incorporate activity log.
   i. All alarming shall be real-time. All alarm shall be reported / displayed in the follow order. New Alarms Unacknowledged to the very top

Alarms Still in Alarm but Acknowledged
Points failed / Communication Loss
Points returned to normal off

Alarm history shall be easily searchable. Points in alarm also shall be shown the graphical interface as well.

j. Accessibility levels to graphical and non-graphical information shall be assigned by user password.

k. All Graphics shall incorporate the ability to override all inputs and outputs from the graphic interface without giving access to edit the code.

l. Graphics are to be consistent in design and user interaction with existing graphical slides current in use and approved by the hospitals building automation group. See figure 1 & 2 below.

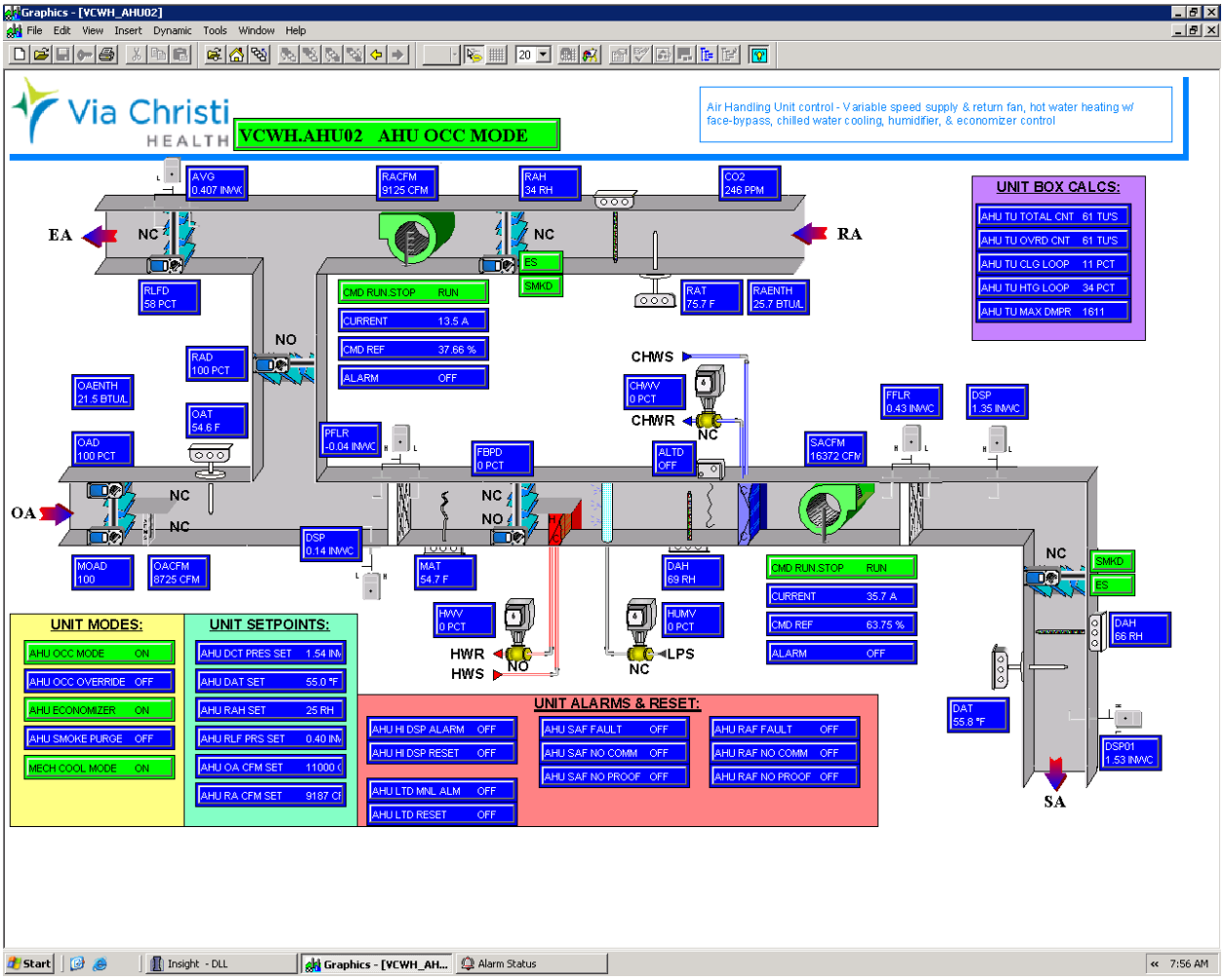

Figure 1: AHU Screen Shot Graphics Example

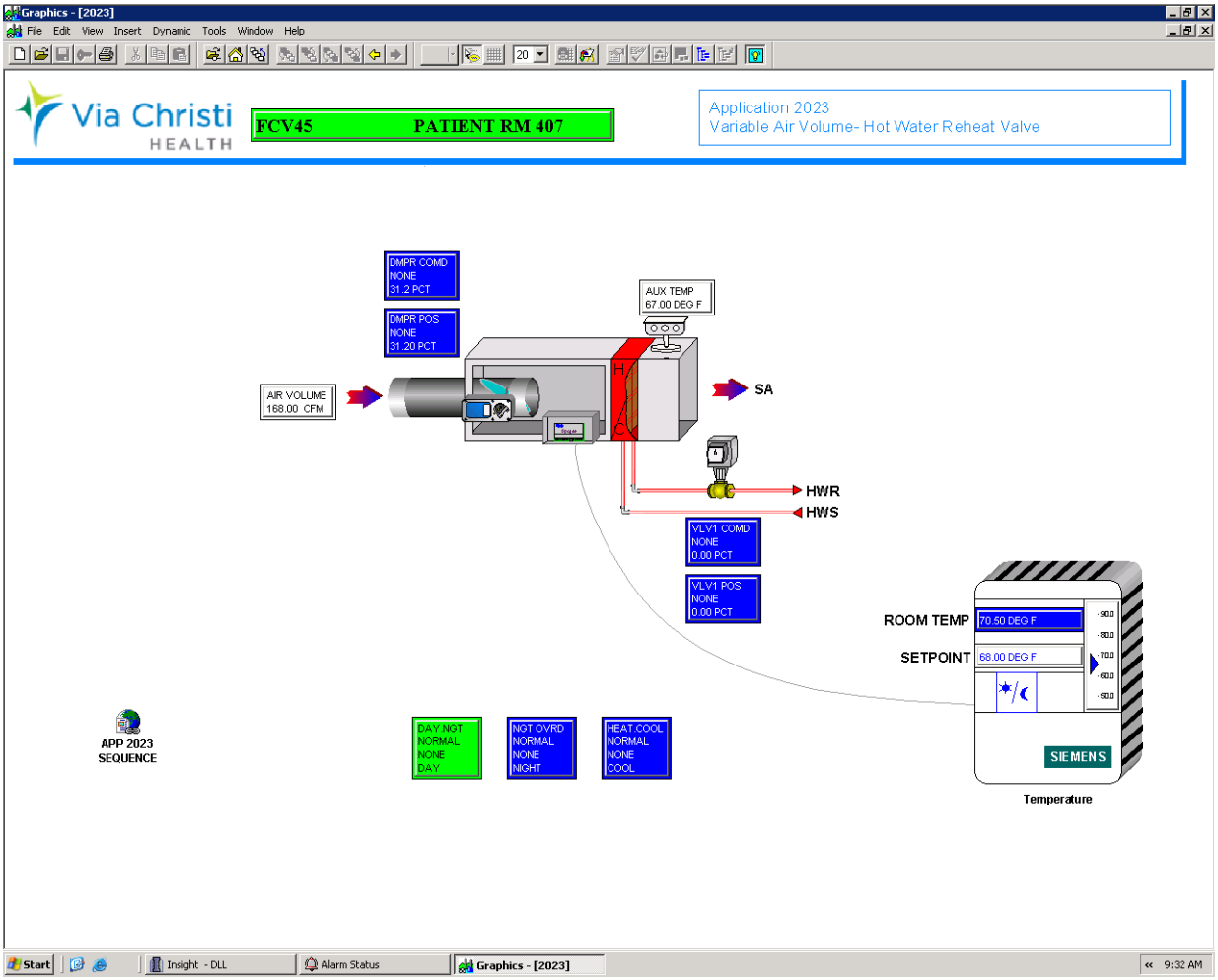

Figure 2: VAV Screen Shot of Graphic Example

2.8 CONTROL WIRING:

A. Provide all wiring required for temperature control systems under this section excluding power feeder wiring.

B. Provide conduit for all control wiring installed in equipment rooms, rooms with hard ceilings, walls, and rooms without ceilings.

C. All wiring and installation shall be in accordance with the Electrical Specifications, Division 26.

D. Direct Digital Control Wiring

1. Input sensors and other input field devices must be wired with 2 or 4 wire shielded cable. When 2-wire cable is used, temperature elements must be calibrated to compensate for cable length.
2. Isolation shall be provided at network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.
3. Wiring for pressure sensors shall be 4 wire twisted shielded pair with a voltage rating equal to or greater than all other conductors in the same conduit.

2.9 AIR FLOW MEASURING STATION (FAN INLET CONFIGURATION)

A. Provide on the indicated fans, Airflow Measuring System(s) consisting of probe arrays mounted in the fan inlets capable of continuously measuring the air handling capacity (air volume) and airflow temperature of the respective centrifugal [or plug, vane-axial] fan(s).

B. Airflow Measuring System (ELECTRA-flo/FI – Thermal Fan Inlet Airflow Measuring Probe):
1. For a single inlet fan, each probe array shall consist of one pair of single-point measuring probes and a single microprocessor-based transmitter. For a double inlet fan, each probe array shall consist of two pairs of single-point measuring probes and a single microprocessor- b a s e d transmitter. The transmitter shall be supplied by the same manufacturer as the probe array(s).
2. Each probe array shall be assembled using heavy wall anodized aluminum tubing, stainless steel adjustable support struts, stainless steel mounting brackets, and an aerodynamically optimized molded sensing apertures to ensure accurate measurement in angular airflow conditions.
3. Probe arrays shall be connected to the transmitter using cable of up to 100' in length, included with the transmitter.
4. Each stand-alone sensing point shall use an ambient temperature thermistor and an externally heated thermistor to determine the point velocity and temperature. Automatic equal area averaging of the individual point measurements shall be performed in the transmitter.
5. Each airflow sensor shall have an operating range of 0-10,000 FPM, with a NIST traceable accuracy of ±2% of reading for velocity measurement and 0.1ºF for temperature measurement. Individual sensors shall be fully field serviceable without need for field calibration, not requiring that the probe be returned to the Factory for repair and/or calibration.
6. Each transmitter shall be capable of averaging as many as thirty-two (32) sensors.
7. The transmitter will have a high visibility backlit LCD for display of either the averaged or individual sensor airflow and temperature measurements, in user selectable units of measure. The transmitter shall be factory configured to output duct air volume for plug and play operation.
8. All transmitter configuration, scaling, and diagnostic functions shall be performed by means of a password protected, cover mounted membrane keypad.
9. The transmitter outputs shall be dual analog (4-20mA, 0-5VDC or 0-10VDC) for airflow and temperature or optional LonWorks® communication interface.
10. The operating temperature range of the transmitter shall be from -20º to 140ºF. The transmitter shall be located where it will be sheltered from water or weather.
11. Input power to each transmitter shall be 24VAC/24VDC.
12. The transmitter shall be provided with interconnect cable for remote mounting up to 100' away.
13. When installed per the manufacturer's minimum installation requirements, the transmitter with probe array shall measure with an accuracy of ±3-10% of actual airflow as installed or within±2-3% of actual flow with field calibration.
14. The Airflow Measuring System shall be the ELECTRA-flo/FI as manufactured by Air Monitor Corporation, Santa Rosa, California.

2.10 AIR FLOW MEASURING STATION (DUCT MOUNTED CONFIGURATION)

A. Provide where indicated, airflow/ temperature probe arrays capable of continuously measuring airflow velocity/volume and temperature.

B. Airflow Measuring System (ELECTRA-flo Plus – Thermal Airflow Measuring Probe Array):
1. Each probe array shall consist of one or more multi-point measuring probes and a single microprocessor-based transmitter. The transmitter shall be supplied by the same manufacturer as the measuring station or probe array.
2. Each multi-point probe shall be assembled using heavy wall anodized aluminum tubing, aluminum mounting plates, aerodynamically optimized molded sensing

apertures to ensure accurate measurement in angular airflow conditions, and neoprene mounting gasket.

3. The probe array shall be connected to the transmitter using a single cable, of up to 100' in length, included with the transmitter.
4. Each stand-alone sensing point shall use an ambient temperature thermistor and an externally heated thermistor to determine the point velocity and temperature. Automatic equal area averaging of the individual point measurements shall be performed in the transmitter.
5. Each airflow sensor shall have an operating range of 5,000 FPM, with a NIST traceable accuracy of ±2% of reading for velocity measurement and 0.1ºF for temperature measurement.
6. The number of sensors for each rectangular probe array shall be:

Station Area	Sensor Density
1 to < 15 Sq. Ft.	1.50 Sq. Ft. Per Sensor
15 to < 30 Sq. Ft.	1.67 Sq. Ft. Per Sensor
30 to < 60 Sq. Ft.	2.10 Sq. Ft. Per Sensor
60 to 100 Sq. Ft.	3.13 Sq. Ft. Per Sensor
60 to 100 Sq. Ft.	3.13 Sq. Ft. Per Sensor

7. Individual sensors shall be fully field serviceable without need for field calibration, not requiring that the probe be returned to the Factory for repair and/or calibration.
8. Each transmitter shall be capable of averaging as many as thirty-two (32) sensors.
9. The transmitter will have a high visibility backlit LCD for display of either the averaged or individual sensor airflow and temperature measurements, in user selectable units of measure. The transmitter shall be factory configured to output duct air volume for plug and play operation.
10. All transmitter configuration, scaling, and diagnostic functions shall be performed by means of a password protected, cover mounted membrane keypad.
11. The transmitter outputs shall be dual analog (4-20mA, 0-5VDC or 0-10VDC) for airflow and temperature or optional LonWorks® communication interface.
12. The operating temperature range of the transmitter shall be from -20º to 140ºF. The transmitter shall be located where it will be sheltered from water or weather.
13. Input power to each transmitter shall be 24VAC/24VDC.
14. The transmitter shall be provided with interconnect cable for remote mounting up to 100' away.
15. When installed per the manufacturer's minimum installation requirements, the transmitter with accompanying station or probe array shall measure with an accuracy of ±2-3% of actual flow.
16. The Airflow Measuring System shall be the ELECTRA-flo Plus as manufactured by Air Monitor Corporation, Santa Rosa, California.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which pneumatic control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF CONTROL SYSTEMS:

A. General: Install system and materials in accordance with manufacturer's instructions, roughing-in drawings and details on drawings.

B. Control Wiring: Install control wiring, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code.

1. Install circuits over 25-volt with color-coded No. 12 wire in electric metallic tubing.
2. Install circuits under 25-volt with color-coded No. 18 wire with 0.031" high temperature (105 deg F (41 deg C)) plastic insulation on each conductor and plastic sheath over all.
3. Install electronic circuits with color-coded No. 22 wire with 0.023" polyethylene insulation on each conductor with plastic-jacketed copper shield over all.
4. Install low voltage circuits, located in concrete slabs and masonry walls, or exposed in occupied areas, in electric conduit.
5. All temperature control wiring shall be labeled at both the DDC panel and field termination.

3.3 DESCRIPTION OF OPERATION:

A. A detailed description of operation for each control system is called out on the plans.

B. A general description of operation applicable to all systems is required per the following.
1. All modulating control dampers shall be electronically actuated as shown on drawings.
2. All modulating control valves electronically actuated
3. All air handling units and fan coil units shall have a freeze stat to shut-down the unit @ 38°F.
4. Air Handling Unit mixing box dampers shall be by the Unit Manufacturer. Controls shall close the O.A. damper when the unit is off.
5. Unless otherwise noted: Unoccupied heating setpoints shall be 62°F. Unoccupied cooling setpoints shall be 80°F.
6. All primary and stand-by pumps shall have a controller with lead-lag switch to automatically start the lag pump and sound an alarm if the lead pump fails.
7. All dampers located in outside air ducts i.e. intake, relief, exhaust shall be ultra-low leak type with both blade and jamb seals. Provided by the T.C.C.

3.4 ADJUSTING AND CLEANING:

A. Start-Up: Start-up, test, and adjust control systems in the presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damage or malfunctioning controls and equipment.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Final Adjustment: After completion of installation, adjust thermostats, control valves, motors and similar equipment provided as work of this section.
1. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.
2. Refer to Commissioning Specifications for Functional Testing Requirements and System Demonstration.

3.5 CLOSEOUT PROCEDURES:

A. Owner's Instructions: Provide services of manufacturer's technical representative for a minimum of one 8-hour day to instruct Owner's personnel in operation and maintenance of DDC control systems. Refer to Commissioning Specifications for additional requirements.
1. Schedule instruction with Owner; provide at least 7-day notice to Contractor, Commissioning Agent, and Engineer of training date.

END OF SECTION

SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Heating water piping, above ground.
   2. Chilled water piping, above grade.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUBMITTALS

A. Product Data:
   1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
   2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
   3. Hangers and Supports: Submit manufacturers catalog information including load capacity.

B. Test Reports: Indicate results of piping system pressure test for each system.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Welders' Certificate: Include welders' certification of compliance with AWS D1.1.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves, equipment and accessories.

B. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

C. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

D. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years experience.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 STEEL TUBE AND FITTINGS, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 40 (0.375 inch (10 mm) wall for sizes 12 inch (300 mm) and larger), black.
   1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
   2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; welded for pipe 2-1/2 inches (65 mm) and larger.

B. Steel Pipe: ASTM A53/A53M, Schedule 40 (0.375 inch (10 mm) wall for sizes 12 inch (300 mm) and larger), black, cut grooved ends.
   1. Fittings: ASTM A395/A395M and ASTM A536 ductile iron, or ASTM A234/A234M carbon steel, grooved ends.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
      a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated compatible with steel piping sizes.
      b. Gasket: Elastomer composition for operating temperature range suitable for service.
      c. Accessories: Zinc electroplated steel bolts, nuts, and washers, comply with ASTM A449.
      d. Rigid: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. Installation-Ready, for direct stab installation without field disassembly.
      e. Flexible: Use in locations where vibration attenuation and stress relief are required.
   3. Fittings: Cold press mechanical joint fitting shall conform to material requirements of ASTM A420 or ASME B16.3 and performance criteria of IAPMO PS117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer.

2.3 COPPER TUBE AND FITTINGS, ABOVE GROUND

A. Copper Tubing: ASTM B88 (ASTM B88M), Type L, hard drawn.
   1. Fittings: ASME B16.22 solder wrought copper.
   2. Tee Connections: At contractor's option, mechanically extracted collars with notched and dimpled branch tube may be used.
   3. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F (220 to 280 degrees C). Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F (640 to 805 degrees C).
   4. Copper Pressure-Seal-Joint Fittings: ASME B16.18 or ASME B16.23.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Viega, Plumbing and Heating Systems.
         2) Preapproved equal.
      b. NPS 2 (DN50 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      c. NPS 2-1/2 to NPS 4 (DN 64 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

B. Copper Tubing: ASTM B88 (ASTM B88M), Type L, hard drawn, rolled grooved ends.
   1. Fittings: ASME B16.22 wrought copper and bronze, or ASME B16.18 and ASTM B584 bronze sand castings, with copper-tube dimensioned grooved ends.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
      a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron with offsetting angle-pattern bolt pads, enamel coated, compatible with copper tubing sizes, to engage and lock.
      b. Gasket: Elastomer composition for operating temperature range suitable for service.
      c. Accessories: ASTM A449 compliant Zinc electroplated steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88 (ASTM B88M), Type M, hard drawn.
   1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F (220 to 280 degrees C).

2.4 UNIONS AND FLANGES

A. Unions for Pipe 2 inches (50 mm) and Smaller:
   1. Ferrous Piping: Class 150, malleable iron, threaded.
   2. Copper Piping: Class 150, bronze unions with soldered joints.
   3. Dielectric Connections: Nipple with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
   4. PVC Piping: PVC.

B. Flanges for Pipe 2-1/2 inches (65 mm) and Larger:
   1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
   2. Copper Piping: Class 150, slip-on bronze flanges.
   3. PVC Piping: PVC flanges.
   4. Gaskets: 1/16 inch (1.6 mm) thick preformed neoprene gaskets.

C. Unions or flanges for servicing and disconnect are not required in installations using grooved joint couplings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel or groove plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges, grooved joint couplings, or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems.

F. The installing contractor shall insure that internal components of the cold press mechanical joint press fitting are properly in place and free from damage. This is to include sealing elements, grip ring, and separator rings.

3.2 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with Division 23 Section "Hangers and Supports for HVAC Piping and Equipment".

B. Support horizontal piping as scheduled.

C. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.

D. Place hangers within 12 inches (300 mm) of each horizontal elbow.

E. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.

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

I. Prime coat exposed steel hangers and supports. Refer also to Division 09. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

K. Comply with requirements in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic restraint devices.

3.3 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

D. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

E. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

F. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.

G. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.

H. Install branch connections to mains using Tee fittings in main with take-off out the bottom of the main, except for up-feed risers which shall have take-off out the top of the main line.

I. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

J. Install dielectric nipples or waterway fittings to join dissimilar metals, including copper coil connections with steel pipe.

K. Install flanges or grooved joint couplings on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

L. Install flexible connectors at inlet and discharge connections to pumps (except inline pumps) and other vibration producing equipment.
   1. Three flexible type grooved joint couplings may be used in lieu of flexible connectors at equipment connections in applicable piping systems. The couplings shall be placed in close proximity to the vibration source.

M. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, inline pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.

N. Press Connections: Copper press fittings shall be made in accordance with manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

O. Install piping in accordance with ASME B31.9.

P. Route piping parallel to building structure and maintain gradient. Diagonal runs are not permitted, unless expressly indicated.

Q. Install piping to conserve building space, and not interfere with use of space.

R. Group piping whenever practical at common elevations, spaced to permit applying insulation and servicing of valves.

S. Sleeve pipe passing through partitions, walls and floors.

T. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.

U. Install pipe identification.

V. Install and anchor piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

W. Provide access where valves and fittings are not exposed.

X. Slope hydronic piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe aligned.

Y. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

Z. Prepare exposed unfinished pipe, fittings, supports, and accessories, ready for finish painting.

AA. Install valves with stems upright or horizontal, not inverted.

BB. Insulate piping and equipment.

3.4 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."

B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
2. Fill the pipe and fittings during brazing, with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.
3. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.

C. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:
1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
2. Align threads at point of assembly.
3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
    a. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

D. Grooved Joints: Install in accordance with the manufacturer's latest published installation instructions. Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to (and including) groove. Gasket shall be manufacturer by the coupling manufacturer and verified as suitable for the intended service. 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, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

E. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

3.5 VALVE APPLICATIONS:

A. General Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:
1. Shut-off duty: Use ball, valves for line size 2" and smaller, use butterfly valves above 2" size.
2. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.

B. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.

3.6 FIELD QUALITY CONTROL

A. Preparation for Testing - Prepare hydronic piping in accordance with ASME B 31.9 and as follows:
1. Leave joints including welds uninsulated and exposed for examination during the test.

2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.

B. Testing - Test hydronic piping as follows:
1. Use clean ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.
3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low-pressure filling lines are disconnected.
4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 125 PSIG. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in appendix A of ASME B31.9, Code for Pressure Piping, Building Services Piping.
5. After the 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 as appropriate, and repeat hydrostatic test until there are no leaks. Continue test for 6 hours minimum and re-examine for leaks.

3.7 ADJUSTING AND CLEANING

A. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

B. During flushing use cleaning compounds specified in Division 23 Section "HVAC Water Treatment."

C. The following procedure shall be used for cleaning and flushing of hydronic water piping.
1. Mix cleaning compound with clean water per chemical manufacturer's instructions and distribute into the chilled water lines.
2. Completely fill system with water and chemical and bleed air.
3. Circulate system for 48 hours. Verify that all valves are open.
4. Clean strainers a minimum of every 2 hours for the first 4 hours; then clean every 4 hours minimum.
5. Drain water and chemical from piping system. Drain all low points. Allow the drain to bleed while system is circulating and verify proper operation of automatic make-up water valve.
6. Refill with clean water and circulate for 4 hours using the automatic make-up.
7. Completely drain water from piping system. Drain all low points.
8. Refill with clean water and corrosion inhibitor in quantity as recommended by the chemical manufacturer, based on water samples taken at the site.
9. Test water sample, if test pH exceeds make-up pH continue flushing operation.

3.8 TESTING

A. 125 Pound Systems: Test hydronic piping subject to main system pressure at not less than 150 pounds per square inch gauge or 1-1/2 times the maximum working pressure devices connected to the piping system, whichever is greater, measured at the low point of the system.

B. Test Result: After cleaning and filling the mechanical system, operate the system for a period of not less than 48 hours continuously during which time water treatment samples shall be taken at 4-hour intervals and the results plotted on a graph. Testing and sampling shall continue until the graph indicates that the water treatment is maintaining the specified levels of chemical within plus or minus 10 percent under all conditions of load.

3.9 COMMISSIONING

A. Fill system with clean water, both new and existing systems which must be drained in order to make connections for new systems.

B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

C. Before operating the system perform these steps:
1. Open valves to full open position. Close coil bypass valves.
2. Remove and clean strainers.
3. Check pump for proper direction of rotation and correct improper wiring.
4. Check air vents at high points of systems and determine if all are installed and bleed all air completely from the system.
5. Set temperature controls so all coils are calling for full flow.
6. Check operation of automatic bypass valves.
7. Lubricate motors and bearings.
8. After air is eliminated, circulate hydronic water systems for a minimum of 72 hours prior to water balancing.

3.10 PIPING SCHEDULE

Application	Piping	Fittings
Chilled Water, Heating Water and Glycol Piping 2" (50 mm) and Smaller (Above Grade)	ASTM A53/A53M Steel Pipe	Threaded, Malleable Iron
	Hard Copper Tube, Type L	Wrought Copper, Soldered Joints
		Copper Pressure Sealed Joints
Chilled Water, Heating Water and Glycol Piping 2-1/2" (65mm) and Larger (Above Grade)	ASTM A53/A53M Steel Pipe	Forged Steel, Welded
		Grooved-Joint
	Hard Copper Tube, Type L	Grooved-Joint Wrought Copper Soldered Joints
		Copper Pressure Seal Joints
Condenser Water Piping 2" (50 mm) and Smaller (Above Grade)	ASTM A53/A53M Steel Pipe	Threaded, Malleable Iron
	PVC, Schedule 80[a,c]	Schedule 80, Solvent Welded

Table Notes:
a. Allowed only where specifically indicated on the drawings.
b. Confirm suitability for penetrations of fire rated assemblies or through fire separations.
c. May not be installed in a return-air plenum.

END OF SECTION

SECTION 23 21 14
COOLING COIL/CONDENSATE DRAIN PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment condensate drains and overflows.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUBMITTALS

A. Product Data:
   1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
   2. Hangers and Supports: Submit manufacturers catalog information including load capacity.

B. Test Reports: Indicate results of piping system pressure test for each system.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Welders' Certificate: Include welders' certification of compliance with AWS D1.1.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

C. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping and "NSF-SEWER" for plastic sewer piping.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years experience.

1.5 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 COPPER TUBE AND FITTINGS

A. Copper Tubing: ASTM B88 (ASTM B88M), Type L, hard drawn.
   1. Fittings: ASME B16.22 solder wrought copper.
   2. Tee Connections: At contractor's option, mechanically extracted collars with notched and dimpled branch tube may be used.
   3. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F (220 to 280 degrees C).
   4. Copper Pressure-Seal-Joint Fittings: ASME B16.18 or ASME B16.23.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Viega, Plumbing and Heating Systems.
         2) Preapproved equal.
      b. NPS 2 (DN50 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      c. NPS 2-1/2 to NPS 4 (DN 64 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

B. Copper Tubing: ASTM B88 (ASTM B88M), Type L, hard drawn, rolled grooved ends.
   1. Fittings: ASME B16.22 wrought copper and bronze, or ASTM B584 bronze sand castings, grooved ends.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
      a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion.
      b. Gasket: Elastomer composition for operating temperature range suitable for service.
      c. Accessories: Zinc electroplated steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88 (ASTM B88M), Type M, hard drawn.
   1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F (220 to 280 degrees C).

2.3 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.
   1. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564.

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

2.4 UNIONS AND FLANGES

A. Unions for Pipe 2 inches (50 mm) and Smaller:
   1. Copper Piping: Class 150, bronze unions with soldered joints.
   2. Dielectric Connections: Nipple with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches (65 mm) and Larger:
   1. Copper Piping: Class 150, slip-on bronze flanges.
   2. Gaskets: 1/16 inch (1.6 mm) thick preformed neoprene gaskets.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems.

3.2 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with Division 23 Section "Hangers and Supports for HVAC Piping and Equipment".

B. Support horizontal piping as scheduled.

C. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.

D. Place hangers within 12 inches (300 mm) of each horizontal elbow.

E. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.

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

I. Prime coat exposed steel hangers and supports. Refer also to Division 09. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

K. Comply with requirements in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic restraint devices.

L. Install underground PVC piping according to ASTM D 2321.

3.3 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

D. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

E. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

F. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.

G. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.

H. Install branch connections to mains using Tee fittings in main with take-off out the bottom of the main, except for up-feed risers which shall have take-off out the top of the main line.

I. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

J. Install dielectric nipples or waterway fittings to join dissimilar metals, including copper coil connections with steel pipe.

K. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

L. Install flexible connectors at inlet and discharge connections to pumps (except inline pumps) and other vibration producing equipment.

M. Press Connections: Copper press fittings shall be made in accordance with manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

N. Pitch all horizontal condensate drain lines to drain at a minimum fall of 1 inch per 10 feet of run.

O. Provide air trap at each equipment condensate drain connection. Depth of trap shall be sufficient to maintain trap seal with equipment operating.

P. Route piping parallel to building structure and maintain gradient. Diagonal runs are not permitted, unless expressly indicated.

Q. Install piping to conserve building space, and not interfere with use of space.

R. Group piping whenever practical at common elevations, spaced to permit applying insulation and servicing of valves.

S. Sleeve pipe passing through partitions, walls and floors.

T. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.

U. Install pipe identification.

V. Install and anchor piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

W. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe aligned.

X. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

Y. Prepare exposed unfinished pipe, fittings, supports, and accessories, ready for finish painting.

Z. Insulate piping.

AA. Install aboveground PVC piping according to ASTM D 2665.

3.4 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."

B. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

C. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.5 FIELD QUALITY CONTROL

A. Preparation for Testing - Prepare condensate drain piping as follows:
   1. Leave joints uninsulated and exposed for examination during the test.
   2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
   3. Isolate equipment that is not to be subjected to the test pressure from the piping.

B. Testing - Test condensate piping as follows:
   1. Use clean ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
   2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.
   3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low-pressure filling lines are disconnected.
   4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 50 PSIG. The test pressure shall not exceed the maximum pressure for any component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength.
   5. After the 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 as appropriate, and repeat hydrostatic test until there are no leaks. Continue test for 6 hours minimum and re-examine for leaks.

3.6 ADJUSTING AND CLEANING

A. Clean and flush condensate drain piping systems.

B. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.7 PIPING SCHEDULE

Application	Piping	Fittings
Equipment Condensate Drains and Overflows (Above Grade)	Hard Copper Tube, Type L or Type M Schedule 40 PVC (a)	Wrought Copper, Soldered Joints PVC socket fitting and solvent – cemented joints (a)

(a)This piping material not allowed in a return air plenum.

END OF SECTION

SECTION 23 21 16
HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Flexible connectors.
2. Air vents.
3. Strainers.
4. Manual calibrated balance valves.
5. Automatic balance valves.
6. Relief valves.

B. Related Documents:
1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUBMITTALS

A. Product Data: Submit for manufactured products and assemblies used in this Project.
1. Manufacturer's data and list indicating use, operating range, total range, accuracy, and location for manufactured components.
2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
4. Submit electrical characteristics and connection requirements.

B. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of actual locations of components and equipment.

B. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.5 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.8 FIELD MEASUREMENTS

A. Verify field measurements before fabrication.

PART 2 - PRODUCTS

2.1 FLEXIBLE CONNECTORS

A. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches (230 mm) long with copper tube ends; for maximum working pressure 300 psig (2070 kPa).

2.2 AIR VENTS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett/ITT Industries
4. Taco, Inc.

B. Manual Type: Short vertical sections of 2 inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber.

C. Automatic Float Type:
1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

****** OR ******

2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.3 STRAINERS

A. Size 2 inch (50 mm) and Smaller:
1. Screwed brass (ASTM B 62, Grade C) or iron body (ASTM A 126, Class B) for 175 psig (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.

B. Size 2-1/2 inch (65 mm) to 4 inch (100 mm):
1. Flanged iron body (ASTM A 126, Class B) for 175 psig (1200 kPa) working pressure, Y pattern with 3/64 inch (1.2 mm) stainless steel perforated screen.

2. Grooved end ductile iron body (ASTM A 536, Grade 65-45-12) for 175 psig (1200 kpa) working pressure, Y pattern with 1/16 inch (1.6 mm) or 1/8 inch (3.2 mm) stainless steel perforated screen.

C. Size 5 inch (125 mm) and Larger:

1. Flanged iron body for 175 psig (1200 kPa) working pressure, basket pattern with 1/8 inch (3.2 mm) stainless steel perforated screen.
2. Grooved end ductile iron body (ASTM A 536, Grade 65-45-12) for 175 psig (1200 kpa) working pressure, Y pattern with 1/8 inch (3.2 mm) or 5/32 inch (4 mm) stainless steel perforated screen.

2.4 AUTOMATIC BALANCE VALVE

A. Manufacturer: Subject to compliance with requirements, provide automatic balance valves by one of the following:
   1. Griswold
   2. Auto Flow
   3. Pre-approved equal

B. Capacity: Flow rate to match equipment served, regardless of system pressure fluctuation, within ± 5%. Control range shall be 1 to 14 PSI, 2 to 32 PSI, 4 to 57 PSI or 8 to 128 PSI depending on location within the piping system.

C. Submittal shall include a schedule which delineates the control range for each specific flow controller at every unit along with the valve size.

D. Features: All internal working parts shall be of passivated stainless steel or nickel plated brass. The valve shall be tamperproof when installed. Body pressure tappings suitable for pressure gauge and thermometer installation and verification of pressure differential across valve orifice shall be provided - Bronze body - 150 PSI and 250°F rating - Units 1 1/2" and smaller located at coils shall have female threaded ball valve with lever handle on system side of controller for isolation with female sweat connection on unit side. A metal identification tag on chain will be provided for each valve. The tag will give valve model number, rated flow GPM, and pressure range. Units 3" and above shall be gray iron body Class 150 for flanged installation.

2.5 RELIEF VALVES

A. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

PART 3 - EXECUTION

3.1 INSTALLATION - HYDRONIC PIPING SPECIALTIES

A. Locate test plugs as indicated on Drawings.

B. Where large air quantities accumulate, provide enlarged air collection standpipes.

C. Install manual air vents at system high points at heat transfer coils, and elsewhere as required for system air venting.

D. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.

E. Provide air separator on suction side of system circulation pump and connect to expansion tank.

F. Provide drain and hose connection with valve on strainer blow down connection.

G. Provide pump suction fitting on suction side of base mounted centrifugal pumps and vertical inline pumps. Remove temporary strainers after cleaning systems.

H. Provide combination pump discharge valve on discharge side of base mounted and vertical inline centrifugal pumps.

I. Support pump fittings with floor mounted pipe and flange supports.

J. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

K. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

L. Pipe relief valve outlet to nearest floor drain, or to glycol mixing drum.

M. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

N. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill to pressure indicated on drawings.

END OF SECTION

SECTION 23 22 13
STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Low pressure steam piping.
2. Low pressure steam condensate piping.
3. Medium and high pressure steam piping.
4. Medium and high pressure steam condensate piping.
5. Equipment drains and over flows.
6. Unions and flanges.

B. Related Documents:
1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.4 - Gray Iron Threaded Fittings.
3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B31.1 - Power Piping.
5. ASME B31.9 - Building Services Piping.
6. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High- Temperature Service.
3. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

C. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

D. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
4. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
7. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
8. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SYSTEM DESCRIPTION

A. Provide flanges, union, and couplings at locations requiring servicing. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

B. Provide pipe hangers and supports in accordance with ASME B31.9, MSS SP 58, MSS SP 69, and MSS SP 89.

C. Use gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Use globe valves for throttling or services.

E. Use spring loaded check valves on discharge of condensate pumps.

F. Use horizontal swing check valves for vacuum breakers and discharge of steam traps.

G. Use 3/4 inch (20 mm) gate valves with cap for blow downs at strainers.

H. Use 3/4 inch (20 mm) gate valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

I. Flexible Connectors: Use at or near pumps where piping configuration does not absorb vibration.

1.4 SUBMITTALS

A. Product Data:
   1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
   2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
   3. Hangers and Supports: Submit manufacturers catalog information including load capacity.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 LOW PRESSURE STEAM PIPING, ABOVE GROUND (15 PSIG (103 KPA) MAXIMUM)

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.

1. Fittings: ASME B16.3 malleable iron Class 125, or ASTM A234/A234M forged steel Class 125.
2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; welded for pipe 2-1/2 inches (65 mm) and larger.

2.2 LOW PRESSURE STEAM CONDENSATE PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 80, black.
   1. Fittings: ASME B16.3 malleable iron Class 125, or ASTM A234/A234M forged steel Class 125.
   2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; welded for pipe 2-1/2 inches (65 mm) and larger.

2.3 MEDIUM AND HIGH PRESSURE STEAM PIPING, ABOVE GROUND - (150 PSIG (1034 KPA) MAXIMUM)

A. Steel Pipe: ASTM A53/A53M, Schedule 40, [0.375 inch (10 mm) for sizes 16 inch (400 mm) and larger,] black.
   1. Fittings: ASME B16.3 malleable iron Class 150, or ASTM A234/A234M forged steel welding type, Class 150.
   2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; welded for pipe 2-1/2 inches (65 mm) and larger.

2.4 MEDIUM AND HIGH PRESSURE STEAM CONDENSATE PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 80, 0.375 inch (10 mm) wall for sizes 12 inch (300 mm) and larger, black.
   1. Fittings: ASME B16.3 malleable iron Class 250, or ASTM A234/A234M forged steel welding type, Class 300.
   2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; welded for pipe 2-1/2 inches (65 mm) and larger.

2.5 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53/A53M Schedule 80, galvanized.
   1. Fittings: ASME B16.3, malleable iron or ASME B16.4, cast iron.
   2. Joints: Threaded for pipe 2 inch (50 mm) and smaller; flanged for pipe 2-1/2 inches (65 mm) and larger.

2.6 UNIONS AND FLANGES

A. Unions for Pipe 2 inches (50 mm) and Smaller:
   1. Ferrous Piping: Class 150, malleable iron, threaded.

B. Flanges for Pipe 2-1/2 inches (65 mm) and Larger:
   1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
   2. Gaskets: A304, stainless steel, grafoil filled, spiral wound

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe for welding.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems.

3.2 INSTALLATION - INSERTS

A. Provide inserts for placement in concrete forms.

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

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches (100 mm) and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

F. Wood blocking is not an acceptable insert material.

3.3 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Install steam supply and steam condensate return piping in accordance with ASME B31.9.

B. Route piping parallel to building structure and maintain gradient.

C. Install piping to conserve building space, and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Sleeve pipe passing through partitions, walls and floors.

F. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.

G. Install pipe identification.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

I. Provide access where valves and fittings are not exposed.

J. Slope steam supply piping one inch in 40 feet (0.25 percent) in direction of flow. Use eccentric reducers to maintain bottom of pipe aligned.

K. Slope steam condensate piping one inch in 40 feet (0.25 percent). Use eccentric reducers to maintain bottom of pipe aligned.

L. Provide drip trap assembly at low points, risers, changes in elevation and before control valves.

M. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.

N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

O. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

P. Install valves with stems upright or horizontal, not inverted.

Q. Insulate piping and equipment.

3.4 FIELD QUALITY CONTROL

A. Test low pressure steam supply piping, low pressure steam condensate piping, medium and high-pressure steam supply piping, medium and high-pressure steam condensate piping in accordance with ASME B31.9.

END OF SECTION

SECTION 23 22 16
STEAM AND CONDENSATE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.

B. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUMMARY

A. Section includes the following piping specialties for LP and HP steam and condensate piping:
   1. Strainers.
   2. Flash tanks.
   3. Safety valves.
   4. Pressure-reducing valves.
   5. Steam traps.
   6. Thermostatic air vents and vacuum breakers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Pressure-reducing and safety valve.
   2. Steam trap.
   3. Air vent and vacuum breaker.
   4. Flash tank.

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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following working pressures and temperatures unless otherwise indicated:
   1. HP Steam Piping: 15 psig and above.
   2. LP Steam Piping: 14 psig and below.
   3. Condensate Piping: 125 psig (862 kPa) at 250 deg F (121 deg C).
   4. Makeup-Water Piping: 80 psig (552 kPa) 150 deg F (66 deg C).
   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 Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," Section 230523.14 "Check Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

B. Stop-Check Valves:
   1. Manufacturers:
      a. Crane, Crane Energy Flow
      b. Jenkins Valves
      c. Lunkenheimer Valves
      d. Davis Valves
   2. Body and Bonnet: Malleable iron.
   3. End Connections: Flanged.
   4. Disc: Cylindrical with removable liner and machined seat.
   5. Stem: Brass alloy.
   6. Operator: Outside screw and yoke with cast-iron handwheel.
   7. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
   8. Pressure Class: 250.

2.3 STRAINERS

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 strainers NPS 2 (DN 50) and smaller; flanged ends for strainers NPS 2-1/2 (DN 65) and larger.
   3. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
   4. Tapped blowoff plug.
   5. CWP Rating: 250-psig (1725-kPa) working steam pressure.

B. 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 (DN 50) and smaller; flanged ends for strainers NPS 2-1/2 (DN 65) and larger.
   3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 250-psig (1725-kPa) 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 (1035-kPa) 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: ASME labeled.
   1. Manufacturers:
      a. Armstrong International
      b. Kunkle Valve
      c. Spirax Sarco, Inc.
      d. Watts
      e. Spence
   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: ASME labeled.
1. Manufacturers:
   a. Armstrong International
   b. Kunkle Valve
   c. Spirax Sarco, Inc.
   d. Spence
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.
8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.6 PRESSURE-REDUCING VALVES

A. Manufacturers:
1. Armstrong International
2. Leslie Controls, Inc.
3. Spence Engineering Company
4. 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 (DN 50) and smaller and flanged connections for valves NPS 2-1/2 (DN 65) 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.

I. Gaskets: Non-asbestos materials.

2.7 STEAM TRAPS

A. Thermostatic Traps:
1. Manufacturers:
   a. Armstrong International
   b. Spirax Sarco, Inc.
   c. Hoffman Specialty
   d. 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. Float and Thermostatic Traps:
1. Manufacturers:
   a. Armstrong International
   b. Spirax Sarco, Inc.
   c. Hoffman Specialty
2. Body and Bolted Cap: ASTM A 126, cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F (25 deg C) of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig (860 kPa).

C. Inverted Bucket Traps:
1. Manufacturers:
   a. Armstrong International
   b. Spirax Sarco, Inc.
   c. Hoffman Specialty
2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Air Vent: Stainless-steel thermostatic vent.
8. Pressure Rating: 250 psig (1725 kPa).

2.8 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:
1. Manufacturers:
   a. Armstrong International
   b. Hoffman Specialty
   c. Spirax Sarco, Inc.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 125 psig (861 kPa).
7. Maximum Temperature Rating: 350 deg F (177 deg C).

B. Vacuum Breakers:
1. Manufacturers:
   a. Armstrong International
   b. Hoffman Specialty
   c. Spirax Sarco, Inc.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.

5. O-Ring Seal: EPR.
6. Pressure Rating: 125 psig (861 kPa).
7. Maximum Temperature Rating: 350 deg F (177 deg C).

2.9 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellows, Flexible Connectors:
   1. Manufacturers:
      a. Hyspan Precision Products
      b. Duraflex, Inc.
      c. Metraflex Company
   2. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
   3. End Connections: Threaded or flanged to match equipment connected.
   4. Performance: Capable of 3/4-inch (20-mm) misalignment.
   5. CWP Rating: 150 psig (1035 kPa).
   6. Maximum Operating Temperature: 250 deg F (121 deg C).

2.10 STEAM METERS

A. Manufacturers:
   1. Spirax Sarco, Inc.
   2. Engineer approved equal.

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."
   4. Microprocessor Enclosure: NEMA 250, Type 4.

C. Sensor: 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.

D. Sensor: 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.

E. Sensor: Spring-loaded, variable-area flowmeter type; density compensated with stainless-steel wetted parts and flange connections. At least 10:1 turndown with plus or minus 2 percent accuracy over full-flow range.

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. 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. Install piping to permit valve servicing.

B. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) full port-ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

C. Install valves according to Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," Section 230523.14 "Check Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

D. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

E. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and full port ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).

H. 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.

3.3 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

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 Section 230519 "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. See Section 230923 "Direct Digital Control (DDC) System for HVAC"

3.6 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.1, "Power Piping"; and ASME B31.9, "Building Services Piping."

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 (DN 65).

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Install traps and control valves in accessible locations close to connected equipment.

B. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Refrigerant piping.
2. Unions, flanges, and couplings.
3. Pipe hangers and supports.
4. Refrigerant moisture and liquid indicators.
5. Valves.
6. Refrigerant strainers.
7. Refrigerant pressure regulators.
8. Refrigerant pressure relief valves.
9. Refrigerant filter-driers.
10. Refrigerant solenoid valves.
11. Refrigerant expansion valves.
12. Electronic expansion valves.
13. Refrigerant receivers.

B. Related Documents:
1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
2. Other sections of this Division, and of other Division, may contain requirements that relate to this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
1. ARI 495 - Refrigerant Liquid Receivers.
2. ARI 710 - Liquid-Line Driers.
3. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers.
4. ARI 750 - Thermostatic Refrigerant Expansion Valves.
5. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

C. American Society of Mechanical Engineers:
1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B31.5 - Refrigeration Piping.
4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
5. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

6. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
7. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.

E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

G. Underwriters Laboratories Inc.:
1. UL 429 - Electrically Operated Valves.

1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.

C. Provide pipe hangers and supports in accordance with ASME B31.5, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.

D. Flexible Connectors: Use at or near compressors where piping configuration does not absorb vibration.

1.4 SUBMITTALS

A. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.

B. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
4. Refrigerant Specialties: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:
   a. Refrigerant moisture and liquid indicators.
   b. Refrigerant strainers.
   c. Refrigerant pressure regulators.
   d. Refrigerant pressure relief valves.
   e. Refrigerant filter-driers.
   f. Refrigerant solenoid valves.
   g. Refrigerant expansion valves.
   h. Electronic expansion valves.

C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Test Reports: Indicate results of refrigerant leak test and refrigerant piping system pressure test.

E. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

F. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

G. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.

B. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.

B. Perform Work in accordance with applicable code and AWS D1.1 for welding hanger and support attachments to building structure.

C. Perform work in accordance with State of Missouri standard.

D. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 WARRANTY

A. Furnish five year manufacturer warranty for valves excluding packing.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING

A. Copper Tubing: ASTM B280, Type ACR hard drawn.
   1. Fittings: ASME B16.22 wrought copper.

2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F (640 to 805 degrees C).

2.2 UNIONS, FLANGES, AND COUPLINGS

A. 2 inches (50 mm) and Smaller:
   1. Copper Pipe: Bronze, soldered joints.

B. 2-1/2 inches (65 mm) and Larger:
   1. Copper Piping: Bronze.
   2. Gaskets: 1/16 inch (1.6 mm) thick preformed neoprene.

C. Grooved and Shouldered Pipe End Couplings:
   1. Housing Clamps: Malleable iron galvanized to engage and lock designed to permit some angular deflection, contraction, and expansion.
   2. Sealing Gasket: C-shape elastomer composition for operating temperature range from -30 degrees F (-34 degrees C) to 230 degrees F (110 degrees C).
   3. Accessories: Steel bolts, nuts, and washers.

D. Dielectric Connections: Provide non-conducting dielectric connections wherever joining dissimilar metals. Use of dielectric nipples or flanges is permitted. Dielectric unions are not allowed.

2.3 PIPE HANGERS AND SUPPORTS

A. Conform to ASME B31.5, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (13 to 40 mm): Carbon steel, adjustable swivel, split ring.

C. Hangers for Cold Pipe Sizes 2 inches (50 mm) and Larger: Carbon steel, adjustable, clevis.

D. Hangers for Hot Pipe Sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis.

E. Hangers for Hot Pipe Sizes 6 inches (150 mm) and Larger: Adjustable steel yoke, cast iron roll, double hanger.

F. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

G. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches (150 mm) and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.

H. Wall Support for Pipe Sizes 3 inches (76 mm) and Smaller: Cast iron hooks.

I. Wall Support for Pipe Sizes 4 inches (100 mm) and Larger: Welded steel bracket and wrought steel clamp.

J. Wall Support for Hot Pipe Sizes 6 inches (150 mm) and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

K. Vertical Support: Steel riser clamp.

L. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

M. Floor Support for Hot Pipe 4 inches (100 mm) and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

N. Floor Support for Hot Pipe Sizes 6 inches (150 mm) and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

O. Copper Pipe Support: Carbon steel rings, adjustable, copper plated.

P. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

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

R. Sheet Lead: ASTM B749, 2.5 lb/sq ft 0.039 inch (0.99 mm) thick.

2.4 REFRIGERANT MOISTURE AND LIQUID INDICATORS

A. Manufacturers:
1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Indicators:
1. Port: Double, UL listed.
2. Body: Copper or brass, flared or solder ends.
3. Sight glass: Color-coded paper moisture indicator with removable element cartridge and plastic cap.
4. Maximum working pressure: 500 psig (3450 kPa).
5. Maximum working temperature: 200 degrees F (93 degrees C).

2.5 VALVES

A. Manufacturers:
1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Diaphragm Packless Valves:
1. UL listed, globe or angle pattern, forged brass body and bonnet solder or flared ends.
2. Phosphor bronze and stainless steel diaphragms, rising stem and hand wheel.
3. Stainless steel spring, nylon seats, disc with positive back seating.
4. Maximum working pressure: 500 psig (3450 kPa).
5. Maximum working temperature: 275 degrees F (135 degrees C).

C. Packed Angle Valves:
1. Forged brass or nickel-plated forged steel, solder or flared ends.
2. Forged brass seal caps with copper gasket, rising stem and seat [with back seating], molded stem packing.
3. Maximum working pressure: 500 psig (3450 kPa).
4. Maximum working temperature: 275 degrees F (135 degrees C).

D. Ball Valves:
1. Two piece forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals, soldered or threaded ends.
2. Maximum working pressure: 500 psig (3450 kPa).
3. Maximum working temperature: 325 degrees F (163 degrees C).

E. Service Valves:
1. Forged brass body with copper stubs, brass caps, removable valve core, [integral ball check valve,] flared or solder ends.
2. Maximum working pressure: 500 psig (3450 kPa).

F. Refrigerant Check Valves:
1. Manufacturers:
a. Alco Controls Div, Emerson Electric Co.
b. Parker Hannifin Corp., Refrig. & Air Cond. Div.
c. Sporlan Valve Co.
2. Globe Type:

a. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc.
b. Maximum working pressure: 500 psig (3450 kPa).
c. Maximum working temperature: 300 degrees F (149 degrees C).

3. Straight Through Type:
a. Spring, neoprene seat.
b. Maximum working pressure: 500 psig (3450 kPa).
c. Maximum working temperature: 250 degrees F (121 degrees C).

2.6 REFRIGERANT STRAINERS

A. Manufacturers:
1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Straight Line or Angle Line Type:
1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass.
2. Maximum working pressure: 430 psig (2960 kPa).

C. Straight Line, Non-Cleanable Type:
1. Steel shell, copper plated fittings, stainless steel wire screen.
2. Maximum working pressure: 500 psig (3450 kPa).

2.7 REFRIGERANT PRESSURE REGULATORS

A. Manufacturers:
1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Brass body, stainless steel diaphragm, direct acting pilot operated with remote pressure pilot, adjustable over 0 to 80 psig (0 to 550 kPa) range, for maximum working pressure of 450 psig (3100 kPa).

2.8 REFRIGERANT PRESSURE RELIEF VALVES

A. Manufacturers:
1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard 450 psig (3100 kPa) setting; selected to ASHRAE 15.

2.9 REFRIGERANT FILTER-DRIERS

A. Manufacturers:
1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Replaceable Cartridge Angle Type:
1. Shell: ARI 710, UL listed, steel, removable cap, for maximum working pressure of 500 psig (3450 kPa).
2. Filter Cartridge: Pleated media with integral end rings, stainless steel support, ARI 730 rating for schedule capacity.
3. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina, ARI 730 rating for scheduled capacity.

4. Wax Removal Cartridge: Molded bonded core of activated charcoal with integral gaskets, ARI 710 moisture rating to support scheduled system.

C. Permanent Straight Through Type:
1. ARI 710, UL listed, steel shell with molded desiccant filter core, for maximum working pressure of 500 psig (3450 kPa).
2. Rating: ARI 710 moisture rating to support schedule system.

2.10 REFRIGERANT SOLENOID VALVES

A. Manufacturers:
1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly, integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psig (3450 kPa). Stem designed to allow manual operation in case of coil failure.

C. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color-coded lead wires, integral junction box [with pilot light].

D. Electrical Characteristics: 120 volts, single phase, 60 Hz.

2.11 REFRIGERANT EXPANSION VALVES

A. Manufacturers:
1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, mechanical pressure limit (maximum operating pressure MOP feature), adjustable superheat setting, replaceable inlet strainer, with replaceable capillary tube and remote sensing bulb and remote bulb well.

C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F (6 degrees C) superheat. Select to avoid being undersized at full load and oversized at part load.

2.12 ELECTRONIC EXPANSION VALVES

A. Manufacturers:
1. Alco Controls Div., Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Valve:
1. Brass bodies with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
2. Capacity: Must support scheduled systems.
3. Electrical Characteristics: 12 volts DC.

C. Evaporation Control System:
1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, pre-selection allowance for electrical defrost and hot gas bypass.
2. Electrical Characteristics: 115 volts, single phase, 50/60 Hz.

D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - INSERTS

A. Provide inserts for placement in concrete forms.

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

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches (100 mm) and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install hangers and supports in accordance with ASME B31.5, ASTM F708, [and] MSS SP 89.

B. Support horizontal piping hangers as scheduled.

C. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.

D. Place hangers within 12 inches (300 mm) of each horizontal elbow.

E. Install hangers to allow 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.

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

I. Prime coat exposed steel hangers and supports in accordance with Division 09. [Finish paint exposed steel hangers and supports in accordance with Division 09. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.5 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Route piping parallel to building structure and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors.

E. Install pipe identification.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Provide access where valves and fittings are not exposed.

H. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

I. Flood refrigerant piping system with nitrogen when brazing.

J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

K. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

L. Install valves with stems upright or horizontal, not inverted.

M. Insulate piping and equipment.

N. Provide replaceable cartridge filter-dryers, with isolation valves and bypass with valve.

O. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

P. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

Q. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

R. Provide electrical connection to solenoid valves. Refer to Section 260503.

S. Fully charge completed system with refrigerant after testing.

T. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

U. Install refrigerant piping in accordance with ASME B31.5.

3.6 INSTALLATION - REFRIGERANT SPECIALTIES

A. Refrigerant Liquid Indicators:
   1. Install line size liquid indicators in main liquid line downstream of condenser.
   2. When receiver is provided, install line size liquid indicators in liquid line downstream of receiver.
   3. Install line size liquid indicators downstream of liquid solenoid valves.

B. Refrigerant Valves:
   1. Install service valves on compressor suction and discharge.
   2. Install gage taps at compressor inlet and outlet.
   3. Install gage taps at hot gas bypass regulators, inlet and outlet.
   4. Install check valves on compressor discharge.

5. Install check valves on condenser liquid lines on multiple condenser systems.
6. Install refrigerant charging valve in liquid line between receiver shut-off valve and expansion valve.

C. Strainers:
1. Install line size strainer upstream of each automatic valve.
2. Where multiple expansion valves with integral strainers are used, install single main liquid-line strainer.
3. On steel piping systems, install strainer in suction line.
4. Install shut-off valves on each side of strainer.

D. Install pressure relief valves on ASME receivers. Install relief valve discharge piping to terminate outdoors.

E. Filter-Dryers:
1. Install permanent filter-dryers in low temperature systems.
2. Install permanent filter-dryer in systems containing hermetic compressors.
3. Install replaceable cartridge filter-dryer vertically in liquid line adjacent to receivers.
4. Install replaceable cartridge filter-dryer upstream of each solenoid valve.

F. Solenoid Valves:
1. Install in liquid line of systems operating with single pump-out or pump-down compressor control.
2. Install in liquid line of single or multiple evaporator systems.
3. Install in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.

3.7 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.

B. Pressure test refrigeration system with dry nitrogen to 200 psig (1470 kPa). Perform final tests at 27 inches (92 kPa) vacuum and 200 psig (1470 kPa) using electronic leak detector.

C. Repair leaks.

D. Retest until no leaks are detected.

3.8 SCHEDULES

A. Pipe Hanger Spacing:

PIPE SIZE Inches (mm)	COPPER TUBING MAXIMUM HANGER SPACING Feet (m)	STEEL PIPE MAXIMUM HANGER SPACING Feet (m)	MINIMUM HANGER ROD DIAMETER COPPER TUBING Inches (mm)	MINIMUM HANGER ROD DIAMETER STEEL PIPE Inches (mm)
1/2 (12)	5 (1.5)	7 (2.1)	3/8 (9)	3/8 (9)
3/4 (20)	5 (1.5)	7 (2.1)	3/8 (9)	3/8 (9)
1 (25)	6 (1.8)	7 (2.1)	3/8 (9)	3/8 (9)
1-1/4 (32)	7 (2.1)	7 (2.1)	3/8 (9)	3/8 (9)
1-1/2 (38)	8 (2.4)	9 (2.7)	3/8 (9)	3/8 (9)
2 (50)	8 (2.4)	10 (3)	3/8 (9)	3/8 (9)
2-1/2 (65)	9 (2.7)	11 (3.4)	1/2 (13)	1/2 (13)
3 (75)	10 (3)	12 (3.7)	1/2 (13)	1/2 (13)
4 (100)	10 (3)	12 (3.7)	1/2 (13)	5/8 (15)

5 (125)	10 (3)	12 (3.7)	1/2 (13)	5/8 (15)
6 (150)	10 (3)	12 (3.7)	5/8 (15)	3/4 (19)

END OF SECTION

SECTION 23 25 00
HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section and the other section of this Division.

B. Other section of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUMMARY

A. This Section includes the following HVAC water-treatment systems:
   1. Chemical treatment.

1.3 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

C. RO: Reverse osmosis.

D. TDS: Total dissolved solids.

1.4 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including hot-water heating, chilled water, dual-temperature water, and glycol cooling, shall have the following water qualities:
   1. pH: Maintain a value within 9.0 to 10.5.
   2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
   3. Boron: Maintain a value within 100 to 200 ppm.
   4. Chemical Oxygen Demand (Non-Glycol Systems): Maintain a maximum value of 100 ppm.
   5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   6. TDS: Maintain a maximum value of 10 ppm.
   7. Ammonia: Maintain a maximum value of 20 ppm.
   8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
   9. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
      c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
      d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
      e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

D. Steam Boiler and Steam Condensate:
   1. Steam Condensate:
      a. pH: Maintain a value within 7.8 to 8.4.
      b. Total Alkalinity: Maintain a value within 5 to 50 ppm.
      c. Chemical Oxygen Demand: Maintain a maximum value of 15 ppm.
      d. Soluble Copper: Maintain a maximum value of 0.20 ppm.
      e. TDS: Maintain a maximum value of 10 ppm.
      f. Ammonia: Maintain a maximum value of 20 ppm.
      g. Total Hardness: Maintain a maximum value of 2 ppm.
   2. Steam boiler operating at 15 psig (104 kPa) and less shall have the following water qualities:
      a. "OH" Alkalinity: Maintain a value within 200 to 400 ppm.
      b. TDS: Maintain a value within 600 to 3000 ppm.
   3. Steam boiler operating at more than 15 psig (104 kPa) shall have the following water qualities:
      a. "OH" Alkalinity: 00 to 400 ppm.
      b. TDS: Maintain a value within 600 to 1200 ppm to maximum 30 times RO water TDS.

E. Open hydronic systems, including condenser and fluid-cooler spray water, shall have the following water qualities:
   1. pH: Maintain a value within 8.0 to 9.1.
   2. "P" Alkalinity: Maintain a maximum value of 100 ppm.
   3. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
   4. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   5. TDS: Maintain a maximum value of 10 ppm.
   6. Ammonia: Maintain a maximum value of 20 ppm.
   7. Free "OH" Alkalinity: Maintain a maximum value of 0 ppm
   8. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/ml.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
      c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
      d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
      e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.
   9. Polymer Testable: Maintain a minimum value within 10 to 40.

F. Passivation for Galvanized Steel: For the first 60 days of operation.
   1. pH: Maintain a value within 7 to 8.
   2. Calcium Carbonate Hardness: Maintain a value within 100 to 300 ppm.
   3. Calcium Carbonate Alkalinity: Maintain a value within 100 to 300 ppm.

1.5 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
   1. Chemicals.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: Power and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For sensors, injection pumps, water softeners, and controllers to include in emergency, operation, and maintenance manuals.

E. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. Water Analysis: Illustrate water quality available at Project site.
3. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

1.6 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:
   1. Initial water analysis and HVAC water-treatment recommendations.
   2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment and glycol solutions prior to operation.
   3. Periodic field service and consultation.
   4. Customer report charts and log sheets.
   5. Laboratory technical analysis.
   6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Chemtreat
   2. Kan-Tech, Inc.
   3. Preapproved equal

2.2 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article. Verify with Owner existing water treatment supplier.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 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. 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.

C. Tests and Inspections:
   1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
   2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
   3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
   4. Do not enclose, cover, or put piping into operation until it is tested, and satisfactory test results are achieved.
   5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
   7. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
   8. Repair leaks and defects with new materials and retest piping until no leaks exist.

D. Remove and replace malfunctioning units and retest as specified above.

E. Comply with ASTM D 3370 and with the following standards:
   1. Silica: ASTM D 859.
   2. Steam System: ASTM D 1066.
   3. Acidity and Alkalinity: ASTM D 1067.
   4. Iron: ASTM D 1068.
   5. Water Hardness: ASTM D 1126.

END OF SECTION

SECTION 23 31 13
METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUMMARY

A. Section Includes:
   1. Single-wall rectangular ducts and fittings.
   2. Double-wall rectangular ducts and fittings.
   3. Single-wall round and flat-oval ducts and fittings.
   4. Double-wall round and flat-oval ducts and fittings.
   5. High Efficiency Takeoffs (HETO)
   6. Sheet metal materials.
   7. Sealants and gaskets.
   8. Hangers and supports.
   9. Seismic-restraint devices.

1.3 DEFINITIONS

A. Low Velocity Ductwork: Supply, return, make-up, and exhaust ductwork systems that are sized at 2,000 FPM or lower.

B. Medium Velocity Ductwork: Supply ductwork systems sized at greater than 2,000 FPM to 3,000 FPM.

C. Low Pressure Ductwork: Ductwork connected to fan systems with a 2" w.c. or less deadhead rating.

D. Medium Pressure Ductwork: Ductwork connected to fan systems with greater than 2" w.c. and less than 6" w.c. deadhead rating.

E. High Pressure Ductwork: Ductwork connected to fan systems with 6" w.c. or greater deadhead rating.

1.4 PERFORMANCE REQUIREMENTS

A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. All work shall comply with the Mechanical Codes.

C. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.
   3. Seismic-restraint devices.

B. LEED Submittals:
   1. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 – "Duct Leakage Tests."
   2. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 – "Ventilation System Start-up."
   3. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VAC content.

C. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   4. Elevation of top of ducts.
   5. Dimensions of main duct runs from building grid lines.
   6. Fittings.
   7. Reinforcement and spacing.
   8. Seam and joint construction.
   9. Penetrations through fire-rated and other partitions.
   10. Equipment installation based on equipment being used on Project.
   11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
   12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
   2. Suspended ceiling components.
   3. Structural members to which duct will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Penetrations of smoke barriers and fire-rated construction.
   6. Items penetrating finished ceiling including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Perimeter moldings.

B. Welding certificates.

C. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.

3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Wichita Sheet Metal
2. McGill AirFlow LLC.
3. Sheet Metal Connectors, Inc.
4. Kruse Corporation

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.

4. Cover insulation with polyester film complying with UL 181, Class 1.

G. Inner Duct: Minimum 0.028-inch (0.7-mm) perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent, unless noted as solid on drawings.

H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Traverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Wichita Sheet Metal
      b. Lindab Inc.
      c. McGill AirFlow LLC.
      d. SEMCO Incorporated.
      e. Sheet Metal Connectors, Inc.
      f. Wesco
      g. Kruse Corporation

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" with the following restrictions:
   1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
   2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.
   3. Snaplock seams are not allowed on any ductwork (SMACNA RL-6A, RL-6B, RL-7, or RL-8)

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements,

materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

2.4 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Wichita Sheet Metal
   2. Lindab Inc.
   3. McGill AirFlow LLC.
   4. SEMCO Incorporated.
   5. Sheet Metal Connectors, Inc.
   6. Wesco
   7. Kruse Corporation

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
   1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
      a. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.
   2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" with the following restrictions:
      a. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
      b. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.
      c. Snaplock seams are not allowed on any ductwork (SMACNA RL-6A, RL-6B, RL-7, or RL-8)
   3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Inner Duct: Minimum 0.028-inch (0.7-mm) perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent, unless noted to be solid on drawings.

E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
   2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
   3. Coat insulation with antimicrobial coating.

4. Cover insulation with polyester film complying with UL 181, Class 1.

2.5 HIGH EFFICIENCY TAKEOFFS (HETO)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Wichita Sheet Metal
   2. Lindab, Inc.
   3. McGill Airflow, LLC
   4. SEMCO, Inc.
   5. Sheet Metal Connectors, Inc.
   6. Wesco
   7. Kruse Corporation
   8. Ductmate Industries, Inc.

B. General Requirements: Galvanized steel, stainless steel or aluminum construction with thickness matching required ductwork construction.

C. Construct in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible, Third Edition 2005, Chapter 4, Figure 4-6.

D. Rectangular opening with flange and neoprene gasket; 45 degree slope on the body.

E. Any volume dampers provided with HETO shall meet the requirements of manual volume dampers specified in this section.

2.6 SHEET METAL MATERIALS

A. General Material Requirements: 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: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60 (Z180).
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60 (Z180).
   2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils (0.10 mm) thick on both sides.
   3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

F. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

H. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.7 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: Minimum 3 inches (76 mm).
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
11. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.

12. Service: Indoor or outdoor.
13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.8 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size

ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease and sloped a minimum of 2 percent to drain grease back to the hood.

B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet (6 m) in horizontal ducts (or more frequently if required by code), and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches (38 mm) from bottom of duct.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
   2. Test the following systems:
      a. Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections**,** selected by Engineer from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
      b. Supply Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
      c. Return Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
      d. Exhaust Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
      e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Test for leaks before applying external insulation.
   5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
   6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
   2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections. Additional ductwork may require testing at Engineer's discretion, if tested duct is found to be defective.

E. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing 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.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. 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 duct sections 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, duct liner, or duct accessories.
4. 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.
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 drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 SCHEDULES

A. Ductwork Material Schedule:

AIR SYSTEM	MATERIAL
Supply (Heating Only Systems)	Galvanized Steel, Aluminum
Supply (System with Cooling Coils)	Galvanized Steel, Aluminum
Return and Relief	Galvanized Steel, Aluminum
General Exhaust	Galvanized Steel, Aluminum
Kitchen Hood Exhaust	Steel, Stainless Steel
Dishwasher Exhaust	Stainless Steel, Aluminum
Outside Air Intake	Galvanized Steel
Combustion Air	Galvanized Steel
Intake and Exhaust	Galvanized Steel
Fume Hood Exhaust, Lab Exhaust	Stainless Steel, PVC Coated Galvanized Steel
Underground Ducts	PVC Coated Galvanized Steel

B. Ductwork Pressure and Leakage Class Schedule:

AIR SYSTEM	PRESSURE CLASS	SEAL CLASS	LEAKAGE CLASS	
			ROUND	RECT
Low-Pressure Supply	2 inch wg (500 Pa).	B	6	12
Medium Pressure Supply (upstream of VAV & CV boxes)	6 inch wg (1500 Pa)	A	3	6
Return and Relief	2 inch wg (500 Pa)	B	6	12
General Exhaust	2 inch wg (500 Pa)	A	3	6
Dishwasher & Laundry Exhaust	2 inch wg (500 Pa)	A	3	6
Laboratory Exhaust Ductwork	6 inch wg (1500 Pa)	A	3	6

NOTE: In no case shall the duct construction class be less than the peak pressure obtainable on the fan curve at the design fan RPM, unless pressure relief devices are installed on the effected sections of ductwork.

C. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
2. PVC-Coated Ducts:
   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: Match duct material.
3. Stainless-Steel Ducts:
   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: Match duct material.
4. Aluminum Ducts: Aluminum.

D. Double-Wall Duct Interstitial Insulation:
1. Supply Air Ducts: 2 inches (51 mm) thick.
2. Return Air Ducts: 1 inch (25 mm) thick.
3. Exhaust Air Ducts: 1 inch (25 mm) thick.

E. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
a. Velocity 1000 fpm (5 m/s) or Lower:
1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
c. Velocity 1500 fpm (7.6 m/s) or Higher:
1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Welded.
d. At Contractor's option, adjustable elbows with fully sealed gores (sealed per Part 2.6 Sealant and Gaskets article) are acceptable for low velocity, round elbows 12" and smaller in diameter.

F. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap, or "low loss" tee.
c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral, or "low loss" tee.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUMMARY

A. Section Includes:
1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Ceiling dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Corridor dampers.
10. Duct silencers.
11. Remote damper operators.
12. Duct-mounted access doors.
13. Duct pressure relief doors.
14. Flexible connectors.
15. Flexible ducts.
16. Duct accessory hardware.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances, and method of field assembly into duct systems and other construction. Include the following:
a. Special fittings.
b. Manual volume damper installations.
c. Control damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Wiring Diagrams: For power, signal, and control wiring.

C. Source quality-control reports.

D. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

1.5 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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 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: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60 (Z180).
   2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.

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 (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. American Warming and Ventilating; a division of Mestek, Inc.
   3. Cesco Products; a division of Mestek, Inc.
   4. Duro Dyne Inc.
   5. Greenheck Fan Corporation.
   6. Lloyd Industries, Inc.
   7. Nailor Industries Inc.
   8. NCA Manufacturing, Inc.
   9. Pottorff; a division of PCI Industries, Inc.
   10. Ruskin Company.
   11. SEMCO Incorporated.
   12. Vent Products Company, Inc.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm (10 m/s) unless noted otherwise.

D. Maximum System Pressure: 2-inch wg (0.50 kPa) unless noted otherwise.

E. Frame: 0.063-inch- (1.6-mm-) thick extruded aluminum, with welded corners and mounting flange.

F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch (150-mm) width, 0.050-inch- (1.2-mm-) thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:
1. Material: Galvanized steel.
2. Diameter: 0.20 inch (5 mm).

J. Tie Bars and Brackets: Galvanized steel.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball.

M. Accessories:
1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. 90 degree stops.

2.3 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Duro Dyne Inc.
5. Greenheck Fan Corporation.
6. Lloyd Industries, Inc.
7. Nailor Industries Inc.
8. NCA Manufacturing, Inc.
9. Pottorff; a division of PCI Industries, Inc.
10. Ruskin Company.
11. SEMCO Incorporated.
12. Vent Products Company, Inc.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 2000 fpm (10 m/s) unless noted otherwise.

D. Maximum System Pressure: 2-inch wg (0.5 kPa) unless noted otherwise.

E. Frame: 0.063-inch- (1.6-mm-) thick extruded aluminum, with welded corners and mounting flange.

F. Blades:
1. Multiple, 0.050-inch- (1.2-mm-) thick aluminum sheet.
2. Maximum Width: 6 inches (150 mm).
3. Action: Parallel.
4. Balance: Gravity.
5. Eccentrically pivoted.

G. Blade Seals: Neoprene.

H. Blade Axles: Galvanized steel.

I. Tie Bars and Brackets:
1. Material: Galvanized steel.

2. Rattle free with 90-degree stop.

J. Return Spring: Adjustable tension.

K. Bearings: Stainless steel or Bronze.

L. Accessories:
1. Adjustment device to permit setting for varying differential static pressures.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers (Under 1500 FPM Velocity):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Air Balance Inc.; a division of Mestek, Inc.
b. American Warming and Ventilating; a division of Mestek, Inc.
c. Flexmaster U.S.A., Inc.
d. McGill AirFlow LLC.
e. METALAIRE, Inc.
f. Nailor Industries Inc.
g. Pottorff; a division of PCI Industries, Inc.
h. Ruskin Company.
i. Vent Products Company, Inc.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
a. Round Dampers: Galvanized steel, 0.040 inch (1.02 mm) thick (20 gauge), 7" minimum length, with rolled stiffener beads.
b. Rectangular Dampers: Galvanized steel with mitered and welded corners.
1) Dampers up to 36" wide x up to 12" High: 0.034 inch (0.86 mm) thick (22 gauge), 3" minimum width with center "V" grove for reinforcement.
2) Dampers over 36" wide or over 12" High: 0.052 inch (1.32 mm) thick (18 gauge), 5" x 1" minimum hat shaped channels with corner braces.
3) For Dampers Over 48" Wide or Over 48" High: 0.064 inch (1.62 mm) thick (16 gauge), 5" x 1" minimum hat shaped channels with corner braces.
5. Blades:
a. Round Dampers: Galvanized Steel.
1) Dampers up to 16" Diameter: 0.040 inch (1.02 mm) thick (20 gauge) single blade.
2) Dampers Above 16" up to 24" Diameter: 0.064 inch (1.62 mm) thick (16 gauge) minimum single blade, or two sandwiched 20 gauge blades.
3) For Dampers Above 24" Diameter: Utilize multiple blade rectangular dampers as specified below with field fabricated square to round transitions.
b. Rectangular Dampers: Galvanized Steel.
1) Dampers up to 36" Wide x Up to 12" High: 0.034 inch (0.86 mm) thick (22 gauge) minimum single blade.
2) Dampers Over 36" Wide or Over 12" High: 0.052 inch (1.32 mm) thick (18 gauge) minimum opposed blades with 8" maximum width and reinforcement grooves or stiffeners.
3) Dampers Over 48" Wide or over 48" High: 0.064 inch (1.62 mm) thick (16 gauge) minimum opposed blades with 8" maximum width and reinforcement grooves or stiffeners.
6. Blade Axles: Cadmium plated steel.

a. Round Dampers Up to 16" Diameter or Rectangular Dampers up to 36" Wide x 12" High: 3/8 minimum square axle shaft, full width, extending through frame. Dampers 12" and smaller may utilize separate axles at each end of blade in lieu of full width.
b. Round Dampers Over 16" diameter and Rectangular Dampers Over 36" Wide or 12" High: 1/2" minimum square or hex axle shaft(s), full width, extending through frame.

7. Bearings:
   a. Molded synthetic or oil-impregnated bronze.
   b. Bearings at both ends of operating shaft.
8. Locking Quadrants: 16 gauge zinc plated steel with wing nut on handle away from the shaft. Provide with 1 1/2" stand-off for external insulation.
9. Tie Bars and Brackets: Galvanized steel.

B. Standard, Steel, Manual Volume Dampers (1500 FPM to 3000 FPM Velocity):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. Flexmaster U.S.A., Inc.
   d. McGill AirFlow LLC.
   e. METALAIRE, Inc.
   f. Nailor Industries Inc.
   g. Pottorff; a division of PCI Industries, Inc.
   h. Ruskin Company.
   i. Vent Products Company, Inc.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Round Dampers: Galvanized steel, 7" minimum length, with rolled stiffener beads.
      1) Dampers 18" diameter and less: 0.040 inch (1.02 mm) thick (20 gauge).
      2) Dampers over 18" up to 24" diameter: 0.052 inch (1.32 mm) thick 18 gauge).
      3) For Dampers Above 24" Diameter: Utilize multiple blade rectangular dampers as specified below with field fabricated square to round transitions.
   b. Rectangular Dampers: Galvanized steel, 0.064 inch (1.62 mm) thick (16 gauge), 5" x 1" minimum hat shaped channels with mitered and welded corners, and corner braces.
5. Blades:
   a. Round Dampers: Galvanized Steel.
      1) Dampers up to 18" Diameter: 0.064 inch (1.62 mm) thick (16 gauge) single blade.
      2) Dampers Above 18" up to 24" Diameter: 0.078 inch (1.98 mm) thick (14 gauge) minimum single blade, or two sandwiched 20 gauge blades.
      3) For Dampers Above 24" Diameter: Utilize multiple blade rectangular dampers as specified below with field fabricated square to round transitions.
   b. Rectangular Dampers: Galvanized Steel, 0.064 inch (1.62 mm) thick (16 gauge) minimum opposed blades with 8" maximum width and reinforcement grooves or stiffeners.
6. Blade Axles: Cadmium plated steel, 1/2" minimum square or hex axle shaft(s), full width, extending through frame.

7. Bearings:
   a. Molded synthetic or oil-impregnated bronze.
   b. Bearings at both ends of operating shaft.
8. Locking Quadrants: 16 gauge zinc plated steel with wing nut on handle away from the shaft. Provide with 1 1/2" stand-off for external insulation.
9. Tie Bars and Brackets: Galvanized steel.

C. Standard, Aluminum, Manual Volume Dampers (Up to 3000 FPM):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. Flexmaster U.S.A., Inc.
   d. McGill AirFlow LLC.
   e. METALAIRE, Inc.
   f. Nailor Industries Inc.
   g. Pottorff; a division of PCI Industries, Inc.
   h. Ruskin Company.
   i. Vent Products Company, Inc.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Round Dampers: Aluminum, 0.063 inch (1.59 mm) minimum thick, 7" minimum length, with rolled stiffener beads.
   b. Rectangular Dampers: Aluminum with mitered and welded corners.
      1) Dampers up to 36" wide x up to 12" High: 0.08 inch (2.04 mm) thick, 3" minimum width with center "V" groove for reinforcement.
      2) Dampers over 36" wide or over 12" High: 0.08 inch (2.04 mm) thick, 5" x 1" minimum hat shaped channels with corner braces.
      3) For Dampers Over 48" Wide or Over 48" High: 0.08 inch (2.04 mm) thick, 5" x 1" minimum hat shaped channels with corner braces.
5. Blades:
   a. Round Dampers: Aluminum.
      1) Dampers up to 16" Diameter: 0.063 inch (1.59 mm) thick minimum single blade.
      2) Dampers Above 16" up to 24" Diameter: 0.063 inch (1.59 mm) thick minimum single blade, or two sandwiched blades.
      3) For Dampers Above 24" Diameter: Utilize multiple blade rectangular dampers as specified below with field fabricated square to round transitions.
   b. Rectangular Dampers: Aluminum.
      1) Dampers up to 36" Wide x Up to 12" High: 0.08 inch (2.04 mm) thick minimum single blade.
      2) Dampers Over 36" Wide or Over 12" High: 0.08 inch (2.04 mm) thick minimum opposed blades with 8" maximum width and reinforcement grooves or stiffeners.
      3) Dampers Over 48" Wide or over 48" High: 0.08 inch (2.04 mm) thick minimum opposed blades with 8" maximum width and reinforcement grooves or stiffeners.
6. Blade Axles: Aluminum.
   a. Round Dampers Up to 16" Diameter or Rectangular Dampers up to 36" Wide x 12" High: 3/8 minimum square axle shaft, full width, extending through frame. Dampers 12" and smaller may utilize separate axles at each end of blade in lieu of full width.

b. Round Dampers Over 16" diameter: and Rectangular Dampers Over 36" Wide or12" High: 1/2" minimum square or hex axle shaft(s), full width, extending through frame.

7. Bearings:
   a. Molded synthetic or oil-impregnated bronze.
   b. Bearings at both ends of operating shaft.
8. Locking Quadrants: 16 gauge zinc plated steel with wing nut on handle away from the shaft. Provide with 1 1/2" stand-off for external insulation.
9. Tie Bars and Brackets: Aluminum.

D. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. Flexmaster U.S.A., Inc.
   d. McGill AirFlow LLC.
   e. METALAIRE, Inc.
   f. Nailor Industries Inc.
   g. Pottorff; a division of PCI Industries, Inc.
   h. Ruskin Company.
   i. Vent Products Company, Inc.
2. Low-leakage rating**,** with linkage outside airstream**,** and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Galvanized-steel channels, 0.064 inch (1.62 mm) thick.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized, roll-formed steel, 0.064 inch (1.62 mm) thick.
6. Blade Axles: Cadmium plated steel.
7. Bearings:
   a. Oil-impregnated bronze.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered stainless steel.
10. Tie Bars and Brackets: Galvanized steel.
11. Locking Quadrants: 16 gauge zinc plated steel with wing nut on handle away from the shaft. Provide with 1 1/2" stand-off for external insulation.

E. Low-Leakage, Aluminum, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. American Warming and Ventilating; a division of Mestek, Inc.
   c. Flexmaster U.S.A., Inc.
   d. McGill AirFlow LLC.
   e. METALAIRE, Inc.
   f. Nailor Industries Inc.
   g. Pottorff; a division of PCI Industries, Inc.
   h. Ruskin Company.

i. Vent Products Company, Inc.

2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
   d. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.
6. Blade Axles: Aluminum or Stainless steel.
7. Bearings:
   a. Oil-impregnated bronze.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered stainless steel.
10. Tie Bars and Brackets: Aluminum.
11. Locking Quadrants: 16 gauge zinc plated steel with wing nut on handle away from the shaft. Provide with 1 1/2" stand-off for external insulation.

F. Jackshaft:
1. Size: 1-inch (25-mm) diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

G. Damper Hardware:
1. Locking quadrant zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated stand-off for insulated duct mounting.

2.5 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Flexmaster U.S.A., Inc.
4. McGill AirFlow LLC.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Pottorff; a division of PCI Industries, Inc.
8. Ruskin Company.
9. Vent Products Company, Inc.

B. Low-leakage rating**,** with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage. AMCA, Class 1A. Leakage shall not exceed 3 CFM/square foot (15.2L/s per square meter) against 1-inch wg (250 Pa) differential static pressure

C. Frames:
1. Hat shaped.
2. 0.064-inch- (1.62-mm-) thick, galvanized sheet steel.
3. Mitered and welded corners.

D. Blades:
1. Multiple blade with maximum blade width of 6 inches (152 mm).
2. Opposed-blade design.
3. Galvanized-steel.
4. 0.064 inch (1.62 mm) thick single skin or 0.0747-inch- (1.9-mm-) thick dual skin.
5. Blade Edging: Closed-cell neoprene.

E. Blade Axles: 1/2-inch- (13-mm-) diameter; plated steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).

F. Bearings:
1. Stainless-steel sleeve.
2. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. McGill AirFlow LLC.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Pottorff; a division of PCI Industries, Inc.
8. Prefco; Perfect Air Control, Inc.
9. Ruskin Company.
10. Vent Products Company, Inc.
11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Dynamic rated and labeled according to UL 555 by an NRTL. Static rated fire dampers are not acceptable.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 4000-fpm (20-m/s) velocity.
1. Clamps – Sizes 3 through 18 inches:
a. Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action.
b. Plenum rated nylon strap with minimum tensile strength of 175 lbs.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: 0.052 inch (1.3 mm) thick, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

2.7 CEILING RADIATION DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. McGill AirFlow LLC.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Prefco; Perfect Air Control, Inc.
7. Ruskin Company.
8. Vent Products Company, Inc.
9. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. General Requirements:
1. Labeled according to UL 555C by an NRTL.
2. 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. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

F. Fire Rating: 2 hours.

2.8 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. PHL, Inc.
6. Ruskin Company.

B. General Requirements: Label according to UL 555S "Dynamic" by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

F. Leakage: Class I.

G. Rated pressure and velocity to exceed design airflow conditions.

1. In low velocity systems (≤1,800 fpm), the minimum rated velocity shall be 2,000 fpm, with a minimum 2.0"w.c. close-off, but in no case shall the qualified close off pressure be less than 1.2 times the dead-head pressure of the fan.
2. In medium velocity systems (1,801 to 2,800 fpm), the minimum rated velocity shall be 3,000 fpm, with a minimum 4.0"w.c. close-off, but in no case shall the qualified close off pressure be less than 1.2 times the dead-head pressure of the fan. Damper blades shall be airfoil design.
3. In high velocity systems (>2,800 fpm), the minimum rated velocity shall be 4,000 fpm, with a minimum 6.0"w.c. close-off, but in no case shall the qualified close off pressure be less than 1.2 times the dead-head pressure of the fan, nor the qualified velocity be less than 1.1 times the design velocity. Damper blades shall be airfoil design.

H. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

I. Damper Motors: Two-position action, unless noted to have modulating action. Automatic reset after system test or power failure.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC 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.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. 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 to meet UL 555S.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor to meet UL 555S.

K. Accessories:
1. Auxiliary switches for position indication when smoke dampers are part of an engineered smoke control system.

2.9 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Ruskin Company.

B. Type: Dynamic rated and labeled according to UL 555 and UL 555S by an NRTL for dynamic operation. Static rated dampers are not acceptable.

C. Rated pressure and velocity to exceed design conditions.
1. In low velocity systems (≤1,800 fpm), the minimum rated velocity shall be 2,000 fpm, with a minimum 2.0"w.c. close-off, but in no case shall the qualified close of pressure be less than 1.2 times the dead-head pressure of the fan.
2. In medium velocity systems (1,801 to 2,800 fpm), the minimum rated velocity shall be 3,000 fpm, with a minimum 4.0"w.c. close-off, but in no case shall the qualified

close off pressure be less than 1.2 times the dead-head pressure of the fam. Damper blades shall be airfoil design.

3. In high velocity systems (>2,800 fpm), the minimum rated velocity shall be 4,000 fpm, with a minimum 6.0"w.c. close-off, but in no case shall the qualified close off pressure be less than 1.2 times the dead-head pressure of the fan, nor the qualified velocity be less than 1.1 times the design velocity. Damper blades shall be airfoil design.

D. Fire Rating: 1-1/2 and 3 hours.

E. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

F. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

G. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

H. Leakage: Class II for low velocity applications (≤1800 FPM) and Class I for medium or high velocity applications.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.

K. Damper Motors: Two-position action, unless noted to have modulating action. Automatic reset after system test or power failure.

L. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC 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.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. 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 to meet UL 555 and 555S.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque to meet UL 555 and 555S.

M. Accessories:

1. Auxiliary switches for position indication when smoke dampers are part of an engineered smoke control system.

2.10 CORRIDOR FIRE/SMOKE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation
4. Nailor Industries Inc.
5. Ruskin Company.

B. Type: Dynamic rated and labeled according to UL 555 and UL 555S by an NRTL for dynamic operation. Static rated dampers are not acceptable.

C. General Requirements: Label combination fire and smoke dampers according to UL 555 for 1-1/2-hour rating by an NRTL.

D. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

E. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

G. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application.

H. Damper Motors: Two-position action unless noted to have modulating action. Automatic reset after system test or power failure.

I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC 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.
   3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   4. 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 (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
   5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
   6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).

J. Accessories:
   1. Auxiliary switches for position indication when smoke dampers are part of an engineered smoke control system.

2.11 DUCT SILENCERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Industrial Noise Control, Inc.
   2. Vibro-Acoustics
   3. VAW Systems
   4. Ruskin
   5. Price
   6. IAC

B. General Requirements:
   1. Factory fabricated.

2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1

C. Shape:
1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.
3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G60 (Z180), galvanized sheet steel, 0.040 inch (1.02 mm) thick.

E. Round Silencer Outer Casing: ASTM A 653/A 653M, G60 (Z180), galvanized sheet steel.
1. Sheet Metal Thickness for Units up to 24 Inches (600 mm) in Diameter: 0.034 inch (0.85 mm) thick.
2. Sheet Metal Thickness for Units 26 through 40 Inches (660 through 1000 mm) in Diameter: 0.040 inch (1.02 mm) thick.
3. Sheet Metal Thickness for Units 42 through 52 Inches (1060 through 1300 mm) in Diameter: 0.052 inch (1.3 mm) thick.
4. Sheet Metal Thickness for Units 54 through 60 Inches (1370 through 1500 mm) in Diameter: 0.064 inch (1.62 mm) thick.

F. Inner Casing and Baffles: ASTM A 653/A 653M, G60 (Z180) galvanized sheet metal, 0.034 inch (0.85 mm) thick, and with 1/8-inch- (3-mm-) diameter perforations.

G. Special Construction:
1. Suitable for outdoor use where installed exterior to building.
2. High transmission loss (HTC) casing to achieve STC 45 where noted on drawings.

H. Connection Sizes: Match connecting ductwork unless otherwise indicated.

I. Principal Sound-Absorbing Mechanism:
1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
2. Film-lined type with fill material. Use dissipative, no inertia types or moisture proof non-fibrous material where noted on drawings.
   a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression.
   b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
3. Lining: Mylar or Tedlar.

J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
1. Lock form and sealed or continuously welded joints.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

K. Accessories:
1. Factory-installed end caps to prevent contamination during shipping.

2.12 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Pottorff; a division of PCI Industries, Inc.

2. Ventfabrics, Inc.
3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed, 3/4 inches (19 mm) deep.

F. Wall-Box Cover-Plate Material: Stainless steel.

2.13 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Ductmate Industries, Inc.
4. Flexmaster U.S.A., Inc.
5. Greenheck Fan Corporation.
6. McGill AirFlow LLC.
7. Nailor Industries Inc.
8. Pottorff; a division of PCI Industries, Inc.
9. Ventfabrics, Inc.
10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Panels - Round Duct."
1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set to prevent over pressurization of protected duct, based on specified pressure class. Set pressure relief device to limit maximum pressure to 125% of rated pressure class.
5. Doors close when pressures are within set-point range.

6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- (25-mm-) thick, fibrous-glass or polystyrene-foam board.

2.14 DUCT ACCESS PANEL ASSEMBLIES (FIRE RATED DUCT ASSEMBLIES)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Flame Gard, Inc.
3. 3M.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch (1.3-mm) carbon or 0.0428-inch (1.1-mm) stainless steel, to match duct material.

D. Fasteners: Carbon or stainless steel, to match duct material. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F (1093 deg C).

F. Minimum Pressure Rating: 10-inch wg (2500 Pa), positive or negative. Higher if required by maximum fan static pressure at design RPM.

2.15 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

F. 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. (810 g/sq. m).
2. Minimum Tensile Strength: 500 lbf/inch (88 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
1. Minimum Weight: 16 oz./sq. yd. (542 g/sq. m).
2. Tensile Strength: 285 lbf/inch (50 N/mm) in the warp and 185 lbf/inch (32 N/mm) in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
   1. Minimum Weight: 14 oz./sq. yd. (474 g/sq. m).
   2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

2.16 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Thermaflex
   2. Flexmaster U.S.A., Inc.
   3. McGill AirFlow LLC.
   4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, woven and coated fiberglass supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
   1. Pressure Rating: 10-inch wg (2500 Pa) positive and 2.0-inch wg (500 Pa) negative.
   2. Maximum Air Velocity: 4000 fpm (20 m/s).
   3. Temperature Range: Minus 20 to plus 250 deg F (Minus 29 to plus 121 deg C).
   4. Insulation R-value: R-6.0 per ASTM C-518.

C. Flexible Duct Connectors:
   1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

2.17 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 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated. Dampers are not allowed in kitchen hood grease ducts.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Connect ducts to duct silencers rigidly.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction and at maximum 50-foot (15-m) spacing.
   8. Upstream and downstream from turning vanes.
   9. Upstream or downstream from duct silencers.
   10. Control devices requiring inspection.
   11. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
   2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
   3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
   4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
   5. Body Access: 25 by 14 inches (635 by 355 mm).
   6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).

L. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5-inch wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts utilizing rigid ducts. Flexible ducts are not allowed on inlet connections to terminal units.

P. Connect supply diffusers to ducts directly or with maximum 72-inch (1800-mm) lengths of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with draw bands. Flexible ducts are not allowed on negative pressure ductwork, in exposed areas, or on inlets to terminal units.

R. Install duct test holes where required for testing and balancing purposes.

S. For utility fan sets with 5-inch W.C. (1250Pa) or higher discharge pressure, install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section

1.2 SUMMARY

A. Section Includes:
   1. Centrifugal roof ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

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

C. Field quality-control reports.

D. Operation and Maintenance Data: For power ventilators 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, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.

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

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 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. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing Corporation.
   2. Twin City Fan Companies, Ltd.
   3. Carnes Company.
   4. Greenheck Fan Corporation.
   5. Loren Cook Company.
   6. PennBarry.

B. 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.
   3. Kitchen hood exhaust fans shall be up blast, vertical, discharge type. The fan, and wheel inlet, and housing shall be all aluminum. Construction shall include built-in grease drain. Motor and drive shall be out of the air stream, with an intake air breather tube extending to an outside location free of discharge containments.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
   5. Fan and motor isolated from exhaust airstream.
   6. Rotary Belt Tensioner

E. Direct Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   4. Fan and motor isolated from exhaust airstream.

F. Accessories (Refer to Drawings):
   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 outside fan housing, factory wired through an internal aluminum conduit.

3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
1. Overall Height: 14 inches minimum above finished roof surface. Coordinate with architectural drawings for thickness of tapered insulation. Provide curb extension for kitchen grease exhaust to provide minimum 41" discharge height above finished roof surface.
2. Pitch Mounting: Manufacture curb for roof slope.
3. Metal Liner: Galvanized steel.
4. Vented Curb: Unlined with louvered vents in vertical sides. Utilized at kitchen grease exhaust ductwork where enclosed in rated shaft.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23.
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
3. Provide electronically commutated (EC) motor where scheduled with internally mounted potentiometer speed controller or leads for connection to 0-10 VDC external controller.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using vibration isolators as specified in Division 23.
1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounted units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Install floor-mounted units on concrete bases designed to withstand, without damage to equipment, the seismic force required by code. Concrete, reinforcement, and formwork requirements are specified in Division 03.

E. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Division 07 for installation of roof curbs.

F. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

G. Support suspended units from structure using threaded steel rods and vibration isolation hangers as specified in Division 23.

H. Install units with clearances for service and maintenance.

I. Label units according to requirements specified in Division 23.

J. Install gravity backdraft or motorized dampers to isolate the fan when off. Refer also to drawings. Dampers are not allowed in kitchen hood exhaust systems.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26.

D. Connect wiring according to Division 26.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   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 adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   10. Shut unit down and reconnect automatic temperature-control operators.
   11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Division 23 for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION

SECTION 23 36 00
AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Single Duct Variable or Constant volume terminal units.
   2. Dual duct terminal units.
   3. Fan powered terminal units.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 REFERENCES

A. American Refrigeration Institute:
   1. ARI 880 - Air Terminals.
   2. ARI 885 -Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. National Fire Protection Association:
   1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

D. Underwriters Laboratories Inc.:
   1. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 SUBMITTALS

A. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures indicated in schedules.

B. Manufacturer's Installation Instructions: Submit support and hanging details, and service clearances required.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

1.5 QUALITY ASSURANCE

A. Test and rate air terminal units' performance for air pressure drop, flow performance, and acoustical performance in accordance with ARI 880 and ARI 885. Attach ARI seal to each terminal unit.

PART 2 - PRODUCTS

2.1 SINGLE DUCT CONSTANT AND VARIABLE VOLUME AIR TERMINAL UNITS

A. Manufacturers:
1. Krueger
2. Titus
3. The Trane Co.
4. Nailor
5. Price
6. Johnson Controls

B. Product Description: Variable air volume terminal units for connection to central air systems.

C. Identification: Furnish each air terminal unit with identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.

D. Basic Assembly:
1. Casings: Steriloc minimum 22 gage (0.8 mm) galvanized steel.
2. Lining: Minimum 1/2 inch (13 mm) thick foil lined fiber insulation, 1.5 lb./cu ft (24 g/L) density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with UL listed film or provide foil faced insulation.
3. Primary Air Inlets: Round stub connections for duct attachment.
4. Primary Air Outlets: S slip-and-drive connections.
5. Insulated, factory installed bottom access panel.

E. Basic Unit:
1. Configuration: Air volume damper assembly with airflow measuring ring inside unit casing. Measuring ring shall be provided with balancing test ports. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 1 inch (0.25 kPa) inlet static pressure.
3. Unit inlet shall be equipped with a multi-point flow sensor with amplifying pressure pick-up points connected to central averaging chamber. The sensor shall amplify duct velocity pressure and shall maintain control accuracy with the same size inlet duct in any configuration.
    a. Pneumatic tees with caps for airflow verification equipment connection shall be installed in both pneumatic tubing lines.

F. Attenuation Section: Line attenuation sections with 2 inch (50 mm) thick insulation.

G. Hot Water Heating Coil:
1. Construction: 1/2 inch (13 mm) copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig (10380 kPa) pressure, factory installed.

H. Automatic Damper Operator:
1. Electric Actuator: 24 volt.

I. Wiring and Controls:
1. Units shall incorporate a single point or dual point electrical connection as shown in electrical connection schedule. Provide and factory install low voltage control transformer, disconnect switch and fan relay. Factory install DDC controller and damper actuator supplied by the successful temperature controls contractor. All electrical components shall be UL/ETL recognized and installed in accordance with the national electric code. All electrical components are to be mounted in a NEMA 1 control enclosure. Separation shall be maintained be maintained between high

and low voltage wiring such that low voltage components, such as controller and damper operator, may be accessed without being exposed to line voltage wiring. All pneumatic tubing shall be UL listed fire retardant (FR) type, dual duct variable volume air terminal units

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify ductwork is ready for air terminal installation.

3.2 INSTALLATION

A. Connect to ductwork in accordance with other Division 23 sections.

B. Install ceiling access doors or locate units above easily removable ceiling components.

C. Support units individually from structure. Do not support from adjacent ductwork.

D. Contractor is responsible for coordinating control box and coil connection locations.

E. All hydronic coils shall be piped in a counter flow configuration.

3.3 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to scheduled minimum. Set units with heating coils for scheduled heating air flow.

END OF SECTION 233600

SECTION 23 37 13
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUMMARY

A. Extent of outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.

B. Types of outlets and inlets required for project include the following:
1. Ceiling air diffusers.
2. Wall and floor registers and grilles.
3. Linear slot diffusers

C. Refer to other Division 23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this section.

D. Refer to other Division 23 sections for balancing of air outlets and inlets; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturers Qualifications: Firms regularly engaged in manufacture of outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".
4. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

C. Performance Requirements:
1. Noise Criterion (NC): NC rating for all air inlets and outlets shall be NC 30 maximum, when rated in accordance with ASHRAE 70-01 with room absorption of 10dB, re 10^{-12} watts.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's data on outlets and inlets including the following:
1. Schedule of air outlets and inlets indicating drawing designation, type, and number furnished, model number, size, and accessories furnished.
2. Data sheet for each type of air outlet and inlet, and accessory furnished, indicating construction, finish, and mounting details.

3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.

B. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

C. 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. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 CEILING AIR DIFFUSERS:

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Standard color of diffusers is white, unless noted otherwise. Where diffusers are installed in hard ceilings or soffits, paint to match adjacent surface.

E. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule. Use all steel diffusers where fire dampers are required. Opposed blade dampers shall be provided only if specifically indicated on the drawings.

F. Manufacturer: Subject to compliance with requirements, provide diffusers of one of the following:
1. Krueger Mfg. Co.
2. Titus Products Div.; Philips Industries, Inc.
3. Air Guide
4. Price
5. Nailor
6. Carnes

2.2 WALL AND FLOOR REGISTER AND GRILLES:

A. General: Except as otherwise indicated, provide manufacturer's standard wall registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide wall or floor registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Wall or Floor Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall or floor systems and that are specifically manufactured to fit into wall or floor construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

D. Standard color of grilles is white, unless noted otherwise. Where grilles are installed in hard ceilings, sidewalls, or soffits, paint to match adjacent surface.

E. Types: Provide wall or floor registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule. Provide all steel registers where fire dampers are required. Opposed blade dampers shall be provided only if specifically indicated on the drawings.

F. Manufacturer: Subject to compliance with requirements, provide registers and grilles of one of the following:
1. Titus Products Div.; Phillips Industries, Inc.
2. Krueger
3. Air Guide
4. Price
5. Nailor
6. Carnes

2.3 LINEAR SLOT DIFFUSER

A. Linear slot diffuser designed for variable air volume application. Diffuser shall discharge air uniformly across slot length, horizontally along ceiling.

B. Plenum/casing shall be constructed of minimum 26 gauge, welded, galvanized steel. Slot edges shall be formed over to provide double thickness. Interior surfaces of plenum shall be acoustically and thermally insulated with 1/2" thick, 1-1/2 pound density foil faced glass fiber insulation meeting NFPA 90A and UL 181. Hanger holes shall be provided at each end of casing for installation.

C. Ceiling mounted diffusers shall be suitable for installation in a standard 2' x 2' exposed "T" bar ceiling grid system. Diffusers 4' in length shall be equipped with a notch to allow diffuser to set over cross "T" located at 2' point. Two-way blow diffusers shall be provided with an intermediate slot for installation over "T".

D. Opposed blade dampers shall be provided only if specifically indicated on the drawings.

E. Manufacturer: Subject to compliance with requirements, provided registers and grilles of one of the following:
1. Krueger
2. Tempmaster
3. Trane
4. Titus
5. Price
6. Nailor

2.4 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.

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 practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Locate units so that ceiling grid is not cut. 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 balancing damper with locking quadrant in runout to supply diffusers.

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 23 62 00
PACKAGED AIR-COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.

B. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 SUMMARY

A. Section includes packaged, air-cooled condensing units and heat pumps.

1.3 ACTION SUBMITTALS

A. Product Data: For each condensing unit. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Shop Drawings: For compressor and condenser units. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certification: For condensing units, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For condensing units 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, by a qualified testing agency, and marked for intended location and application.

B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in other sections.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in other sections.

C. Coordinate location of piping and electrical rough-ins.

PART 2 - PRODUCTS

2.1 PACKAGED AIR-COOLED CONDENSING UNITS, 6 TO 120 TONS (21 TO 422 KW)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. York, a Johnson Control Company

B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.

C. Compressor: Hermetic scroll compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.
1. Capacity Control: Hot-gas bypass, Variable capacity digital scroll.

D. Compressor: Hermetic or semihermetic rotary screw compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.
1. Capacity Control: Variable-frequency controller, Hot-gas bypass.

E. Compressor: Provide inverter driven variable capacity hermetic scroll type compressor.
1. Mount compressor on vibration isolators.
2. Provide internal overload protection.
3. Inverter shall modulate capacity to match the load.

F. Refrigerant: R-410A.

G. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.

H. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:
1. Permanently lubricated, ball-bearing variable speed ECM motors.
2. Separate motor for each fan.
3. Dynamically and statically balanced fan assemblies.

I. Operating and safety controls include the following:
1. Manual-reset, high-pressure cutout switches.
2. Automatic-reset, low-pressure cutout switches.
3. Low-oil-pressure cutout switch.
4. Compressor-winding thermostat cutout switch.
5. Three-leg, compressor-overload protection.
6. Control transformer.
7. Magnetic contactors for compressor and condenser fan motors.
8. Timer to prevent excessive compressor cycling.

J. Accessories:
1. Low-Ambient Controller: Cycles condenser fan to permit operation down to 0 deg F (minus 18 deg C) with time-delay relay to bypass low-pressure switch.
2. Gage Panel: Package with refrigerant circuit suction and discharge gages.
3. Hot-gas bypass kit.
4. Part-winding-start timing relay, circuit breakers, and contactors.

K. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:
   1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
   2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
   3. Gasketed control panel door.
   4. Nonfused disconnect switch, factory mounted and wired, for single external electrical power connection.
   5. Condenser coil hail guard.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC 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.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate compressor and condenser units according to ARI 206/110 or ARI 306/110 as applicable.

B. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," Section 6, "Heating, Ventilating, and Air-Conditioning."

C. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Testing Requirements: Factory test sound-power-level ratings according to ARI 370.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of condensing units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where condensing units will be installed.

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

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated.

B. Install roof-mounting units on equipment supports specified in other sections.

C. Equipment Mounting:
   1. Install condensing units on cast-in-place concrete equipment bases.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

B. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

C. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
   2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   5. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Condensing units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
      a. Inspect for physical damage to unit casing.
      b. Verify that access doors move freely and are weathertight.
      c. Clean units and inspect for construction debris.
      d. Verify that all bolts and screws are tight.
      e. Adjust vibration isolation and flexible connections.
      f. Verify that controls are connected and operational.

B. Lubricate bearings on fan motors.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Adjust fan belts to proper alignment and tension.

E. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

F. Measure and record airflow and air temperature rise over coils.

G. Verify proper operation of condenser capacity control device.

H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

I. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units.

END OF SECTION

SECTION 23 74 13
PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
   1. Direct-expansion cooling.
   2. Hot-gas reheat.
   3. Steam-heating coils.
   4. Economizer outdoor- and return-air damper section.
   5. Roof curbs.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

1.2 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

H. VVT: Variable-air volume and temperature.

1.3 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural members to which RTUs will be attached.
   2. Roof openings
   3. Roof curbs and flashing.

B. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan Belts: One set for each belt-driven fan.
   2. Filters: One set of filters for each unit.

1.7 QUALITY ASSURANCE

A. ARI Compliance:
   1. Comply with ARI 210/240 and ARI 345/350 for testing and rating energy efficiencies for RTUs.
   2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:
   1. Comply with ASHRAE 15 for refrigeration system safety.
   2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

D. UL and NEMA Compliance: Provide electrical components required as part of roof top units, which have been listed and labeled by UL and comply with NEMA Standards. Roof top units shall UL listed and labeled.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Outside Air Damper Leakage: Test in accordance with AMCA 500.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
   2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.
   3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than five years from date of Substantial Completion.
   4. Warranty Period for Control Boards: Manufacturer's standard, but not less than five years from date of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

B. Protect units from weather and construction traffic by storing in dry, roofed location.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION

A. Johnson Controls YORK Solution air-handling units are designed and built to meet performance detailed in this submittal.

B. Unit will be complete with fans, motors, motor controls, coils, dampers, controls, access doors and other components/options, as shown on product drawings, wiring diagrams, and as described in performance specifications.

C. Fans and drives will be balanced to limit vibration at operating speeds.

D. Unit will ship in one (1) piece whenever possible. Shipping splits will be provided when necessary. Lifting lugs will be provided where required for proper lifting.

E. Unit casing and frame will be factory insulated.

F. Units will be ETL labeled.

2.2 BASE RAIL

A. Structural base rail will be provided under the full perimeter of the unit, formed from mill galvanized steel.

2.3 UNIT CASING

A. Solution unit is specifically designed for outdoor applications.

B. Unit casing will consist of a structural frame with insulated roof, wall, and floor panels.

C. Removal of wall panels will not affect structural integrity of units.

D. Unit casing will be insulated with spray injected foam to achieve thermal resistance of R13 hr-ft2-°F/BTU. Insulation application will meet the requirements of NFPA 90A.

E. Unit will conform to ASHRAE Standard 111 Class 6 for casing leakage no more than 1% of design airflow at 1.25 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections.

F. Wall panels and access doors will deflect no more than L/240 when subjected to 1.5 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.

G. Unit will have double wall, 2" insulated panels for walls, roof, and floor. Exterior skin will be 18-Ga galvanized and painted sheet steel. Individual segments will have galvanized sheet steel, stainless sheet steel, or perforated galvanized interior liner, as described in performance specifications.

H. Unit roof will be double-sloped with a longitudinal peak and a minimum pitch of 1/4" per foot.
1. Roof snow-loads capacity will be at least 50 lb/ft^2.
2. Roof overhangs unit perimeter by 1-1/2".

I. Floor panels will be double wall construction, designed to provide at most L/240 deflection when subjected to a 300 lb. load at mid-span. Unit will have 0.125" aluminum tread plate floor

J. Double wall access doors will be provided on sections as shown on product drawings with single door handles.
1. Stainless steel hinges permit a 180° door swing.
2. Access door will be of the same material type as exterior/interior casing.
3. Access door latches will use a roller cam latching mechanism.

K. View ports will be double-pane tempered glass.

L. Primary and auxiliary drain pans will comply with the guidelines of ASHRAE 62.
1. Drain pans will be double sloped at least 1/8" per foot and have no horizontal surfaces.
2. Drain connection material will be the same as drain pan.
3. Drain pans will drain to one point.
4. Drain connections will be welded to drain pans
5. Drain pans will have at least 1" clearance between pan and coil supports.

M. Optional pipe chases will be furnished, as shown on drawings.
1. Pipe chases will be constructed in the same manner as units.
2. Pipe chase doors will be provided, as shown on drawings.
3. Pipe chases will have the same base rail options as units.

2.4 ROOF SYSTEM

A. Roof system outer layer

B. Shall have no points of penetration.

C. Shall use no fasteners.

D. Shall have no metal-to-metal seams joints.

E. Shall not use or require caulking.

F. Roof system shall be warranted by manufacturer against water penetration for a period of 10 years.

G. Roof system shall be sloped with a minimum pitch of 1/8" per foot.

H. Roof system shall overhang side and end panels by a minimum of 2."

I. Doors shall have drip edge guard above door frame. Drip edge guard shall extend 2" beyond door surface.

J. Field connection at roof of section splits shall not require use of fasteners, sealants or metal seam caps.

2.5 FANS

A. Fans will provide CFM and static pressure, as shown in performance specifications.

B. Fans will be Class I, II, or III, as required to meet selected RPM and horsepower shown in performance specifications.

C. Fans will be DWDI (housed) or SWSI (plenum), as shown on product drawings.

D. Fans will have forward curved or airfoil blades, as shown in performance specifications.

E. Airfoil fans will bear the AMCA Seal. Airfoil fan performance will be based on tests in accordance with AMCA standard 210 and will comply with the requirements of AMCA certified ratings programs for air and sound. Airfoil wheels will comply with AMCA standards 99-2408-69 and 99-2401-82.

F. Fans shafts will be polished steel and sized such that the first critical speed will be at least 125% of the maximum operating speed for the fan pressure class. Shaft will be coated with an anti-corrosion coating.

G. Fan and motor assembly will be internally mounted on a common base. Fan and motor base will be spring isolated on a full width isolator support channel.
   1. Fan motor will be on an adjustable base.
   2. Fan discharge will be connected to cabinet via a flexible connection.
   3. Access doors will be provided as shown on product drawing.

H. Fans will be plenum type, as manufactured by Twin City Fan & Blower. Fans will have a sharply rising pressure characteristic extending through the operating range and continuing to rise beyond the peak efficiency to ensure quiet and stable operation. Fans will have a non-overloading design with self-limiting horsepower characteristics and will reach a peak in the normal selection area.
   1. Blank off Panels — Each Multiple Fan section to be provided with one fan blankoff panel to enable manual isolation of fan for servicing.
   2. Fan Options — The following options will be available for multiple fans:
      a. Piezometer Ring: Airflow station will be factory installed in each fan inlet. Tubing will be manifolded so that the measurement is representative of all fans in the array. The device will have a measurement accuracy of ± 5%.
      b. Shaft Grounding Rings
      c. Fan Inlet Screen

2.6 BEARINGS AND DRIVES

A. Fan bearings will have average life (L50) of at least 200,000 hours. Bearing fatigue life ratings will comply with ANSI/AFBMA 9.

B. SWSI fans will be belt driven or direct driven, as shown on product drawings.

C. Fan drives will be selected for a 1.5 service factor and will be furnished with anti-static belts.
   1. Drives 15 hp or smaller on constant volume fans will be adjustable pitch.
   2. Drives 20 hp or larger or drives on fans with VFDs will be fixed pitch.
   3. Sheaves will be machined from close grain cast iron and statically balanced.
   4. Drive belts will be V type, precision molded, raw edge construction, anti-static, oil and heat resistant.

2.7 ELECTRICAL MOTORS

A. Fan motors will be built in accordance with the latest NEMA and IEEE standards.

B. Fan motors comply with ASHRAE Standard 90.1.

C. Fan motors will be furnished in sizes, electrical power and starting characteristics as shown in performance specifications.
   1. Fan motors will be rated for continuous, full load duty at 104°F (40°C) ambient temperature and 1.15 service factor.

a. Exception: 1.5 hp and 3 hp, dual voltage (230/460V), 900 RPM, TEFC motors will have a 1.0 service factor.

2. Fan motors will be NEMA design ball bearing type.
   a. Direct drive plenum fans will be coupled with motors that closely match required fan RPM.
3. Fan motors will be totally enclosed, fan cooled (TEFC)
4. Premium Efficiency Inverter ready per NEMA STD MG1 PART 31.4.4.2
5. Motors will be suitable for use with variable frequency drives, per NEMA MG-1 Part 30.

2.8 FAN VARIABLE FREQUENCY DRIVES

A. Variable frequency drives will be furnished (shipped loose) or provided (factory mounted and wired to motor) with units, as shown in submittal documents.

B. VFDs will be UL or ETL listed and comply with applicable provisions of the National Electric Code.

C. VFDs will be housed in a dedicated, weather resistant compartment.
   1. Shipped loose VFDs and VFDs provided on units without single point power will be housed in a NEMA 3R enclosure.
   2. Weatherproof compartments will be provided on units with single point power.

D. VFDs furnished or provided with units will be programmed and started by a Johnson Controls trained and employed technician.

E. VFD will include harmonic distortion feedback protection:
   1. Swinging DC Line Choke (equivalent to 5% input line reactor)
   2. Integral RFI/EMI filtering to meet EMC EN61800-3 for First Environment

F. User interface will include:
   1. 30 Character multi-lingual alphanumeric display
   2. Parameter set-up and operating data
   3. Display data includes:
      a. output frequency (Hz)
      b. speed (RPM)
      c. motor current
      d. calculated % motor torque
      e. calculated motor power (kW)
      f. DC bus voltage
      g. output voltage
      h. heat sink temperature
      i. elapsed time meter (re-settable)
      j. kWh (re-settable)
      k. input / output terminal monitor
      l. PID actual value (feedback) & error
      m. fault text
      n. warning text
      o. scalable process variable display

G. VFD protection circuits will include:
   1. over current
   2. ground fault
   3. over voltage
   4. under voltage
   5. over temperature
   6. input power loss of phase
   7. loss of reference/feedback
   8. adjustable current limit regulator

H. VFD will be UL 508C approved for electronic motor overload (12t).

I. VFD will include high input transient protection and surge suppression:
   1. 4 MOVs ahead of diode bridge
   2. 120 Joule rated 1600V diode module
   3. Compliant with UL 1449 / ANSI 61.4

J. VFD communication features include:
   1. Two programmable analog inputs
   2. Six programmable digital inputs
   3. Two programmable analog outputs
   4. Three programmable digital relay outputs
   5. Modbus RTU Communications protocol
   6. Adjustable filters on analog inputs and outputs
   7. Input speed signals, including 4-20 mA and 0-10 VDC
   8. Acceleration/Deceleration contacts (floating point control)
   9. Auto restart (customer selectable and adjustable)
   10. Start/Stop options will include 2 wire (dry contact closure), 3 wire (momentary contacts), application of input power, and application of reference signal (PID sleep/wake-up)
   11. Integrated control interface for Siemens FLN, Johnson N2, Modbus RTU, and BACnet MS/TP
      a. Optional LONworks over RS-485.

K. VFD will have the following functions:
   1. Premagnetization on start
   2. DC braking/hold at stop
   3. Ramp or coast to stop
   4. Seven preset speeds
   5. Three critical frequency lockout bands
   6. Start function will include ramp, flying start, automatic torque boost, and automatic torque boost with flying start

2.9 JOHNSON CONTROLS MANUFACTURED HEATING AND COOLING COILS

A. Johnson Controls manufactured coils described in this specification will not include:
   1. Electric Heat coils
   2. Integral face and bypass coils
   3. Heat pipe coils

B. Water, direct expansion (DX), and steam coil capacity and pressure drop performance will be certified in accordance with AHRI Standard 410, when selected within fluid velocity, inlet fluid temperature, and entering air temperature ranges specified by AHRI 410.

C. Cooling coil segments will have a full-width IAQ drain pan that extends at least 6" downstream of the last coil in the section.

D. Coils will be removable from the side of unit, via removable AHU panels. No more than one panel must be removed to remove a coil.

E. Coils will have frames constructed of galvanized steel (stainless steel for cooling coils). Casing channels will be free-draining and do not block fin area.

F. Cooling coils with finned height greater than 48" will have an intermediate drain pan with downspout to drain condensate to main drain pan. Intermediate drain pan material will match coil frame material.

G. Coil segment door clearances will allow for at least 2-inches of field installed piping insulation.

H. Coil bulkheads and blank-offs will prevent air from bypassing coils.

I. Coil segment casing to accommodate full-face or reduced-face coils will be provided. Provide face and bypass coil segments with factory installed bypass damper

J. Coil connections will be extended through unit casing.

K. Water and glycol coils will have a 1/4" FPT plugged vent or drain tap on each connection that is accessible from outside the unit.

L. Spool shaped coil grommets will be provided to insulate and seal coil penetrations.

M. Water and glycol coils will be designed to operate at 250 psig and up to 300° F and will be factory tested with 325 psig compressed air under water.

N. Direct expansion (DX) coils will conform to ANSI B9.1 (Safety Code for Mechanical Refrigeration) when operating with a refrigerant pressure not exceeding 250 psig. Coils will be factory tested with 325 psig compressed air under water. DX coils will be dehydrated and sealed prior to installation.

O. Steam distributing coils will be designed for operation at 50 psig pressure, and a corresponding saturated steam temperature of 298° F. Coils will be factory tested with 315 psig compressed air under water. Coils will be dehydrated and sealed prior to shipping.

P. DX coils will have brass distributor with solder-type connections. Suction and discharge connections will be on the same end. DX liquid lines will extend outside the unit.

Q. Water, glycol and DX coils tubes will be mandrel expanded to form fin bond and burnished, work-hardened interior surface.

R. Steam coil tubes will have outer tube outside diameter of 1" and inner distribution tube outside diameter of 5/8". Circuiting will be non-trapping, drainable, suitable for a gravity drain. Steam will discharge in direction of condensate flow to ensure even heat transfer across each tube.

S. Coil fins will be die-formed, continuous aluminum, and have fully drawn collars to accurately space fins, and form a protective sheath for tubes.

2.10 FILTERS

A. Filter segments will be provided, as shown on product drawings. Filter tracks/frames will be an integral part of the unit.

B. Filter media for Solution units delivered in the continental United States will not be shipped with units. Filters will be shipped to a customer defined location. Coordinate filter delivery with Johnson Controls sales representatives.

C. Filter types, nominal sizes, efficiencies, and performance characteristics will be as shown in performance specifications.

D. Filter access will be provided via access doors on filter segments or adjacent segments as required by filter loading scheme. See product drawings for details.

E. Flush mounted, factory installed differential pressure gauge on the drive side of unit to measure pressure drop across filters will be provided

2.11 DAMPERS

A. Dampers will be factory installed.

B. Dampers will have airfoil blades with extruded vinyl edge seals and flexible metal compressible jamb seals.

C. Dampers will have a maximum leakage rate of 4 CFM/square foot at 1" w.g. and comply with ASHRAE 90.1.

D. Maximum damper torque requirement will be 7 in. lbs./ft^2.

E. Damper blades will be opposed blade acting unless submitted otherwise.

F. Damper blades will be aluminum.

2.12 HUMIDIFIERS

A. Condair live steam humidifier complete with stainless-steel valve and actuator.

B. SAMe short absorption manifold with stainless steel insulated tubes

C. Casing/liner shall be stainless steel

D. IAQ stainless steel drain pan

2.13 UVC FIXTURES

A. Fixtures and controller shall be field mounted.

B. Fixtures have been tested, listed and labeled as UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards: 153, 1598 & 1995 respectively.

C. Fixtures meet the "UL" drip proof design and each fixture is equipped with an electrical interlock.

D. Each lamp contains no more than 5.5 milligrams of mercury consistent with current environmental practices while producing the specified output at 500 fpm in temperatures of 55-135° F.

E. Useful lamp life will be 9000 hours with no more than a 20% output loss at the end of one year of continuous use. They are constructed with UVC proof metal bases and will not produce ozone.

2.14 ROOF CURBS

A. Roof curbs will be furnished, as shown on product drawings.

B. Roof curbs will be galvanized steel and support the perimeter of units, including pipe chases.

C. Roof curbs will have a wood nailing strip.

D. Roof curbs will be shipped loose for installation prior to unit installation.

2.15 APPURTENANCES

A. Safety grates capable of supporting a 300 lb. center load will be provided over bottom openings, as shown in performance specifications.

B. Formed steel base rails suitable for rigging and lifting will be provided, as shown on product drawings.

C. Lifting lugs will be provided where required for proper lifting.

2.16 FINISHES

A. External unit surfaces will be factory cleaned prior to finishing or shipping.

B. Unit will be painted, as shown in performance specifications.
   1. Painted units will be prime-coated prior to painting.
   2. Paint will be acrylic polyurethane.
   3. Painted unit will exceed 500-hour salt spray test, with (5%) solution, without any sign of red rust when tested in accordance with ASTM B-117.

C. Unpainted air-handling units constructed of galvanized steel will pass the ASTM B-117 test for 220-hour salt spray solution (5%) without any sign of red rust.

2.17 TESTS AND INSPECTIONS

A. Fan skid will be run-balanced at specified speed to insure smooth, operation.

1. Constant volume fan assemblies will be balanced at design RPM.
2. Variable volume fan assemblies will be balanced from 10% to 100% of design RPM.
3. Filter-in measurements will be taken in horizontal and vertical axes on drive and opposite-drive sides of fan shafts.
4. Constant speed fan vibration limits: filter-in measurements will not exceed 4 mils.
5. Variable speed fan vibration limits: filter -in measurements will not exceed 7 mils.

B. Unit wiring with voltage greater than 30VAC will be hipot tested prior to shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

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

3.2 INSTALLATION

A. Equipment Mounting:
1. Comply with requirements for vibration isolation control devices specified in Section 230548 "Vibration Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.3 CONNECTIONS

A. Install condensate drain, connection size shall be at least the same size as the nipple on the drain pain (3/4" minimum), with trap and indirect connection to receptor as indicated on floor plans, drain to nearest roof drain or area drain.

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

C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.

3.4 FIELD QUALITY CONTROL

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

B. 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. Report results in writing.

C. Tests and Inspections:
   1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
   1. Inspect for visible damage to unit casing.
   2. Inspect for visible damage to furnace combustion chamber.
   3. Inspect for visible damage to compressor, coils, and fans.
   4. Inspect internal insulation.
   5. Verify that labels are clearly visible.
   6. Verify that clearances have been provided for servicing.
   7. Verify that controls are connected and operable.
   8. Verify that filters are installed.
   9. Clean condenser coil and inspect for construction debris.
   10. Remove packing from vibration isolators.
   11. Verify lubrication on fan and motor bearings.
   12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
   13. Adjust fan belts to proper alignment and tension.
   14. Start unit according to manufacturer's written instructions.
      a. Start refrigeration system.
      b. Do not operate below recommended low-ambient temperature.
      c. Complete startup sheets and attach copy with Contractor's startup report.
   15. Inspect and record performance of interlocks and protective devices; verify sequences.
   16. Operate unit for an initial period as recommended or required by manufacturer.
   17. Calibrate thermostats.
   18. Adjust and inspect high-temperature limits.
   19. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
   20. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F (8 deg C) above return-air temperature:
      a. Coil leaving-air, dry- and wet-bulb temperatures.
      b. Coil entering-air, dry- and wet-bulb temperatures.
      c. Outdoor-air, dry-bulb temperature.
      d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
   21. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
   22. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
      a. Supply-air volume.

b. Return-air volume.
c. Relief-air volume.
d. Outdoor-air intake volume.

23. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
24. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
    a. High-temperature limit on gas-fired heat exchanger.
    b. Low-temperature safety operation.
    c. Filter high-pressure differential alarm.
    d. Economizer to minimum outdoor-air changeover.
    e. Relief-air fan operation.
    f. Smoke and firestat alarms.
25. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Section 017900 "Demonstration and Training."

END OF SECTION

SECTION 23 81 23
COMPUTER-ROOM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes air conditioning units, controls and control panels.

B. Related Documents:
   1. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 specification sections, apply to this section and the other sections of this Division.
   2. Other sections of this Division, and of other Division, may contain requirements that relate to this section.

1.2 REFERENCES

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

B. American Society of Mechanical Engineers:
   1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

C. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Product Data: Submit manufacturers literature and data indicating [water,] drain, [refrigeration,] and electrical characteristics and connection requirements.

B. Manufacturer's Installation Instructions: Submit procedures for rigging and making service connections.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. Manufacturer's Field Reports: Indicate conditions at initial start-up including date, and initial set points.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum oneweek prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept computer room units on site in factory packing. Inspect for damage.

B. Protect units from damage by storing away from computer room until floor and ceiling are installed.

1.8 WARRANTY

A. Furnish five year manufacturer's warranty for entire unit.

1.9 MAINTENANCE SERVICE

A. Furnish service and maintenance of units for one years from Date of Substantial Completion.

B. Examine unit components monthly. Clean, adjust, and lubricate equipment.

C. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

D. Perform work without removing units from service during building normal occupied hours.

E. Provide emergency call back service at all hours for this maintenance period.

F. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

G. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.

H. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.10 EXTRA MATERIALS

A. Furnish one set of filters for each unit.

PART 2 - PRODUCTS

2.1 FLOOR OR CEILING MOUNTED AIR CONDITIONING UNITS

A. Manufacturers:
   1. Liebert.

B. Product Description: Packaged, air cooled, factory assembled, pre-wired and pre-piped unit, consisting of cabinet, fans filters, humidifier and controls, reheat and heating coils.

C. Cabinet and Frame:
   1. Structural Frame: 14 gage (1.8 mm) welded steel suitably braced for rigidity, capable of supporting compressors and other mechanical equipment and fittings with welded tubular steel floor stand with adjustable legs and vibration isolation pads.
   2. Doors and Access Panels: 18 gage (1.2 mm) [galvanized] steel with polyurethane gaskets, hinges to allow removal of panels, and concealed fastening devices.
   3. Finish of Exterior Surfaces: Baked-on textured vinyl enamel; to match computer equipment.

D. Evaporator Fans and Motors:
   1. Fans: Double inlet, forward curved centrifugal fans, statically and dynamically balanced.
   2. Motor: Drip proof, permanently lubricated ball bearing motor with built-in current and overload protection.
   3. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed, variable and adjustable pitch motor sheave, minimum of two matched belts, drive rated minimum 2.0 times nameplate rating of motor.

E. Compressors:

1. Type: Hermetic with resilient suspension system, oil strainer, crankcase sight glass, internal motor protection, low pressure switch, manual reset high pressure switch.
2. Compressors: Individually serviceable without dismantling other components.
3. Refrigeration Circuits: Two, each with hot gas mufflers, thermal expansion valve with external equalizer, liquid line solenoid valve, liquid line filter-drier, refrigerant sight glass with moisture indicator, service shut-off valves and charging valves and accumulator sized for liquid seal under light load.

F. Evaporator Coils:
1. Alternate row circuits, direct expansion cooling coils of seamless copper tubes expanded into aluminum fins.
2. Mount coil assembly in stainless steel drain pan.

G. Condensers:
1. Air Cooled: Corrosion resistant cabinet, copper tube aluminum fin coils arranged for two circuits, multiple direct drive propeller fans with [permanently lubricated ball bearing] single phase motors with internal overload protection. Furnish capacity control by cycling fans and modulating one fan.

H. Filters:
1. See Drawings.

I. Refrigerant Reheat Coil:
1. Hot gas refrigerant coil of seamless copper tubes expanded into aluminum fins with three-way solenoid valve on first stage refrigerant circuit.

J. Reheat/heating Coils:
1. Heating Coils: Enclosed fin electrical elements arranged for minimum of two stages.
2. Circuit Protection: Primary and secondary thermal cutouts, differential air pressure switch, and manual reset overload protection and branch circuit overcurrent protection.

K. Humidifier:
1. Infrared Type: High intensity quartz lamps mounted above stainless steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; pre-piped and utilizing condensate water from cooling coils with stainless steel or brass float valve mechanism; located in bypass air stream; with flush cycle timer and solenoid drain valve.

L. Control Cabinet: NEMA 250; Type 2 enclosure, UL listed, with piano hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control circuit transformer.

M. Disconnect Switch: Non-automatic molded case circuit breaker with handle accessible with panel closed.

N. Electronic Control System:
1. Solid state with start button, stop button, temporary loss of power indicator, manual reset circuit breakers, temperature control humidity control, and monitor panel.
2. Monitor Panel: Back lighted with no visible indicator lights until operating function is activated; indicators include cooling, humidification, loss of air flow, change filters, high temperature, low temperature, high humidity, low humidity, high head pressure (each compressor), and low suction pressure (each compressor).
3. 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 indicate mode of operation.
4. Location: Through hinged door in front of unit; isolated from conditioned air stream to allow service while system is operating.

O. Microprocessor Control System:
   1. Logic Circuitry: Microprocessor continuously monitors operation of process cooling system; continuously displays room temperature and room relative humidity; sounds alarm on system malfunction and simultaneously displays problem. When more than one malfunction occurs, display fault in sequence with room temperature, capability of remembering alarm even when malfunction is cleared, and continue to display fault until reset.
   2. Malfunctions:
      a. Power Loss.
      b. Loss of Air Flow.
      c. Clogged Air Filter.
      d. High Room Temperature.
      e. Low Room Temperature.
      f. High Humidity.
      g. Low Humidity.
      h. [Smoke/Fire.]
      i. Compressor No. 1 - Overload.
      j. Compressor No. 1 - Low Pressure.
      k. Compressor No. 1 - High Pressure.
      l. Compressor No. 2 - Overload.
      m. Compressor No. 2 - Low Pressure.
      n. Compressor No. 2 - High Pressure.
      o. Supply Fan Overload.
   3. Light Emitting Diodes Display: Control Power On, System On, Humidification, De-humidification taking place, Compressor No. 1 operating, Compressor No. 2 operating, Heat or Reheat operating, Economy Cooling.
   4. Push Buttons: To STOP process cooling system, START process cooling system, SILENCE audible alarm, push-to-test LED indicators, and display room relative humidity.
   5. Remote Signaling: Furnish termination for remote signaling of system status and alarms.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify ceiling system is ready to receive work and opening dimensions are as indicated on shop drawings.

3.2 INSTALLATION

A. Coordinate installation of computer room air conditioning units with computer room raised floor.

B. Coordinate installation of air conditioning unit with computer room ceiling.

C. Install drainage piping connections for and humidifier flushing system.

D. Install hot water heating piping connections to reheat coils. Install shut-off valves in hot water heating inlet and outlet piping.

E. Install steam piping connections to steam heating coils. Install shut-off valves in steam supply piping and in condensate outlet piping. Install steam trap in condensate outlet piping.

F. Install refrigerant piping connections to air-cooled condensing units.

G. Install accessories furnished loose for field mounting.

H. Install electrical devices furnished loose for field mounting.

I. Install control wiring between control panel and field mounted control devices.

J. Provide connection to electrical service.

3.3 FIELD QUALITY CONTROL

A. Test and record for maintenance of room conditions over continuous 24-hour period.

B. Adjust and balance and repeat test when necessary to demonstrate compliance with performance.

3.4 MANUFACTURER'S FIELD SERVICES

A. Furnish services of factory trained representative for minimum of one days to start-up, calibrate controls, and instruct Owner on operation and maintenance.

B. Set initial temperature and humidity set points.

3.5 DEMONSTRATION

A. Demonstrate system operations and verify specified performance.

B. Demonstrate alarm conditions.

END OF SECTION

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 GENERAL CONDITIONS:

A. The General Conditions, Supplementary General Conditions, General Requirements, and Special Conditions shall be and are hereby made a part of this Section of the specifications.

B. In case of conflicts between the electrical drawings and Division 26 of these specifications, the more stringent requirements shall govern. In all cases, notify the Engineer for direction.

C. The requirements of COMMON WORK RESULTS FOR ELECTRICAL establish minimum requirements, apply to, and are hereby made a part of all sections of Division 26, 27, and 28 of this specification.

D. The Contractor shall be responsible for excavation of all earth, soil, and rock conditions at the site. Review the elevations and soil boring logs and include all associated costs.

1.2 DESCRIPTION:

A. The electrical work shall include all labor, materials, tools, transportation, equipment, services and facilities, required for the complete, proper and substantial installation of all electrical work shown on the plans, and/or outlined in these specifications. The installation shall include all materials, appliances, and apparatus not specifically mentioned herein or noted on the drawings but which are necessary to make a complete working installation of all electrical systems.

B. All of the electrical related work required for this project (unless specified otherwise) is a part of the Electrical Contract price but is not necessarily specified under this division of the specifications or shown on the electrical drawings. Therefore, all divisions of the specifications and all drawings shall be consulted.

C. The plan drawings are schematic only and are not intended to show the exact routing of raceway systems unless dimensions are noted on the drawings. Final routing will be governed by field conditions (structural members, mechanical equipment, ductwork, underground piping, duct banks, etc.) and shall be determined by the Contractor and approved by the Architect. Any changes in routing shall not change the design of the raceway system.

D. The plan drawings showing device and equipment locations are schematic only and are not intended to show exact locations unless dimensions are noted on the drawings. The Contractor shall review all contract drawings that may affect the location of devices and equipment to avoid possible interference and permit full coordination of all work. The right to make any reasonable change in location within 6'-0", is reserved by the Architect up until the time of rough-in at no extra cost.

E. Furnish and install electrical wiring, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings of transformers, cable, switchgear, panelboards, motor control, and other items, arrangement for specified items in general are shown on drawings.

F. Ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized.

1.3 MINIMUM REQUIREMENTS:

A. Codes Rules and Regulations: Execute all work under ADA, the latest rules and regulations of the National Electrical Code (NEC), the National Fire Protection Association, and with all laws, regulations and ordinances of the County, State, City, and the Utility Company.

B. Codes shall govern in case of any direct conflict between codes, plans and specifications; except when plans and specifications require higher standards than those required by

code. Variance from the plan and specifications made to comply with code must be approved by the Architect. If approved they shall be made with no increased cost to the Owner.

1.4 STANDARDS:

A. All material and equipment shall be listed, labeled or certified by UL LLC, where such standards have been established. Equipment and material which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.

B. Definitions:

1. Certified: Equipment is "certified" if:

a. Equipment has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards, or to be safe for use in a specified manner.

b. Production is periodically inspected by a nationally recognized testing laboratory.

c. It bears a label, tag, or other record of certification.

2. Nationally recognized testing laboratory: A testing laboratory, which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

1.5 QUALIFICATIONS (PRODUCTS AND SERVICES):

A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.

B. Product Qualification:

1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.

2. The Engineer reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will respond within two hours of receipt of notification that service is needed. Submit name and address of service organization.

1.6 MANUFACTURED PRODUCTS:

A. Materials and equipment furnished shall be new, of best quality and design, free from defects, of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts should be available. All items used on this project shall be free of asbestos, PCB, and mercury material.

B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:

1. Components of an assembled unit need not be products of the same manufacturer unless indicated otherwise.

2. Manufacturers of equipment assemblies, which include components made by others, shall be completely responsible for the final assembled unit.

3. Components shall be compatible with each other and with the total assembly for the intended service.

4. Constituent parts which are similar shall be the product of a single manufacturer.

D. Factory and Field wiring shall be identified on the equipment being furnished and on all wiring diagrams.

E. When Factory Testing is Specified:

1. The Engineer shall have the option of witnessing factory tests. The Contractor shall notify the Engineer a minimum of 15 working days prior to the manufacturer making the factory tests.

2. Four copies of certified test reports containing all test data shall be furnished to the Engineer prior to final inspection and not more than 90 days after completion of the tests.

3. When equipment fails to meet factory test and reinspection is required, the Contractor shall be liable for all additional expenses, including expenses of the Engineer.

1.7 EQUIPMENT PROTECTION:

A. Equipment and material shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain.

B. During installation, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter and be vacuum cleaned both inside and outside before testing, operating and painting.

C. Damaged equipment shall be, as determined by the Engineer, placed in satisfactory operating condition or be returned to the source of supply for repair or replacement.

D. Painted surfaces shall be protected with factory installed removable heavy Kraft paper, sheet vinyl or equal.

E. Damaged paint on equipment and materials shall be restored to the original quality of paint and workmanship as used by the manufacturer so repaired area is not obvious.

1.8 GENERAL WORK REQUIREMENTS:

A. Arrange, phase and perform work to assure electrical service both temporary and permanent for buildings at all times.

B. Coordinate location of equipment and conduit with other trades to minimize interferences.

C. Examination of Site:

1. Visit the site, inspect the existing conditions and check the drawings and specifications so as to be fully informed of the requirements for completion of the work.

2. Lack of such information shall not justify an extra to the contract price.

D. Permits:

1. Obtain and pay for all licenses and permits, fees, inspection and certificates required for the execution of this work.

2. Pay fees and charges for connection to outside services and use of property.

3. Deliver permits and certificates to the Architect to be transmitted to the Owner.

E. Services:

1. This Contractor shall pay for all expenses, deposits, reimbursements, etc., required by the local rules and codes for the service to the buildings, complete and ready for use. See plot plan.

F. Responsibility:

1. This Contractor will be held responsible for any and all damage to any part of the building or to the work of other contractors, as may be caused through this contractor's operation.

2. Any mutilation of building finishes or equipment initiated by electrical construction shall be properly corrected by the respective finishing contractor and paid for by the Electrical Contractor.
3. The operation of the temporary power and the permanent electrical system shall be the responsibility of this Contractor until acceptance of the building by the Owner.

G. Work to be done by General Contractor:

1. Build in all openings, sleeves, chases, etc., for conduit and equipment as established, furnished and set by this Contractor. The General Contractor shall seal or grout all openings after this Contractor has installed the conduits.
2. Build in bolts, brackets, hangers etc., for work established, furnished and set by this Contractor.
3. All concrete work required for equipment furnished and set by this Contractor including clean up pads under electrical gear, fixture bases, transformer bases, etc.
4. Painting: All painting of electrical equipment installed in finished areas shall be done by the General Contractor. Painting will not be required on receptacles, switches, circuit breakers etc. All fixtures and exterior poles specified to be factory-primed shall be painted by General Contractor. Paint all wiremold, exposed conduit and equipment, etc., to match final wall colors.
5. Provide fireproofing above fixtures located in fire rated ceilings per U.L. requirements.
6. Pay all utility costs for operation of electrical system during construction until acceptance of building by the Owner.

H. Work done by the Mechanical Contractor:

1. The Mechanical Contractor shall furnish wiring diagrams and temperature control drawings of all equipment furnished to the Electrical Contractor. (Catalog information is unacceptable, provide point to point drawings.)
2. The Mechanical Contractor shall furnish and install all control equipment requiring connections to air, water, steam, etc., such as pneumatic electric relays, remote bulb temperature controls, solenoid valves, aquastats and pressure controls.
3. The Mechanical Contractor shall reimburse the Electrical Contractor for any changes in system design i.e., control or equipment which affects the Electrical Contractor. Also refer to equipment connections, controls and instrumentation in 260500.

I. Workmanship and Coordination:

1. Make installation substantially as shown on the plans.
2. Make alterations in location of apparatus or conduit as may be required to conform to building construction without extra charge.
3. Mechanical equipment service clearances and electrical apparatus service clearances as specified in their respective manufacturer's product data shall be maintained free from conduit.
4. Cooperate with other trades in their installation of work.
5. Complete the installation in a workmanlike manner, completely connected and ready to give proper and continuous service.
6. Use only experienced licensed electricians.

J. Cutting and Patching:

1. Notify the General Contractor in ample time, of the location of all chases, sleeves, and other openings required in connection with the work of this contract.

2. Cutting and patching made necessary because of failure to comply with the above shall be done by the General Contractor at the expense of the Electrical Contractor.
3. When it is necessary for the Electrical Contractor to cut building materials, it shall be done in a neat and workmanlike manner meeting with the approval of the Architect.
4. Holes through concrete shall be carefully drilled with a "Concrete Termite" drill. A Star Drill or Air Hammer will not be permitted. Structural members shall not be cut without approval from the Architect.
5. Any penetrations thru the roof shall be made with "Stoneman" 900 Series flashing connections as manufactured by Elmdor/Stoneman, City of Industry, California, or as approved by the Architect.
6. Any penetrations made in exterior or basement foundation walls shall be sealed with Thunderline "Link-Seal" connections, as manufactured by Thunderline Corporation, Wayne, Michigan.

K. Manufacturer's Instructions:

1. Apply, install, connect, erect, use, clean, and condition articles, materials and equipment as directed by the manufacturer.

1.9 EQUIPMENT INSTALLATION AND REQUIREMENTS:

A. Equipment location shall be as close as practical to locations shown on the drawings.

B. Working spaces shall not be less than specified in the National Electrical Code for all voltages specified.

C. Inaccessible Equipment:

1. Where the Engineer determines that the Contractor has installed equipment without proper clearances or not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled as directed at no additional cost to the Owner.
   a. Install access panels as approved by the Architect to provide access to all equipment, J-boxes and outlets located in non-accessible spaces. Panels shall be flush locking type with a fire rating equal to the ceiling system.
2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and ductwork. Outlet and box covers shall be removable by using regular length (8") screw drivers.

D. Distribution Equipment:

1. All items of Electrical Distribution Equipment (switchboards - panelboards - disconnects) shall be of one manufacturer, unless specifically noted on the drawings, in the specifications, or approved by the Engineer. Intermixing of distribution equipment by different manufacturers will not be permitted.
2. Equipment layouts on the drawings are based on one manufacturer. Verify all actual equipment sizes with equipment manufacturer prior to bidding.
3. If layout changes are required due to differing electrical manufacturer's equipment size, they must be submitted to and approved by the Engineer. National Electric Code working clearances must be maintained at all times. Extra remuneration will not be allowed for layout changes that differ from those shown.
4. Provide and install all steel supports as required for mounting of electrical equipment.

5. Anchor all free standing electrical equipment including switchboards, switchgear, substations, motor control centers, paralleling gear, transfer switches, transformers, etc. to the floor with plated, 1/2" diameter minimum, anchor bolts or as recommended by the manufacturer.

1.10 EQUIPMENT CONNECTIONS, CONTROLS AND INSTRUMENTATION:

A. General: The following applies to all electrical power and control connections for all equipment requiring electrical installation work provided by others.

B. Electrical Contractor shall install and connect the following items for equipment requiring electrical power that is either furnished or specified by other Contractors and/or the Owner. Where these required items are not furnished with the equipment being connected, it shall be the Electrical Contractors responsibility to provide the necessary items including conduit, boxes and wiring.

1. Starters
2. Disconnecting Devices
3. Thermal Overload Devices
4. Overcurrent Devices
5. Short Circuit Protective Devices
6. Voltage Transformation Equipment
7. Control Devices (Local and Remote)
8. Audible and Visual Control Status Annunciation Devices
9. Equipment Mounting Structures
10. Additional Miscellaneous Devices

C. In general, all major equipment will be specified to be factory prewired with only service and interconnecting wiring required at the site by the electrical contractor; however, the Electrical Contractor shall check all divisions of the specification to verify if the equipment is specified factory prewired and if not, then it shall be the responsibility of the Electrical Contractor to provide the complete wiring of the equipment in accordance with wiring diagrams provided by other contractors and/or Owner to the Electrical Contractor. All interconnecting of equipment shall be by the Electrical Contractor.

D. All line and low voltage wiring and connections required to control the equipment are a part of this section and shall be provided by the Electrical Contractor. Mechanical controls are to be provided by a Temperature Controls Contractor (TCC). Low voltage control wiring and associated conduit for the controls system shall be provided and installed by the TCC. Terminations will be made by the TCC. All line and low voltage wiring shall be in conduit.

E. The Electrical Contractor shall provide 120 volt control power supply; #12 Ga. CU. THHN/THWN in 1/2"C. minimum at all points required by controls, instrumentation and sprinkler risers. Circuit as shown on the plans or to the nearest 120 volt panel if no circuiting is indicated. Use spare 20 Amp. breakers. Each control panel shall be on a separate circuit unless otherwise indicated. If the controlled equipment is fed from the emergency system, then the control power supply must feed from the emergency system.

F. The Contractor shall become familiar with the equipment to be furnished by the other Contractors and/or the Owner in connection with this work and include provisions for such connections and work in the Contractor's price. Extra remuneration will not be allowed for such work.

G. Connections to all equipment have been designed from units as specified on the drawings or in the specifications. In the event equipment or control differs on approved shop drawings it shall be the responsibility of the Supplying Contractor to coordinate electrical connections to the units and reimburse Electrical Contractor for any changes in system design. These changes shall not involve additional cost to the Owner.

H. Review all plans and specifications to verify all equipment connections that are required by mechanical and/or other contractors. Although the electrical drawings will show equipment connection requirements, it is the Electrical Contractor's responsibility to connect all equipment furnished by other Contractor's at no extra cost to the Owner, even if this equipment connection is not shown on the electrical drawings. Coordinate all required connections not shown on the electrical drawings with the Engineer.

1.11 NAMEPLATES:

A. General: The following items shall be equipped with nameplates:

1. Disconnect switches (fused or nonfused), transformers, switchgear and switchboards (including branch circuit breakers/switches), panelboards, separately mounted circuit breakers, starters, contactors, relays, junction boxes and pull boxes.

B. Inscription: Nameplates shall adequately describe the function or use of the particular equipment involved. Nameplates for panelboards and switchboards shall include the panel designation, voltage, and phase, A.I.C. rating of the supply (see schedules, one-line diagram, and color coding). For example, "Panel A" 120/208 V, 3-Phase, 4-Wire, 10,000 A.I.C. or "50,000 AIC with 22 KA Breakers, Series with class 'J' Fuses":

1. Phase A - Black
2. Phase B - Red
3. Phase C - Blue
4. Neutral - White
5. Ground - Green

C. The name used for a machine nameplate shall be the same as the one used on the machine's motor starter, disconnect and P.B. station nameplates. Nameplates for fused switches and panels shall also indicate fuse type and size.

1. In addition to the instructions listed above:
   a. All panelboards and transfer switches fed from the critical branch shall be labeled "Critical Branch".
   b. All panelboards and transfer switches fed from the life safety branch shall be labeled "Life Safety".
   c. All panelboards and transfer switches fed from the equipment branch shall be labeled "Equipment".
   d. All panelboards and transfer switches fed from the standby system shall be labeled "Standby System".

D. Construction:

1. Nameplates shall be as follows:
   a. Normal power - laminated phenolic plastic white front and back with black core.
   a. Critical Branch - laminated phenolic plastic orange front and back with white core.
   b. Life Safety Branch - laminated phenolic plastic yellow front and back with black core.
   c. Equipment Branch - laminated phenolic plastic green front and back with white core.
   d. Standby Power - laminated phenolic plastic blue front and back with white core.
2. Lettering shall be engraved through front layer to form 1/4" characters. Nameplates shall be securely fastened to the equipment to be identified, with No. 4 Phillips,

round head, cadmium plated, steel self-tapping screws or nickel-plated brass bolts. Motor nameplate may be nonferrous metal not less than 0.03 inches thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable. Letters engraved thus, shall be filled with contrasting enamel. All nameplates and their installation are part of this work. Free hand lettering or dymo label marker will not be acceptable.

1.12 MATERIALS OF APPROVED EQUAL:

A. Where items of equipment and/or materials are specifically identified herein by a manufacturer's name, model or catalog number, and only such specific items may be used in the base bid, except as hereinafter provided.

B. Unless requests for changes in base bid specifications are received, approved and noted by written addendum prior to the opening of bids, the successful contractor will be held to furnish specified items.

C. After contract is awarded, changes in specifications shall be made only as defined under "Substitution of Equipment".

1.13 SUBSTITUTION OF EQUIPMENT:

A. After execution of the contract, substitution of equipment of makes other than those specifically named in the contract documents, may be approved by the Engineer, only if the equipment named in the specifications cannot be delivered to the job in time to complete the work in proper sequence and due to conditions beyond control of the Contractor. Provide documentary proof in writing from the manufacturer that the specified equipment will not be available in time. If the Contractor is responsible for the delay, the substitution will not be approved.

B. Requests for substitutions must be accompanied by documentary proof of equality or difference in price and delivery, if any, in form of certified quotations from suppliers of both specified and proposed equipment.

1.14 SUBMITTALS: IN ACCORDANCE WITH SECTION SAMPLES AND SHOP DRAWINGS, FURNISH THE FOLLOWING:

A. The Engineer's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.

B. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Engineer to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.

C. Submittals shall be complete and submitted together for each section. Individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assemble as a whole. Partial submittals will not be considered for approval.

1. Mark the submittals, "SUBMITTED UNDER SECTION_____". Mark out all statements on sheets that do not apply otherwise. The Engineer may select options and equipment not originally specified. All options that are not marked out will be assumed that the Contractor will furnish the same.

2. Submittals shall be marked to show specification reference including the section and paragraph numbers.

3. Submit each section separately.

4. Mark catalog cuts to indicate equipment, capacities, finishes, sizes, etc. Each individual item shall have its own sheet provided for approval. (Example: Separate sheets for each panelboard.)

D. The submittals shall include the following:

1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
2. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
4. Quantities of materials will not be verified by the Architect or Engineer. Approval stamp on shop drawings does not constitute approval of quantities listed on shop drawings.
5. Shop drawings:
    a. All shop drawings shall be checked and signed by this contractor and general contractor prior to submittal to the Architect/Engineer.
    b. Shop drawings submitted without Contractor's signatures or approval and verification will not be approved.
    c. Shop drawings shall be submitted on devices, lighting fixtures (including distribution curves), motor starters, panelboards, disconnects, transformers, low-voltage systems, etc.
6. Each sheet shall be either 8 1/2" x 11"; 8 1/2" x 13"; or 11" x 17" bond with a 5" x 3" clear area for engineer's stamp. (This area shall not be used by this contractor or the general contractor's stamp.) Larger drawings shall be able to be blue printed.
7. Submittals for low-voltage systems (fire alarm, security, PA, controls, sound, clock, nurses' call, intercom, etc.) shall include complete riser diagrams showing all conductors and conduit sizes.

E. Engineer's acceptance of Compliance Submittals will not relieve the Contractor from his responsibility for any deviations from the requirements of the contract documents, unless Contractor has in writing called Engineer's attention to such deviation at the time of submission and the Engineer has given written approval to the specific deviation; nor shall any acceptance by Engineer relieve Contractor from responsibility for errors or omissions in Compliance Submittals.

F. Quantity of Submittals: See the general specification sections.

1.15 ELECTRICAL WORK COMPLETION:

A. Before requesting final inspection the following work must be completed.

B. Operating Instructions:

1. The Contractor shall submit along with the shop drawings of the equipment, three (3) copies of operating instructions for all items. Instructions shall be prepared by the manufacturer of the equipment.
2. After the operating instructions have been approved by the Engineer, the Contractor shall include the three (3) copies in maintenance instructions brochures.
3. The Contractor shall also obtain all manufacturers' instructions, manuals, and one complete set of drawings and turn these over to the Architect at the completion of the project.
4. The Contractor shall keep in a safe place; all keys and special wrenches furnished with equipment under this contract and shall give same to the Architect at the completion of the project.

5. The Contractor shall prepare a complete brochure, in triplicate, covering all systems and equipment furnished and installed under his contract. Brochures shall be submitted to the Architect-Engineer for approval and delivery to the Owner. The cost of this brochure shall be included in the contract cost. Brochures shall contain the following:
   a. Certified equipment drawings and/or catalog data clearly marked for equipment furnished as required for approval submission under detailed section of the specifications.
   b. Complete operating and maintenance instructions for each item of equipment.
   c. Complete part list for each equipment item.
   d. Any special emergency operating instructions or a list of service organizations (including addresses and telephone numbers) capable of rendering emergency service to the various parts of the system.
6. Brochures shall be bound in hard backed three ring binders with an index, sub dividers and reinforced sheets.
   a. Project name and address.
   b. Section of work covered by brochure, i.e., "Electrical Work".
   c. Name and address of Architect.
   d. Name and address of Engineer.
   e. Name and address of Contractor.
   f. Telephone number of Contractor, including night or emergency number.
7. In addition to these written instructions, each respective Contractor shall fully and carefully instruct the Owner, or Owner's selected representatives, as to the proper operation, care and maintenance of each system and its equipment.

1.16 TESTING AND ADJUSTMENT:

A. Record loads on each phase of all panelboards, distribution panels, switchboards, transformers and submit final readings to the Architect for records. This Contractor shall adjust equipment, instruments, gages, meters etc., as required to test and adjust these systems.

B. Check, test, and adjust the mechanisms of all electrical equipment and adjustable parts of lighting fixtures as required for optimum performance.

C. Perform tests for insulation resistance in accordance with the requirements of the National Electrical Code and insure that all circuits are free from short circuits.

D. Keep a calibrated voltmeter and ammeter available at all times and provides service for test readings when and as required, up until the project is accepted by the Owner.

E. Electrical Testing and Verification: Refer to the following specification sections (as applicable) for required tests and verifications:
   1. 260519 – Low Voltage Electrical Power Conductors and Cables
   2. 260526 – Grounding and Bonding for Electrical Systems
   3. 260527 – Isolation and Equal Potential Grounding
   4. 262200 – Low Voltage Transformers
   5. 262416 – Panelboards
   6. 262726 – Wiring Devices
   7. 271500 – Communications Horizontal Cabling
   8. 283100 – Fire Alarm – Addressable

1.17 AS-BUILT DRAWINGS:

A. Show on black or blue line prints in red ink all changes from original plans made during the installation. Return two (2) sets of red marked drawings, specifications and addenda, as set forth in the General Conditions, to the Architect upon completion of the project.

1.18 FINAL INSPECTION:

A. Final inspection will be made upon written request from the General contractor after the project is completed; in accordance with the Supplementary General Conditions.

B. Furnish a workman familiar with this project to accompany the Engineer on final inspection and have available ladders, drop cords, and other equipment as required to gain access to any portion of this system.

C. This Contractor and his principal subcontractors shall be represented at the inspection by a person of authority responsible to demonstrate to the engineer that his work conforms to the intent of the plans and specifications.

D. Extra inspections made necessary by the Electrical Contractor's failure to comply with the conditions as set forth above shall be charged to the Contractor for the Inspector's time both on the job and spent in travel between the office and the project site.

1.19 GUARANTEE:

A. Guarantee all work, material and equipment for a period of one year after date of substantial completion.

B. During the one year guarantee period the Electrical Contractor shall be responsible for any defects which develop in the electrical systems. Upon notification of a defect by the General Contractor the Electrical Contractor shall make immediate effort to correct it and shall notify the Architect when this work is completed. This guarantee does not include ordinary lamp failure.

C. Repairs and/or replacements shall be made with no cost to Owner.

D. Provide as part of the work of this contract, in addition to the first year's guarantee on equipment and materials, the following routine maintenance and inspection. (The one year time period will not start until each item is completed in accordance with plans and specifications and accepted by the Owner). Correct and adjust all emergency systems, controls, fire alarm, transformer, etc. This service to be provided throughout the guarantee period.

1.20 SINGULAR NUMBER:

A. Where any device or part of equipment is referred to in these specifications in the singular number (such as "the switch"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.21 LOW-VOLTAGE SYSTEMS:

A. Equipment and wiring for special systems shall be as shown in the following schedule:

SYSTEM	EQUIPMENT FURNISHED BY	EQUIPMENT INSTALLED BY	WIRING FURNISHED AND INSTALLED BY
Voice/Data	Contractor	Contractor	Contractor
Public Address	Contractor	Contractor	Contractor
Nurse Call	Contractor	Contractor	Contractor
Code Blue	Contractor	Contractor	Contractor

Fire Alarm	Contractor	Contractor	Contractor

B. Power wiring for low-voltage systems shall be furnished and installed by the contractor as shown on the drawings and as required by the equipment manufacturer.

C. Low voltage outlets shall be installed as shown on the drawings and shall be as specified for voice outlets, hereinbefore, or as otherwise shown or required by the application or by the equipment manufacturer.

D. Nurse call, code blue, medical gas, and fire alarm systems shall be completely installed in separate conduit systems. All cable for these systems shall be in conduit and shall not be combined with any other system cable. Conduits systems shall be furnished and installed by the Electrical Contractor.

E. Conduit for low-voltage systems other than nurse call, code blue, medical gas, and fire alarm shall be limited to the following and shall be furnished and installed by the Electrical Contractor.

1. Conduit in walls, from outlets to accessible ceilings, terminated with open end bushing above ceiling.
2. Conduits between floors, terminated with open end bushings.
3. Conduits across fire and/or smoke walls, terminated with open end bushings, and sealed with approved fire rated material.
4. Other conduits as shown on drawings.

F. Conduits shall be sized as required by the number and type of conductors applied and/or as noted on plans (minimum 1") and shall be not smaller than sizes recommended by the equipment manufacturer. All conduits shall be labeled to identify which system it is to be used for i.e.: Fire Alarm, Nurse Call, Code Blue, P.A. etc.

G. When ceiling voids are used as air return plenums, only U.L. Listed plenum cable shall be used or cables shall be completely routed in conduit.

H. All low voltage wiring installed in ceiling voids shall be bundled, neatly routed, suspended above the grid system or located in cable tray and labeled with appropriate tags as to service.

I. Low voltage wire and cable shall be specifically designed to function with equipment supplied. Cable shall be color coded for ease of installation and service, twisted, shielded, and grounded for control of voice circuits and covered with wear-resistant moisture proof protective insulation. Wire shall bear manufacturer's trademark either embossed or printed on cable.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

A. Section includes:

1. Building wires and cables rated 600 VAC and less.
2. Connectors, splices, and terminations rated 600 VAC and less.
3. Wire lubricating compound.
4. Control wiring.
5. Communication and signal wiring.
6. Fireproofing tape.

1.3 SUBMITTALS

A. Product Data (Where indicated in Section "Common Work Results for Electrical", provide the following information): For each type of product indicated.

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 use.

B. Comply with NFPA 70.

C. Comply with NEMA WC 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES (POWER AND LIGHTING):

A. Conductors and Cables: NEMA WC 70, except as hereinafter specified.

1. All conductors shown on plans are sized for copper.
2. UL label required.

B. Single Conductor:

1. Soft annealed copper.
2. Stranded is acceptable for sizes No. 14 and larger, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise.
3. Minimum size No. 12, except where larger sizes are shown. (Size No. 14 minimum for controls).

C. Stranding:

1. Conductors between stationary and moving devices, such as hinged doors or panels, shall have Class H or Class K stranding. All other conductors shall have Class B or Class C stranding.

D. Insulation:

1. THHN-THWN, XHHW - Sizes No. 12 and larger.

E. Hospital Grade Metal Clad (Type MC) and Hospital Grade Armored Cable (Type AC):

1. Refer to 260519-2.1B for minimum conductor sizes.
2. Hospital Grade Metal Clad Cable shall be as manufactured by Southwire – Type HCF MC-AP, aluminum armor.
    a. Cable assembly shall include conductors with THHN insulation, an insulated ground conductor, mylar tape conductor insulation covering, and an interlocked armor aluminum outer jacket with a bonding wire.
3. Hospital Grade Armored Cable shall be as manufactured by AFC Cable Systems – Type HCF, steel or aluminum armor or Southwire Type AC-HCF.
    a. Cable assembly shall include conductors with THHN insulation, an insulated ground conductor, paper wrap conductor insulation covering, and an interlocked armor (galvanized steel or aluminum) outer jacket with a bonding wire.
4. Cable shall be UL compliant for one, two and three hour wall penetration fire ratings. The cable shall have passed UL 1479 and meet NEC 300.22(C) for Environmental Air Handling spaces.

F. Aluminum Conductors:

1. Aluminum conductors shall be of an AA-8000 Series electrical grade aluminum alloy conductor material in accordance with NEC Article 310.14 for circuits rated 200A or larger.
2. Where aluminum conductors are used, Stabiloy or Southwire brands shall be used.

2.2 SPLICES AND JOINTS:

A. In accordance with UL 486 A, B, D and NEC.

B. Split-bolt type connectors are not allowed.

C. Branch circuits (No. 10 and smaller):

1. Connectors: Solderless, screw-on, reusable pressure cable type, 600 volt, 105 degree C. with integral insulation, approved for copper and aluminum conductors.
2. The integral insulator shall have a skirt to completely cover the stripped wires.
3. The number, size, and combination of conductors, as listed on the manufacturer's packaging shall be strictly complied with.

D. Branch Circuits (No. 8 and No. 6):

1. Connectors: Pre-insulated, mechanical, reusable cable type, 600 volt, 90 degree C. with integral insulation, approved for copper and aluminum conductors, cold temperature rated to -45 degree C. Connectors shall be equal to those manufactured by Polaris Connectors.
2. Provide connectors rated for the location where installed.
3. The number, size, and combination of conductors, as listed on the manufacturer's packaging shall be strictly complied with.

E. Feeder Circuits:

1. All feeder conductors shall be the same size and type and be continuous from the overcurrent device to the panel or equipment the feeder terminates at.
2. Connectors shall be indent type, UL listed for use with the size and type of wire installed of high conductivity and corrosion-resistant material. Do not install more than one conductor per connector unless the connector is UL listed for use with the number of conductors installed.
3. Power distribution blocks shall be provided for splices or where quantity or size of conductors exceeds the terminal rating of the device to be connected. Power

distribution blocks shall be equal to Square D by Schneider Electric Class 9080 Type LB or Mersen Electrical Power MPDB series. Provide with covers. Power distribution blocks shall be securely mounted in a code sized enclosure.

4. Field installed compression connectors for cable sizes 250 kcmil and larger shall have not less than two clamping elements or compression indents per wire.

5. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Insulation rating shall be not less than that of the conductor that is being joined.

6. Plastic electrical insulating tape: Flame retardant, cold and weather resistant.

2.3 CONTROL WIRING:

A. Unless otherwise specified in other sections of these specifications, size control wiring as specified for power and lighting wiring, except the minimum size shall be not less than No. 14, 90 degrees C. insulation. Where stranded conductors are used, provide with spade type insulated copper terminals.

B. Size wire large enough so that the voltage drop under inrush conditions does not adversely affect operation of the controls.

2.4 COMMUNICATION AND SIGNAL WIRING:

A. Shall conform to the recommendations of the manufacturers of the communication and signal systems; however, not less than what is shown.

B. Wiring shown is for typical systems. Provide wiring as recommended by the manufacturer for the systems being furnished.

C. Multi-conductor cables shall have the conductors color coded.

2.5 WIRE LUBRICATING COMPOUND:

A. The cable pulling lubricant shall be compatible with all cable jackets. The lubricant shall be UL (or CSA) listed. The lubricant shall contain no waxes, greases, silicones, or polyalkylene glycol oils or waxes.

B. A 200-gram sample of the lubricant, when placed in an one-foot, split metal conduit and fully dried for 24 hours at 105 degrees C, shall not spread a flame more than three-inches beyond a point of ignition at a continued heat flux of 40 kW/m^2. Total time of test shall be one-half hour.

C. Approved Lubricant is:

1. Polywater J from American Polywater Corporation

PART 3 - EXECUTION

3.1 INSTALLATION, GENERALLY:

A. Install in accordance with the NEC, and as specified.

B. Install all wiring in raceway systems.

C. Where No. 10 or No. 12 stranded conductors terminate at receptacles, toggle switches, or other devices with a screw-type connection, provide a solid conductor pigtail or spade-type connector listed for use with the appropriate class of stranded wire.

D. Install a ground wire sized per NEC 250.122 in each conduit containing phase conductors.

E. Color Code:

1. All conductors shall be identified by circuit number and color coding at all termination points and splices. All conductors shall be identified in all pull and junction boxes by the following method of color coding. Means of identification

shall be permanently posted at each branch circuit panel with a nameplate identifying color coding system used in that panelboard.

Phase	208/120V	480/277V
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green

2. Use solid color compound or solid color coating for No. 6 and smaller branch circuit conductors and neutral sizes.
3. Phase conductors No. 4 and larger color code using one of the following:
   a. Solid color compound or solid color coating.
   b. Colored as specified using 3/4-inch wide tape. Apply tape in half overlapping turns for a minimum of three-inches for terminal points, and in junction boxes, pull boxes, troughs, manholes, and handholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.
4. Where neutrals are located in the same raceway, junction box or enclosure, neutrals shall be marked or labeled to indicate which circuit conductor (phase conductor) they are associated with. Neutrals (with stripes matching the associated phase conductor color) meeting the requirements of NEC Section 200.6 are acceptable for this purpose.
5. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
6. Provide plastic engraved color code legend on each panelboard and switchboard per NEC Section 210.5 (C).
7. All improperly color-coded conductors will be completely replaced at no additional cost to Owner.

F. All cable and wiring shall be continuous between electrical equipment. Splices shall not be added except as required for taps in branch circuits or as approved by the engineer.

G. Splice cables and wires only in outlet boxes, junction boxes, pull boxes, manholes, or handholes. Do not splice cables in panelboards, switchboards, disconnects, etc.

H. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.

I. For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, and tie all cables.

J. Seal cable and wire entering a building from underground between the wire and conduit, where the cable exits the conduit, with a non-hardening approved compound.

K. Wire Pulling:
1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
2. Use ropes made of nonmetallic material for pulling feeders.

3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the Engineer.
4. Pull multiple cables into a single conduit with a single continuous pull.
5. Use wire lubricant per this specification when recommended by the cable manufacturer or as required to prevent damage to cables during installation.

L. Individual neutrals shall be provided for each circuit. Multi-wire branch circuits (i.e. Two or more phase sharing a neutral conductor) shall not be allowed, unless specifically noted or shown on the plans. Where multi-wire branch circuits are shown or noted on the plans, provide a disconnecting means that will simultaneously disconnect all phase conductors at the panel where the branch circuit originates.

3.2 SPLICE INSTALLATION:

A. Splices and terminations shall be mechanically and electrically secure.

B. Where the Engineer determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Owner.

3.3 CONTROL, COMMUNICATION, AND SIGNAL WIRING INSTALLATION:

A. Unless otherwise specified in other sections of these specifications, install wiring as described below. Wiring shall be connected to perform the functions shown and specified in other sections of this specification.

B. Except where otherwise required, install a separate power supply circuit for each system, or control equipment, or control power. Circuit to nearest 120 volt panel or nearest emergency panel if equipment controlled is connected to emergency system. Use spare 20 Amp breakers in panels where none are designated. Verify all requirements with actual equipment supplied in field.

C. Install a breaker lock-on clip on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de-energizing of the systems. Lock-on clips for circuit breakers serving fire alarm systems shall be painted red.

D. System voltages shall not exceed 120 volts and shall be lower voltages where shown on the drawings or required by the NEC.

E. Wire and cable identification:

1. Install a permanent wire marker on each wire at each termination, outlet box, junction box, panel, and device. Markers shall be typed or handwritten and shall be clearly legible.
2. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
3. Wire markers shall retain their markings after cleaning.

3.4 FEEDER IDENTIFICATION:

A. In each, interior pullbox and junction box, identify each phase, neutral and/or ground conductor by conductor color coding or tape based on system voltage.

3.5 FIELD TESTING:

A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices such as fixtures, motors, or appliances.

B. Test shall be performed by megger and conductors shall test free from short-circuits and grounds.

C. Test conductors' phase-to-phase and phase-to-ground.

D. Megger motors after installation but before start-up and test free from grounds.

E. The Contractor shall furnish the instruments, materials, and labor for these tests.

3.6 HOSPITAL GRADE METAL CLAD CABLE (TYPE MC) AND HOSPITAL GRADE ARMORED CABLE (TYPE AC)

A. Hospital Grade Metal Clad Cable and Hospital Grade Armored Cable may only be used on normal power and lighting circuits. Hospital Grade Metal Clad Cable and Hospital Grade Armored Cable is not allowed for use on emergency power and lighting circuits or in damp or wet locations.

B. Hospital Grade Metal Clad Cable or Hospital Grade Armored Cable may be utilized for branch circuit wiring from junction boxes to fixtures and wiring devices. All home runs shall be in conduit.

C. The use and installation of Hospital Grade Metal Clad Cable and Hospital Grade Armored Cable shall conform to NEC Article 320 or 330 as applicable, state and local codes and this specification. In all cases, the most restrictive requirements shall govern.

D. Color coding of insulation shall comply with this specification.

E. Support:

1. Hospital Grade Metal Clad Cable shall be supported at intervals not exceeding 6 feet and within 12 inches of every box, cabinet, fitting or other cable termination. Comply with additional requirements of Article 330, Paragraph 330.30.

2. Hospital Grade Armored Cable shall be supported at intervals not exceeding 4 feet 6 inches and within 12 inches of every box, cabinet, fitting or other cable termination. Comply with additional requirements of Article 320, Paragraph 320.30.

F. Install in a neat and workmanlike manner. Align and run cable parallel or perpendicular to the building lines.

3.7 ALUMINUM CONDUCTORS:

A. At the contractor's option, aluminum conductors may be utilized for 200amp or larger feeders. Increase conduit size and equipment lug size to facilitate feeders. Ratings for aluminum conductors shall be identical to or greater than the copper conductor ratings shown.

B. Aluminum conductors shall be provided with termination lugs and splicing sleeves, hereinafter called connectors. They shall be of the compression type installed on the conductors by dies exerting circumferential hydraulic compression or crimp action with a hydraulic tool capable of a minimum compression of 10,000 lbs. per sq. in. The finished installation of the connector shall be so that connector and wire are compressed to almost one solid mass over 80 percent of the total length of the mating surface of the connector. An aluminum oxide inhibiting compound shall be used on all mating surfaces in strict accordance with the Manufacturer's written instructions.

C. Aluminum cable terminations and splices shall be made in the following manner:

1. Remove the cable insulation to a length which will allow no exposure of bare cable beyond the end of the connector. Care shall be exercised in removal of insulation to avoid nicking the soft aluminum cable. Cover the exposed portion of the aluminum conductor immediately with a suitable compound supplied by or recommended in writing by the manufacturer of the connector to remove the aluminum oxide and inhibit further formation of oxide. Compound shall be rubbed thoroughly into the exposed portion of the conductor and between the strands to remove all high resistance components from sides, ends and individual strands of the cable.

2. Select a suitable terminating connector of the exact size for use on the specific conductor it is to be applied. Multiple range sized connectors shall not be used. The mating surface of the connector shall be coated with oxide removing compound using a wire brush or abrasive cloth to work the compound thoroughly in.

3. Insert the cable all the way into the connector and compress it upon the cable with the hydraulic compression tool. If the circumferential pressure type of tool is used, select the proper size die for the connector used. Wipe the excess compound from the connector and insulation.
4. Remove wire lugs from panel bus device and bolt connector in place.
5. Splices shall be tightly wrapped with "Scotch 33" (sizes 8 -4/0) or "Scotch 88" (sizes 250-MCM and larger) to the same mil thickness of the insulation of the cable being spliced. Wrapping shall extend a minimum of three-fourths of the length of the splice each way beyond the end of the splice. Connectors shall be Burndy YA-A series for aluminum conductors using Y35 or similar Burndy "hypress" hydraulic tool or shall be Anderson Electric (Square D by Schneider Electric) Versa Crimp system VCL series lugs and VCS series splicing sleeves using the VC6 hydraulic compression tool. Any other system proposed must be presented to the engineer and shall have the Engineer's written approval before such a system can be used on the job. Low pressure crimp type connectors will not be approved.
6. Any connector installation which does not meet with the approval of the Engineer based on these specifications shall be redone at no additional expense to the Owner.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

1.3 QUALITY ASSURANCE:

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

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS:

A. Insulated General Purpose: UL and NFPA 70 approved types, copper, with THW, XHHW or dual rated THHN-THWN insulation color identified green.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.

C. Size conductors not less than what is shown on the drawings and not less than required by the NFPA 70.

2.2 CONNECTORS:

A. Listed and labeled by a NRTL acceptable to the authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Compression Connectors: Hydraulic crimped, irreversible compression type kits. Connectors shall be factory filled with oxide inhibitor. All crimps shall be made with a hydraulic tool that embosses the index number on the outside of the connector.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long barrel, two-bolt connection to ground bus bar.

E. All splices and grounding electrode connections shall be made with exothermic welds or with hydraulic compression fittings.

PART 3 - EXECUTION

3.1 APPLICATIONS:

A. Conductors: Install solid or stranded conductors for #10 AWG and smaller and stranded conductors for #8 AWG and larger unless otherwise indicated.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Aboveground Connections to Ground Rods: Bolted connectors.

3.2 INSTALLATION, GENERALLY:

A. Ground in accordance with the NFPA 70 as shown, and as hereinafter specified. All equipment ground conductors shall be terminated on a ground bus or ground lug attached to equipment can.

B. System Grounding:

1. Secondary service neutrals shall be grounded at the supply side of the secondary disconnecting means and at the related transformers.

2. Separately derived systems (transformers downstream from the service entrance) ground the secondary neutral.

C. Equipment Grounding:

1. Metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be grounded for personnel safety and to provide a low impedance path for possible ground fault currents.

3.3 SECONDARY EQUIPMENT AND CIRCUITS:

A. Conduit Systems:

1. Ground all metallic conduit systems.

2. Non-metallic conduit systems shall contain a grounding conductor.

3. Conduit provided for mechanical protection containing only a grounding conductor, bond to that conductor at the entrance and exit from the conduit via grounding bushings.

B. Feeders and Branch Circuits: Install green grounding conductors with feeders and branch circuits in all feeders and branch circuits and in any raceway containing a phase conductor.

C. Boxes, Cabinets, Enclosures, and Panelboards:

1. Bond the grounding wires to each pullbox, junction box, outlet box, cabinets, and other enclosures through which the ground wires pass (except for special grounding systems for intensive care units and other critical units shown.).

2. Make ground wire connections to ground bus in motor control centers, panelboards, etc.

D. Receptacles and toggle switches are not approved for grounding through their mounting screws. Ground with a ground wire from green ground terminal on the device to the outlet box ground screw.

E. Ground lighting fixtures to the green grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixture connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

F. Fixed electrical appliances and equipment shall have a ground lug installed for termination of the green ground conductor.

3.4 CONDUCTIVE PIPING:

A. Bond all conductive piping systems in the building to the electrical system ground. Bonding connections shall be made as close as practical to the water pipe ground or service equipment ground bus.

3.5 SPLICES:

A. All splices and grounding electrode connections shall be made with exothermic welds or with hydraulic compression fittings.

3.6 GROUNDING RESISTANCE:

A. Grounding system ground resistance must not exceed 5 ohms. Final tests shall assure that this requirement is met.

B. Where permanent ground connections are required, make the connections by the exothermic process or hydraulic compression method to form solid metal joints.

3.7 INSTALLATION:

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where subject to strain, impact, or damage.

B. Grounding electrode conductors shall be continuous.

3.8 FIELD QUALITY CONTROL:

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation. Inspect compression type connections for proper die index number embossment.

B. Perform the following testing:

1. After installing grounding system, but before permanent electrical circuits have been energized, test for compliance with requirements.

END OF SECTION

SECTION 26 05 27
ISOLATION AND EQUAL POTENTIAL GROUNDING

PART 1 - GENERAL

1.1 SCOPE:

A. The work includes providing all labor, materials and equipment indicated, specified and necessary for complete isolated power distribution systems as shown on the drawings.

1.2 APPLICABLE DOCUMENTS:

A. The following specifications and standards of latest issue listed in this paragraph (including addenda, amendments and errata), but referred to hereinafter by basic designation only, form a part of this specification.

1. National Fire Protection Association (NFPA)
    a. 70 - "National Electrical Code"
    b. 99 - "Health Care Facilities"
2. Underwriters' Laboratories, Inc., Publications:
    a. "Electrical Appliance and Utilization Equipment List"
    b. "Electrical Construction Materials List"
    c. U/L Standard 1047, "Isolated Power System Distribution Equipment
    d. U/L Standard 1022, "Line Isolation Monitors"

PART 2 - PRODUCTS

2.1 COLOR CODING:

A. Each ungrounded branch circuit conductor supplied from an isolated electrical system shall be color coded in accordance with NFPA-99.

2.2 WIRING INSULATION:

A. Conductors used for branch circuit wiring supplied from an isolated electrical system shall be stranded copper having a cross linked polyethylene insulation or equivalent with a dielectric constant of 3.5 or less. Underwriters' designed type XHHW is suitable for this purpose. Wire pulling compound produces an adverse effect upon the dielectric constant of conductor insulation and is specifically prohibited when pulling branch circuit wiring energized from the secondary of an electrical isolation transformer.

2.3 CONDUIT:

A. Conduit shall be EMT, 1" minimum with a maximum of 2 circuits per conduit. Conduit routing shall be as short and direct as possible.

B. Fittings shall be steel compression type to ensure continuous ground path.

2.4 CIRCUIT IDENTIFICATION:

A. A rapid method of circuit indexing reduces the total time required to identify the usual source of ground fault alarm. To provide this capability, cover plates for all electrical receptacles supplied by isolated power shall be of stainless steel with branch circuit identification numbers permanently engraved and filled with red paint. Contractor shall be responsible for a completed index system.

2.5 FACTORY WIRING:

A. Factory wiring shall include all internal circuitry from incoming line to outgoing connectors for power and signal circuits. Terminals for secondary power circuits shall be color indexed orange, brown and green. Segregation between grounded and ungrounded

conductors shall be maintained and a barrier shall prevent field wiring from entering the transformer compartment.

2.6 MANUFACTURER:

A. Equipment herein specified is based on Square "D".

2.7 OPERATING ROOM PANELS:

A. The operating room panels shall be located as indicated on the drawings. The LIM used in these units shall indicate alarm when the total hazard current exceeds 5 milliamperes. The local remote indicator alarm unit shall be located in the face of the panel. The panel will be placed so its bottom edge is 61 inches above the finished operating room floor. Location within the operating room is as indicated on the drawings.

B. A second indicator alarm unit shall be built into an annunciator containing indicator alarm units for all line isolation monitors in the operating suite. This console will be located at the OR supervisor's station. Refer to plans for locations.

C. Components: The following components shall be provided by the manufacturer of the operating room, or laser outlet panel as one integral unit.

D. Transformers: The transformer shall be wound with an electrostatic shield between the primary and secondary windings. The windings shall be grounded to the enclosure. The electrostatic shield will be designed to prevent direct shorting of the primary winding to the secondary winding, and to reduce the coupling of harmonic distortions between the primary circuit and secondary circuits.

1. The total leakage current to ground from the transformer secondary winding shall not exceed the values shown in Table 29.2 of UL 1047.
2. Regulations to be certified not to exceed 2.6% at .8 PF at 20°C above the full load continuous operating temperature in accordance with NEMA-ANSI standards.
3. The transformer is to be single phase, 60 Hz with primary and secondary voltages as listed in the drawings and/or schedule.
4. Class H rated insulation shall be used in the manufacture of the transformer and the temperature rise will be limited to 55° C above ambient under full load conditions, when tested in accordance with NEMA-ANSI standards. Transformers must have a 220°C UL recognized insulation system.
5. The core shall be of stacked design and securely clamped and bolted. The core and coils shall be internally isolated from the enclosure by means of a suitable vibration dampening system; varnish impregnated and shall have a final wrap of insulating material to prevent exposure of bare conductors.
6. The design sound level of the completed units shall not exceed 27 decibels for units up to 5 KVA, and 35 decibels for 7.5 through 25 KVA units. Certified sound level reports shall be furnished for each individual unit upon the request of the consulting engineer.

E. Circuit Breakers: All circuit breakers must be 2-pole with a minimum interrupting capacity of 10,000 amperes. Panels shall have a maximum capacity of 12 secondary circuit breakers. Refer to the panelboard schedule for quantity and sizes of breakers. All circuit breakers shall be thermal-magnetic type. Thermal-only type circuit breakers will not be considered as equal.

F. Line Isolation Monitor (LIM): The line isolation monitor shall be able to detect all combinations of capacitive and resistive faults, including balanced, unbalanced, and hybrid faults. The LIM shall incorporate two channel circuitry designed to continually monitor the impedance from both lines to ground. LIMs which internally switch between either line to ground will not be accepted as equal.

1. A meter will provide continuous visual indication of the total hazard current in the monitored system. The LIM shall incorporate a momentary test switch to ensure operational integrity. Test switches which require manual reset will not be accepted. The LIM shall display a green safe light and red hazard light on the front panel. The unit shall be fused, and the fuses will be accessible from the front panel.
2. An external set of normally open and normally closed dry contacts shall be provided on the LIM. IN addition, the unit shall provide a means for audible and visible alarm when the ground connection to the unit is broken. Under any fault or system condition, the current contribution to the system by the LIM shall not exceed 50 microamperes.
3. The alarm point shall be set for a threshold value of 5 milliamperes total hazard current under nominal line voltage conditions. The alarm band differential shall not exceed 250 microamperes at nominal line voltage. The LIM shall be UL recognized under UL Standard 1022.
4. Remote Indicator Alarm: The remote indicator alarm shall be flush mounted and have a brushed stainless steel front trim. When the hazard current is within the predetermined limits for the circuits being monitored, a constant green light will remain illuminated. When the figure is exceeded, the green light will extinguish, a red indicator will illuminate, and an audible signal will sound.
    a. A silencing switch for the audible sign shall be provided. When pressed, it will cause a yellow warning light to illuminate, indicating that the audible signal has been silenced. When the current flow to ground returns to an acceptable level, the unit will automatically reset. The wiring from the line isolation monitor to the indicator alarm shall not contribute any leakage current to the isolated system.

G. Construction:

1. Enclosures: The enclosure shall be 12 gauge steel which is degreased, phosphatized, primed, and finished baked enamel paint. The front trim shall be type 304 stainless steel with a number 4 brushed finish. The enclosure will be flush mounted unless otherwise stated on the plans; units through 10 kVA shall have a maximum depth of eight inches. The flush trim panels shall have a hinged door, with keyed lock, to give access to the circuit breakers and line isolation monitor, and to provide for testing.
    a. The front panel shall not contain any type of grille or a louver for ventilation. The panel and transformer shall be so designed that heat generated by the transformer under full load conditions shall not affect the normal operation of the circuit breakers and line isolation monitor. The maximum front panel temperature shall not exceed 30°C under full load continuous operation. Certification of this temperature test shall be provided to the consulting engineer upon request. The entire section behind the hinged door shall be of a dead front design. All hinges will be concealed.
2. Wiring: Wiring within all panels shall meet all applicable NEC standards. Low leakage insulation shall be used on all wire. The total leakage for all panel types shall not exceed the values shown in Table 29.1 of UL 1047.
    a. The panel manufacturer shall provide certified test data on each individual panel as to maximum leakage of each complete assembly.
    b. The contractor shall wire all external receptacles to the panels using copper stranded conductor having a cross-liked polyethylene insulation or equivalent with a dielectric constant of 3.5 or less. Under no circumstances shall wire pulling compound be used when pulling the

wire for isolated circuits. All wiring shall be color-coded in accordance with NEC and appropriate NFPA standards.

3. Approved Manufacturer: Approved manufacturer for the various components of a complete isolated power distribution system shall be as listed herein.
   a. Transformer shall be a shielded low-leakage isolating transformer, specifically manufactured for the use in hospital isolated systems, Class 7450 Isolating Transformer manufactured by the Square D Company.
   b. Line isolating monitor shall be Square D Company Iso-Gard Line Isolation Monitor.
   c. Circuit breakers shall be Type QO, QOB, Q1, FAL or KAL as manufactured by Square D Company.
   d. Remote alarm indicator shall be Square D Company Type IA-IC.
4. Standards and Test: All panels, components, and accessories shall be manufactured in accordance with the applicable UL, NEMA and NFPA standards including, but not limited to:
   a. NFPA No. 99
   b. NEC-ARTICLE 517
   c. UL-1047
   d. UL-1022
5. Testing by the Manufacturer: The contractor shall include the cost of and make all arrangements for testing all underground isolated systems in the hospital by a qualified factory technician provided by the manufacturer of the isolation systems. The testing shall include a complete inspection of all connections and materials used. The contractor shall be prepared to demonstrate the factory technician that proper polarity was observed, and installation practices were in accordance with the drawings and specifications for these systems.
6. The factory technician shall check and record system current leakages. The factory technician shall further simulate faults on the isolated system on a magnitude high enough to bring the total system leakage, which the line isolation monitor (LIM) detects, above the calibrated point, thus verifying correct operation of the LIM. The faults simulated shall be combinations of resistive and capacitive faults.
7. The factory technician shall check the resistance between the ground point of each receptacle and the reference point, and it shall be less than 0.1 ohms. The voltage potential difference between any exposed conductive surfaces in the patient vicinity shall be checked, the difference to be no more than 40 millivolts. These tests are required by NFPA No. 99 for new construction area.
8. The factory technician shall instruct the hospital maintenance staff in the use of the following:
   a. The panel and LIM as a leakage measuring device.
   b. How instrument leakage areas can be measured and labeled.
   c. How to perform leakage tests.
9. The technician shall also test the system impedance of the entire isolated power system to ensure compliance with the applicable sections of NFPA No. 99, Chapter 3. The measured system impedance shall become part of the permanent logged records of each panel.
10. After all tests are complete, a letter shall be given to the hospital and the consulting engineer. The letter shall state that the system conforms with all codes, good installation practices, and the specifications.

11. Upon completion of all tests, the factory technician shall meet with hospital medical and maintenance staff to thoroughly explain the operation of the equipment installed, and the need and procedure of periodically testing and logging test results. He shall furnish logbooks to the maintenance department, enter the first readings of all panels in these logbooks, and clearly instruct the hospital maintenance staff how to enter future readings.

12. All questions that the hospital staff might have shall be answered completely and thoroughly at this time. The consulting engineer shall be notified of the dates and time of testings so he may, at his discretion, witness any of the tests or meetings conducted by the factory technician.

PART 3 - EXECUTION

3.1 EQUAL POTENTIAL GROUNDING:

A. This Contractor shall provide equal potential grounding in accordance with NFPA 99, as indicated on the drawings and herein specified. Equal potential grounding shall be provided to all fixed metal items and equipment within the room.

1.

Item	Method of Grounding
Medical gas, vacuum, water waste and heating pipes; conduits unrelated to to electrical distribution system; conductive window and door frames, ducts and metal partitions.	10 AWG copper, stranded, insulated, continuous conductor not more than 15'-0" long, to closest ground bus.

3.2 INSTALLATION:

A. A factory trained technician or Engineer shall visit the job site to check out the field installation and shall certify to the Owner that the system is in proper working order and shall instruct the Owner's personnel in the proper operation and maintenance of the system.

END OF SECTION

SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Description:

1. This section includes the furnishing, installation, and connection of raceways, fittings, and boxes to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.
2. The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

B. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Non-metallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Non-metallic wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes and enclosures.
7. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS:

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

D. RGS: Rigid galvanized steel.

1.4 ACTION SUBMITTALS:

A. Product Data (Where indicated in Section "Common Work Results for Electrical", provide the following information): For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings (Where indicated in Section "Common Work Results for Electrical", provide the following information): For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 CONDUIT:

A. Raceway Size: In accordance with the NFPA 70 but not less than 1/2-inch unless otherwise shown. Where permitted by the NFPA 70, 1/2-inch flexible conduit may be used for connections to recessed lighting fixtures.

B. Raceway Supports:

1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
2. Pipe Straps: Fed. Spec. FF-S-760, Type I, Style A or B.

3. Individual Raceway Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
4. Multiple Raceway (trapeze) hangers: Not less than 1-1/2 by 1-1/2 inch, 12 gauge steel, cold formed, lipped channels or not less than 2-1/8 by 2-1/8 inch, 18 gauge B-Line "4Dimension Channel"; with not less than 3/8-inch diameter steel hanger rods.
5. Solid Masonry and Concrete Anchors: Fed. Spec. FF-S-325; Group III self-drilling expansion shields, or machine bolt expansion anchors Group II, Type 2 or 4, or Group VIII.

C. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.

2.2 RACEWAYS:

A. Install raceway types as shown on drawings and as listed below.

B. Metal Conduit:

1. Rigid steel: UL 6 and ANSI C80.1.
2. Rigid intermediate steel conduit (IMC): UL 1242 and ANSI C80.6.
3. Electrical metallic tubing (EMT): U.L. 797 and ANSI C80.3. Maximum size 5-inch. Permitted only with cable rated 600 volts or less.
4. Flexible steel conduit (commercial Greenfield): UL 1, zinc-coated steel.
5. Liquid-tight flexible metal conduit: UL 360 flexible galvanized steel tubing covered with extruded liquid-tight jacket of polyvinyl chloride (PVC). Provide conduit with a continuous copper bonding conductor spiral between the convolutions.
6. PVC Coated Rigid Steel: NEMA RN 1. Conduit and fittings shall be as manufactured by Robroy Industries; Plasti-Bond, Perma-Cote, and KorKap or Thomas & Betts; Ocal. Any deviation will require approval of the specifying Engineer or Owner.
    a. Shall be UL listed.
    b. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.
    c. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.

C. Conduit Fittings for Metal Conduit:

1. Comply with NEMA FB 1 and UL 514B.
2. Rigid steel and IMC conduit fittings:
    a. Standard threaded couplings, locknuts, bushings, and elbows: Fed. Spec. W-F-408, except only material of steel or malleable iron is acceptable. Integral retractable type IMC couplings are acceptable also.
    b. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure
    c. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted. Bushings for conduit smaller than 1-1/4-inch shall have flared bottom with ribbed sides.
    d. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.

e. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank coverplates having the same finishes as that of other electrical plates in the room.

f. In trade sizes 2-1/2 inches to 4-inches for rigid steel raceway or intermediate metal raceway, contractor may use Allied 'Kwik-Couple' fittings in lieu of individual steel couplings. 'Kwik-Couple' fittings shall not be used in hazardous locations. Where 'Kwik-Couple' fittings are used exterior for vertical risers, install fitting with taper end up.

3. Electrical metallic tubing fittings:

a. Fed. Spec. W-F-408, except only material of steel for compression type. Steel or die-cast is acceptable for set screw type. Die-cast compression is not acceptable.

b. Couplings and connectors: Concrete tight and rain tight, with connectors having flared throats. Use gland and ring compression type or set screw type couplings and connectors. Set screw type couplings for conduit 2 inches and larger shall be four set screws each. Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.

c. Indenter type connectors or couplings are prohibited.

d. In trade sizes 1-1/4 inches to 4 inches, contractor may use Allied "Kwik-Fit EMT" or "Kwik-Fit Compression EMT" fittings in lieu of individual steel couplings.

4. Flexible steel conduit (greenfield) fittings:

a. Fed. Spec. W-F-406 and UL 5, except only steel or malleable iron material is acceptable.

b. Clamp type, with insulated throat.

5. Liquid-tight flexible metal conduit fittings:

a. Fed. Spec. W-F-406, except only steel or malleable iron material is acceptable.

b. Type incorporating a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.

6. Expansion and deflection couplings:

a. UL 467 and UL 514.

b. Accommodate, 1.9 cm (0.75") deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.

c. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, NFPA 70 Section 250.98, and the NFPA 70 code tables for ground conductors.

d. Shall be watertight, seismically qualified, corrosion-resistant, threaded for and compatible with rigid or intermediate metal conduit.

e. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

f. Expansion fittings shall accommodate a minimum of 4-inches of movement.

D. Nonmetallic Conduit:

1. PVC Conduit: NEMA TC 2 and UL 651 Schedule 40, conduit size is 3/4-inch minimum.

E. Conduit Fittings for Non-Metallic Conduits:

1. PVC Conduit: Comply with NEMA TC 3; match to conduit type and material.

2.3 OUTLET BOXES:

A. UL-50, UL514A and NEMA OS 1.

B. Cast metal where required by NFPA 70 or shown and equipped with rustproof boxes; NEMA FB 1.

C. Sheet metal boxes: 4-inch square, galvanized steel, except where otherwise shown.

D. Boxes installed in concrete or masonry and boxes larger than two gang shall be masonry type.

E. Box extensions used to accommodate building finishes shall be of the same material as the recessed box.

F. Boxes for use with IMC or RGS raceways shall be cast 'F' type or stainless steel unless noted otherwise on the drawings.

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

I. Boxes for use with nonmetallic conduit: Comply with NEMA OS2 and UL 514C.

2.4 WIREWAYS AND AUXILIARY GUTTERS:

A. Sized according to NFPA 70.

B. Equip with hinged covers, except where removable covers are shown. Wireways shall only be permitted as indicated on the drawings or approved by the Engineer.

C. Fittings and accessories: Include covers, couplings, offsets, elbows expansion joints, adapters, hold down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

D. Metal Wireways:

1. Sheet metal complying with UL 870 and NEMA 250.

2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70 and shall be marked for intended location and application.

2.5 PULL AND JUNCTION BOXES:

A. Small boxes shall comply with NEMA OS 1.

B. Larger boxes shall comply with UL 50 and NEMA 250.

C. Pull and junction boxes shall be code gauge steel boxes with hinged, bolted or screwed covers. Boxes shall be flush or surface mounted as shown or required.

D. Junction and pull box shall be installed where shown on drawings and additional boxes shall be installed if required for pulling of wire provided location and installation is approved by the Architect. All boxes shall be code construction with screw type cover and shall be installed in accessible locations.

E. Pull and junction boxes for use with IMC or RGS raceways shall be cast 'FS' type or stainless steel unless noted otherwise on the drawings. Comply with NEMA FB 1 and UL 1773 with gasketed cover.

2.6 FLOOR BOXES

A. Floor boxes shall be a specified on the drawings or in the special Outlet Schedule. General installation/construction shall be as follows:

1. Shall be listed and labeled as defined in NFPA 70.

2. Floor box housings for single and multi-gang floor boxes shall be fully adjustable, concrete tight with knockouts on bottom and all four sides (1/2", 3/4" and 1" sizes). Deep boxes shall be used when concrete floor thickness above any part of deck is 4-inch thick or more. Shallow boxes shall be used when concrete floor thickness is 3-inch up to 4-inch.
3. Cover pates shall be polished brass unless noted otherwise. Dual hinged lift lids for duplex receptacles, removable plug insert sized to match the receptacle to be installed for single special receptacles, telephone, TV, microphone, or other low voltage devices.
4. Provide low profile carpet flanges in all carpeted areas. Color to be per Architect.
5. Approved manufacturers shall be Hubbell or Steel city unless noted otherwise on the plans and/or in special outlet schedule.

PART 3 - EXECUTION

3.1 RACEWAY:

A. Minimum 1/2-inch above grade, 3/4-inch below grade, and 1-inch on site, unless otherwise noted.

B. A ground wire sized per NFPA 70 Section 250.122 shall be installed in all conduits containing phase conductor(s).

C. RGS or IMC must be used at all times when exposed to weather or physical abuse and in all NFPA 70 classified hazardous locations. EMT may not be used in direct contact with earth, or in concrete slabs on grade.

D. U.L. approved Schedule 40 P.V.C. conduit may be used where feeders or branch circuits are to be run in earth or slabs (3/4" minimum).

1. Use PVC coated RGS ells and risers approved for underground use. All conduit risers through concrete floors shall be RGS from below the top of the floor slab. Use conduit adapters when converting from PVC to steel conduit.
2. Use plastic spacers when more than one conduit is installed together. See Drawings for areas requiring concrete encasement.

E. All nonmetallic (PVC and fiberglass) conduits shall be provided with separate ground conductor sized per NFPA 70.

3.2 PENETRATIONS:

A. Cutting or Holes:

1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Structural Engineer prior to drilling through structural sections.
2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Structural Engineer as required by limited working space.

B. Fire Stop:

1. Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases, and maintains specified fire rating. Completely fill and seal clearances between raceways and openings with the fire stop material. See Section "Common Work Results for Low Voltage Systems Cabling" for firestopping requirements for low voltage cabling sleeves.

C. Fire Barrier Penetration Seals:

1. Manufacturer: Subject to compliance with requirements, provide fire barrier penetration seals of one of the following:
   a. Electro Products Div./3M
   b. Nelson; Unit of General Signal.
2. Provide seals for any opening through fire-rated walls, floors, ceilings, or assemblies used as passage for components such as conduits or cables.
3. Cracks, voids or holes up to 4-inch diameter: Use putty or caulking, one-piece intumescent elastomer, non-corrosive to metal, compatible with synthetic cable jackets, and capable of expanding 10 times when exposed to flame or heat and UL-listed.
4. Openings greater than 4-inch diameter and raceway sleeves thru floors at telephone terminal boards: Use sealing system capable of passing 3-hour fire test in accordance with ASTM E-814, consisting of wall wrap or liner, partitions, and end caps capable of expanding when exposed to temperatures of 250 degrees to 350 degrees F (121 to 177·C), that is UL-listed. KBS "Sealbags" manufactured by P-W Industries will be acceptable.
5. Execution: Fill entire opening with sealing compound. Adhere to manufacturer's installation instructions. All fire barrier seals shall meet the rating of the wall.

D. Waterproofing:
1. Install sleeves and sleeve seals at exterior floor, exterior wall, and roof conduit penetrations and completely seal clearances around the conduit and sleeve and make watertight as specified in Section, SEALING AND CAULKING.

3.3 CONDUIT SYSTEMS INSTALLATION, GENERAL:

A. Installation: In accordance with UL, NFPA 70, as shown, and as hereinafter specified.
1. Where non-metallic (PVC or fiberglass) conduits are used, a ground wire sized per NFPA 70 Section 250.122 shall be provided if not already specified.

B. All branches of the emergency system shall be installed entirely independent of other raceway systems. Common supports and hangers may be used.

C. Raceway Burial Depths: (Underground work)
1. 18" minimum, 30" maximum cover to grade or bottom of floor slab.
2. 24" minimum under streets, highways, roads, alleys, driveways and parking lots.
3. 2" minimum below concrete slab inside a building.
4. Prior to any underground work, contractor shall verify and locate all existing underground utilities. All existing utilities may not be shown on the drawings. Verify in field with owner and with utility locating services. The contractor shall exercise extreme caution when trenching or boring, hand digging at all crossings and where in close proximity of existing utilities. Repair existing parking lots, streets, roads, alleys, driveways, etc. to its original condition in a timely manner prior to substantial completion. Contractor shall be responsible for any damage to underground utilities.
5. Underground conduits shall be installed in a sand bed and in an organized manner.

D. Install raceways as follows:
1. Comply with NECA 1, comply with NECA 101 for metal conduit and NECA 102 for aluminum conduit except where requirements on drawings or this article are stricter.
2. In complete runs before pulling in cables or wires.
3. Flattened, dented, or deformed raceways are not permitted. Remove and replace the damaged raceways with new undamaged material.

4. Assure raceway installation does not encroach into the ceiling height head room, walkways, or doorways.
5. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
6. Mechanically and electrically continuous.
7. Independently support raceway. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts.). Group raceways with common supports where possible. Conduit shall be supported within 12-inches of connectors.
8. Close ends of empty raceway with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
9. Raceway installations under fume and vent hoods are prohibited.
10. Secure raceways to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For RGS and IMC raceway installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make raceway connections to junction box covers.
11. Flashing of penetrations of the roof membrane is specified in Section, FLASHING AND SHEET METAL.
12. Raceways shall not be used as a support.
13. Use thread compounds that are UL approved conductive type to insure low resistance ground continuity through the raceways.
14. Tightening set screws with pliers is prohibited.
15. Keep raceways a minimum of 6 inches away from parallel runs of flues and steam or hot-water pipes.

E. Raceway Bends:

1. Make bends with standard raceway bending machines.
2. Raceway hickey may be used for slight offsets, and for straightening stubbed out raceways.
3. Bending of raceways with a pipe tee or vise is prohibited.

F. Raceways Installed Under Metal - Corrugated Sheet Roof Decking

1. Where rigid metal conduit or intermediate metal conduit is not used, raceways shall be installed and supported so the nearest outside surface of the raceway is not less than 1.5 inches from the nearest surface of the roof decking.

G. PVC coated RGS:

1. Use only fittings listed for use with this type of conduit.
2. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduit and fittings. Use sealant recommended by conduit manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit.
4. All clamping, cutting, threading, bending, and assembly instructions listed in the manufacturer's installation guide should be vigorously followed. Installer certification, before installation, is required.

3.4 CONCEALED WORK INSTALLATION:

A. General:

1. Raceway and Outlet Boxes Installation: All raceway systems work and outlet boxes shall be installed concealed in walls, floor and roof construction or concealed within

furred spaces or above ceilings. In equipment or mechanical rooms exposed work shall include feeders and connections to equipment unless noted otherwise.

B. In Concrete:

1. Raceway: RGS, IMC, PVC or EMT; except do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.
2. Align and run raceways in direct lines.
3. Install raceways through concrete beams only when the following occurs:
   a. Where shown on the structural drawings.
   b. As approved by the Structural Engineer prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
4. Installation of raceways in concrete that is less than three inches thick is prohibited. All raceways installed in concrete shall be approved by the Structural Engineer.
   a. Raceway outside diameter larger than one-third of the slab thickness is prohibited.
   b. Space between raceways in slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
   c. Install raceways approximately in the center of the slab so that there will be a minimum of 3/4-inch of concrete around the raceways.
5. Make couplings and connections watertight.

C. Above Furred or Suspended Ceilings and in Walls:

1. Raceways for conductors 600 volts and below:
   a. RGS, IMC, or EMT. Types mixed indiscriminately in the same system are prohibited.
2. Raceways for conductors above 600 volts:
   a. RGS. Do not use aluminum in wet locations or in contact with concrete.
3. Align and run raceways parallel or perpendicular to the building lines.
4. Connect recessed or lay-in lighting fixtures and all other devices installed in a lay-in ceiling to raceway runs with flexible metal conduit extending from a junction box to the fixture. Provide a ground wire in all flexible conduits.
5. Tightening set screws with pliers is prohibited.

3.5 EXPOSED WORK INSTALLATION:

A. Raceways for Conductors 600 volts and below:

1. RGS, IMC, or EMT. Types mixed indiscriminately in the system are prohibited.
2. All raceways exposed to physical abuse and in all industrial pump, treatment plant locations shall be RGS, or IMC.

B. Raceways for conductors above 600 volts:

1. RGS.

C. Align and run raceways parallel or perpendicular to the building lines.

D. Install horizontal runs close to the ceiling or beams and secure with raceway straps.

E. Surface metallic raceways:

1. Surface metallic raceway shall only be used where shown on the drawings, and in remodels and modifications to existing where wall and ceiling voids do not permit concealed installation but shall not be used at any other location unless called for on the drawings.

2. All surface raceway and outlets must be painted to match the surface it is attached to.

3. Install a ground wire sized per NFPA 70 Section 250.122 for the largest circuit in the raceway if not already specified.

F. Painting:

1. Paint exposed raceways as specified in Section, PAINTING.

2. Paint raceways containing cables rated over 600 volts safety orange as specified in Section, PAINTING. In addition, paint legends, using 2-inch high black numerals and letters, showing the cable voltage rating. Provide legends where raceways pass through walls and floors and at maximum 20-foot intervals in between.

3.6 WET OR DAMP LOCATIONS:

A. Unless otherwise shown, use raceways of RGS or IMC above grade. Use PVC conduit below grade, except RGS ells and risers shall be used.

B. Provide sealing fittings, to prevent passage of water vapor, where raceways pass from warm to cold locations, i.e., (refrigerated spaces, constant temperature rooms, air-conditioned spaces) or similar spaces.

C. Rooftops:

1. Where raceways or cables are exposed to direct sunlight on or above rooftops, raceways or cables shall be installed a minimum of 7/8" above the roof to the bottom of the raceway or cable.

2. The ampacity of conductors or cables shall be de-rated in accordance with N.E.C. Section 310.15(B)(3)(c).

3. Raceways or cables shall be supported up off the surface of the roof with a polymeric rooftop support equal to Caddy Pyramid series. Supports shall be non-penetrating and shall be designed to prevent damage to the roofing materials. Wood supports are not allowed.

3.7 MOTORS AND VIBRATING EQUIPMENT:

A. Use flexible metal conduit (Type FMC) for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission. Provide liquid-tight flexible metal conduit Type (LFMC) for installation in exterior locations, kitchens, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, treatment plants, pump stations, and locations subject to seepage or dripping of oil, grease or water. Provide a green ground wire with all flexible metal conduit.

3.8 EXPANSION JOINTS:

A. Expansion fittings shall be used wherever the change in length of PVC conduit due to temperature variation exceeds 0.25-inches per NEC Section 352.44.

B. All conduits routed outdoors or in non-conditioned spaces (i.e., attics, non-insulated plenums, etc.) shall have expansion fittings per the following:

1. Steel: One expansion fitting in runs longer than 40 feet. Provide additional expansion fittings every 200 feet.

2. PVC: One expansion fitting in runs longer than 20 feet. Provide additional expansion fittings every 50 feet.

C. Equip raceways 3-inches and larger, that are rigidly secured to the building structure on opposite sides of a building expansion joint, with expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.

D. Equip raceways smaller than 3-inches, that are rigidly secured to the building structure on opposite sides of a building expansion joint, with junction boxes located 12-inches either side of the expansion joint. Connect junction boxes with 24-inches of flexible conduit that

is slack (to allow for movement). Flexible conduit shall have an insulated copper bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 3-inches and larger conduits are acceptable.

3.9 RACEWAY SUPPORTS, INSTALLATION:

A. All raceways shall have supports at maximum spacing of 10-feet and within 3-feet of a fitting, elbow, change of direction, box outlet or enclosure. Safe working load shall not exceed 1/4 of proof test load of fastening devices. This shall apply to both vertical and horizontal conduit runs.

B. Use pipe straps or individual raceway hangers for supporting individual conduits.

C. Support multiple raceway runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the raceways, wires, hanger itself, and 200 pounds. Attach each raceway with U-bolts or other approved fasteners.

D. Support raceways independently of junction boxes; pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.

E. Fasteners and Supports in Solid Masonry and Concrete:

1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.

2. Existing Construction:

a. Steel expansion anchors not less than 1/4-inch bolt size and not less than 1-1/8 inch embedment.

b. Power set fasteners not less than 1/4-inch diameter with depth of penetration not less than 3-inches.

c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.

F. Hollow Masonry: Toggle bolts are permitted. Bolts supported only by plaster are not acceptable.

G. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

H. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

I. Chair, wire, or perforated strap shall not be used to support or fasten conduit.

J. Spring steel type supports "caddy clips" that are listed for the intended use are acceptable in appropriate locations.

K. Vertical Supports: Vertical raceway runs shall have riser clamps and supports in accordance with NFPA 70 and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.10 BOX INSTALLATION:

A. Boxes for Concealed Raceways:

1. Mount flush. Boxes protruding from the finished wall surface or with more than 1/8-inch gap between the wall or outlet mounted in the box will be changed out with all wall reconstruction expense paid by the Electrical Contractor.

2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.

C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

D. Outlet boxes in the same wall mounted back-to-back are prohibited.

E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4-inches square by 2-1/8 inches deep, with device covers for the wall material and thickness involved.

F. Where lighting fixtures and appliance outlets are to be mounted in concrete or in plaster finish on concrete, outlet boxes shall be installed in forms at exact dimensions from bench marks, columns, walls or floors.

G. Where lighting fixtures and appliances outlets are to be mounted on masonry walls and/or plastered furring or other finish, outlet boxes shall be roughed in to general location before installation of wall and furring and shall be reset to exact dimensions before walls and furring are constructed.

H. All outlet boxes shall be set true to horizontal and vertical lines parallel to walls, floors and ceilings and true to finish lines. All boxes shall be secured to ceilings or walls so all installations are solidly mounted.

I. Boxes mounted to wall studs shall be secured to a horizontal box mounting bracket equal to B-Line Series #BB2 or Caddy Series #SGB. B-Line Series #BB4, Caddy Series #H23 or equal one piece support brackets may be used for mounting light switch boxes only. However, metal stud clips with far side box supports are not acceptable.

J. Boxes for exterior exposed work (where approved by the engineer) shall be Appleton or Pyle National Type FS or FSC for shallow devices and Type FD or FDC for deep devices. Boxes for ceiling mounted light fixtures shall have approved no-bolt fixture studs. Boxes used as junction boxes shall have beveled edge flat steel blank cover.

K. Where outlet boxes are mounted exposed in unfinished areas, (where approved by the engineer) surface mounted boxes shall be 4-inches square, have rounded corners and 1/2-inch raised steel cover plates.

L. Location of outlets on small drawings is approximate and exact dimensions for locations of outlets shall be as taken from large scale plans and details on drawings or as directed by the Architect/Engineer.

1. Outlets shall be located generally from column centers and finished wall lines or to center of wall or joints between wall panels. Ceiling outlets shall be installed at elevation of suspended ceiling connected to outlets in ceiling or slab above. Where necessary to fit and center with panel or ceilings and wall spaces, the contractor must, at no expense the Owner, shift the lighting outlets or other outlets as required by the Architect.

M. Clock outlets shall be mounted 7-inches below ceiling height unless otherwise noted on the drawings. All other outlets shall be mounted at heights above floor as called for on drawings or as directed.

N. Bracket lights over mirrors shall be centered on mirrors with 2-inch fixture clearance above mirror.

O. Boxes for switches and receptacles installed in columns shall be located off center to allow for future partitions.

P. Boxes for switches at or near door shall be installed on the side opposite the hinge. Verify door swing direction prior to rough-in.

Q. To prevent sound from traveling through walls, electrical devices from different rooms shall not be mounted in the same stud place. Through-wall boxes shall not be used. In fire rated walls or partitions, outlet boxes on opposite sides of walls or partitions shall be separated by a horizontal distance of 24-inches. Outlet boxes larger than 4-inch square shall not be installed in fire rated walls or partitions. Verify location of fire rated walls or partitions with Architectural drawings prior to rough-in.

R. Mark all junction boxes and pull boxes and/or the conduit where it enters the box with panel designation and circuit number in permanent, black marker. Mark on the outside where located in unfinished spaces and mark on the inside in finished spaces.

S. Verify exact location of floor boxes and poke-throughs with Architect prior to rough-in.

3.11 TELEPHONE, CABLE TV, COMMUNICATIONS, SECURITY AND OTHER SYSTEMS CONDUIT:

A. These specifications include the furnishing of all labor and materials necessary for the complete installation of a system of conduits, outlets, and boards for use by the system suppliers.

B. This installation must be done according to the requirements of the system suppliers and the general specifications covering "Light and Power" herewith.

C. Provide and install pull boxes at all locations as required by the system suppliers. Mark all pull boxes and/or the conduit where it enters the box with type of system in permanent, black marker. Mark on the outside where located in unfinished spaces and mark on the inside in finished spaces.

D. Provide and install conduit sleeves thru floors and walls as required by the system suppliers.

E. The systems shall be provided with main service conduit sized as indicated on drawings. Each phone, data or TV location requires 1-inch empty conduit with pull rope unless noted otherwise. Conduits shall be routed to nearest associated telephone or data terminal board or above lay-in ceiling. If ceiling is an air return plenum, cables shall be routed completely in conduit or must be rated for use in air return plenum. Verify conditions of job prior to rough-in.

F. Outlets:

1. All wall outlets shall be installed with standard square box, plates furnished by system suppliers, or as directed. All outlets to be located as directed. Outlet boxes not used shall be provided with blank covers.

G. Install the raceway system as shown on drawings.

H. All conduit ends shall be equipped with non-metallic insulated bushings.

I. All 2, 3 and 4-inch conduits within buildings shall include pull boxes after every two 90 degree bends. Size per NFPA 70 Article 370.

J. Vertical conduits/sleeves through closets floors shall terminate not less than 3-inches above the floor and not less than 3-inches below the ceiling of the floor below.

K. Terminate conduit runs to/from the associated telephone or data backboard in a closet or designated space at the top or bottom of the backboard. Conduits shall enter closets next to the wall and be flush with the backboard.

L. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.

M. All empty conduits located in equipment closets or on backboards shall be sealed with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.

N. Conduit runs shall contain no more than four quarter turns (90 degree bends) between pull boxes/backboards.

O. Furnish and install nylon pull rope in all empty conduits. (Sleeves through floor/wall are exceptions).

3.12 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES:

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from ½-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finish grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line.

E. Where conduits enter side of enclosures, field-cut openings for conduits according to manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.13 COLOR CODING OF BOXES, ENCLOSURES, CONDUIT AND RACEWAYS:

A. All boxes, enclosures, conduit and raceways, shall be color coded as follows:

1. Essential Electrical System:
    a. Life Safety Branch: Yellow
    b. Critical Branch: Orange
    c. Equipment Branch: Green
    d. Emergency Power Distribution Not Listed Above: Purple
2. Other Systems:
    a. Fire Alarm: Red
    b. Building Automation and Controls: Blue

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY:

A. This section includes the furnishing, installation, and connection of wiring devices.
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Hospital-grade receptacles.
   3. Weather-resistant receptacles.
   4. Snap switches and wall-box dimmers.

1.3 DEFINITIONS:

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. SPD: Surge Protective Device.

1.4 ADMINISTRATIVE REQUIREMENTS:

A. Coordination:
   1. Receptacles for Owner Furnished Equipment: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS:

A. Product Data (Where indicated in Section "Common Work Results for Electrical", provide the following information): For each type of product.

B. Shop Drawings (Where indicated in Section "Common Work Results for Electrical", provide the following information): List of legends and description of materials and process used for premarking wall plates.

1.6 CLOSEOUT SUBMITTALS:

A. Operational and Maintenance Data: For wiring devices to include all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 GENERAL WIRING DEVICE REQUIREMENTS:

A. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

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

C. Comply with NFPA 70.

2.2 RECEPTACLES:

A. Comply with NEMA WD 1, NEMA WD 6, and UL 498.

B. LIST OF ACCEPTABLE RECEPTACLE MANUFACTURERS

Manufacturer	Volt	Hubbell / Kellems	Leviton	P&S	Bryant	Cooper Wiring Devices
3. Hospital Grade:						
Duplex:	20 A. 125 V.	HBL8300	8300	8300	BRY8300	8300
Ground Fault:	20 A. 125 V.	GFRST83	GFNT2-HG	2097HG	GF83*ST	---
Tamper Resistant:	20 A. 125 V.	HBL8300SGA	8300-SG	TR63H	BRY8300TR	TR8300
Weather Resistant:	20 A. 125 V.	---	---	---	BRY8300WR	---
Tamper Resistant Ground Fault:	20 A. 125 V.	GFTWRST83	GFTR2-UG	2097HGTR	---	---
Weather Resistant Ground Fault:	20 A. 125 V.	GFTWRST83	GFWT2-UG	---	---	---

C. See plans for Special Outlet Schedule.

D. Receptacle body shall be formed of high-impact nylon faced thermoplastic or urea and receptacle contacts shall be Bronze. Hard use industrial specification grade receptacles shall have a one piece brass bridge with integral ground contacts.

E. When only one receptacle is connected to a 20 amp circuit by itself, that receptacle must be rated 20 Amp.

F. All receptacles shall be self-grounding with ground lug.

G. Install receptacles to clear all cabinets, equipment, etc.

H. Color of receptacles: Color of receptacles on the emergency system: Red. Verify colors with architect prior to ordering.

I. All 120V, 20A receptacles located, within kitchens, within 6 feet of a sink, exterior locations, elevator machine rooms, elevator pits, garages, per NFPA 70 and as located on the plans shall be ground fault circuit interrupters (GFCI) for personnel protection (Class A) with 5ma trip. Feed through GFCI receptacles or GFCI breakers may be used to protect other receptacles in the same room and on the same circuit if wired per the manufacturer's recommendations. Prior to final inspection, perform ground fault test on each protected receptacle and submit list of all receptacles tested with results to the Engineer. Label receptacles that are GFCI protected by another feed through GFCI receptacle or by GFCI breaker "GFCI protected".

J. All 20 amp, 125 or 250 volt non-locking receptacles in damp or wet locations should be listed as "weather resistant".

2.3 PENDANT CORD-CONNECTOR DEVICES:

A. Description:

1. Matching plug and receptacle body connector.
2. Body: Nylon with screw-open, cable-gripping jaws and provisions for attaching external cable grip.
3. External Cable Grip: Woven wire mesh type made of high-strength, galvanized steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.4 CORD AND PLUG SETS:

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket, with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable clamping jaws. Match cord and receptacle type for connection.

2.5 TOGGLE SWITCHES:

A. Wall Switches: Wall switches in general, used to control lighting shall be quiet operating.

B. Comply with NEMA WD 1, UL 20, and FS W-S-896.

C. Switches shall be single pole, two-pole, three-way, four-way, keyed, and with pilot light as called for on the drawings. Groups of switches shall be under one gangplate. Where switches are in fire rated walls groups of switches shall be maximum of two (2) gangs under one cover plate.

D. Switches shall be as follows unless specified otherwise.

Single Pole	20 A. 120 V. / 277 V.
Two Pole	20 A. 120 V. / 277 V.
Three-Way	20 A. 120 V. / 277 V.
Four-Way	20 A. 120 V. / 277 V.
Pilot Light	20 A. 120 V. / 277 V.
Key Switch	20 A. 120 V. / 277 V.

E. When only one switch is connected to a 20 amp circuit by itself, it must be rated 20A.

F. All switches shall be self grounding with ground lugs.

G. LIST OF ACCEPTABLE SWITCH MANUFACTURERS

Manufacturer:	P&S	Hubbell / Kellems	Leviton	Bryant	Cooper Wiring Devices
Specification Grade Switches	PS 20AC Series	HBL 1220 Series	1220 Series	4901	AH 1220 Series
Light Commercial/ Residential Grade	500-G Series	CSB 120 Series	1100-G Series	CSB120 Series	CSB120 Series
Key Switches:	*PS 20AC-L Series	HBL 1220-L Series	1221-L Series	4901L	AH 1220 Series
Pilot Light Switches	PS 20AC-CPL Series	HBL 1220-PL Series	1221-PLR Series	4901PLR Series	AH 1220 PL Series

//DESIGNER//	26021 Series	DS 120 Series	5621 Series	9901 Series	7620 Series

H. Pilot light switches shall be illuminated toggle switch lighted red in "on" position. Key switches shall be master keyed.

I. Color of switches: White. Color of switches on the emergency system: Red. Verify colors with Architect prior to ordering.

J. Provide barriers between 277V switches and between 277V and 120V switches installed in a common outlet box.

2.6 WALL-BOX DIMMERS:

A. Comply with UL 1472. Provide with single pole or three-way switching per the drawings.

B. Wall box dimmers shall be linear slide type with preset, no exposed cooling fins, equal to Lutron DIVA Series or Cooper SKYE Series. Wattage as required by load plus 25%.

C. Dimmers shall be provided with required filtering and of the types (solid state, low voltage. 0-10 volt, etc.) as required for the LED driver connected. LED driver hum will not be tolerated.

2.7 WALL PLATES:

A. Wall plates shall be flexible (non-breakable) nylon.

B. Wall plates in high abuse areas shall be stainless steel.

C. Nylon plate color shall be white unless otherwise specified. Nylon plate color for devices on the emergency system shall be Red unless otherwise specified. Nylon plate manufacturer shall be the same as the device manufacturer so that colors match.

D. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.

E. Provide plates for all telephone, cable TV, communication outlets.

2.8 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements set forth by the drawings and these specifications, provide products by one of the following:

1. Hubbell Building Automation/Unenco
2. Leviton Mfg. Company Inc.
3. Watt Stopper
4. Synergy Lighting Controls; Acuity Brands

B. General:

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 5 to 30 minutes. At time of installation, Contractor to set sensor at maximum sensitivity and a time out of 20 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20A ballast load at 120V and 277V ac, for 13A tungsten at 120V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24V dc, 150mA, Class 2 power source as defined by NFPA 70.
4. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay/Power Pack: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.

c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

C. Sensor Types:

1. Passive infrared (PIR) Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage. Typical usages include (but are not limited to) small restrooms, storage rooms, and high volume spaces (i.e. work bays, gymnasiums, etc.).

2. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage. Typical usages include (but are not limited to) large storage spaces, large or multiple stall restrooms, open offices, corridors, break rooms, and work areas.

3. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit. Typical usages include (but are not limited to) classrooms, large offices, and meeting rooms.

D. List of approved products:

Manufacturer:	Hubbell/ Unenco	Leviton	Wattstopper	Synergy	Greengate
1. Wall Mounted, Single Relay, Passive Infrared (900SF)	LHIRS	OSS-ID	PW-100	LIRW	ONW-P-1001-MV
2. Wall Mounted, Dual Relay, Passive Infrared	LHIRD	ODS0D-TD	PW-200	LIRW-DS	ONW-P-1001-DMV
3. Ceiling Mounted Ultrasonic (1000SF)	OMNIUS 1000	OSC10-UOW	WT-1105	LUSOH	ODC-U-1001
4. Ceiling Mounted Ultrasonic (2000SF)	OMNIUS 2000	OSC20-UOW	WT-2205	LUSOH	ODC-U-2000
5. Ceiling Mtd Ultrasonic (Corridor)			WT-2255		
6. Ceiling Mounted Dual-Technology (1000SF)	OMNIDT 1000	OSC10-MOW	DT-300	LMTOH	OMC-DT-2000-R

7. Wall/Ceiling Mounted Dual-Technology (2000SF)	LODT		DT-200		
8. Electronic Timer Switch*	TD-200		TS-400		TSW-MV

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Installation shall be in accordance with NFPA 70, and as shown on the drawings.

B. Comply with NECA 1.

C. Switches shall be located on the latch side of all doors. If switches must be located on the hinge side of a door, they shall be located so that they are not behind the door when it is open. All questionable locations shall be brought to the Engineers/Architects attention.

D. Verify all outlet locations on the job prior to rough-in. Locations may be altered up to 6'-0" in any direction without additional cost to the Owner.

E. When conductors larger than #12 AWG are used on 15A or 20A circuits, splice #12 AWG pigtails for device connections.

F. Install ground pin up on vertically mounted receptacles and install ground pin to the right on horizontally mounted receptacles.

G. Dimmers: Do not remove cooling fins from dimmers. Space boxes as required.

3.2 FIELD QUALITY CONTROL:

A. Convenience Receptacles:

1. Verify ground continuity.
2. Verify correct polarity of hot and neutral conductors.

B. Hospital Grade Receptacles:

1. In addition to above tests for convenience receptacles, test straight-blade receptacles in patient care rooms for the retention force of the grounding blade shall not be less than 4 oz. per NFPA 99.
2. Provide test reports per NFPA 99.

END OF SECTION

SECTION 26 51 00
BUILDING LIGHTING

PART 1 - GENERAL:

1.1 DESCRIPTION:

A. This section includes the furnishings, installation of and connection of all building lighting.

1.2 DEFINITIONS:

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES:

A. Shall conform to the detail drawings, NEC Article 410 and UL-57.

B. Approved Manufacturers: Provide products of firms regularly engaged in the manufacturer of lighting fixtures of types and rating required, whose products have been in satisfactory use in similar service for not less than 5 years. The manufacturer of the lighting fixtures shall comply with the provisions of the appropriate code and standards. All fixtures shall be pretested before shipping.

C. UL or CSA US Listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL 8750 or others as they may be applicable. A listing shall be provided for each fixture type, and the appropriate label or labels shall be affixed to each fixture in the position concealing it from normal view.

D. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.

E. Sheet Metal:

1. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved), and parallel to each other as designed.

2. Wireways and fittings shall be free of burrs and sharp edges and shall accommodate internal and branch circuit wiring without damage to the wiring.

3. Where lighting fixture types are detailed with minimum 20 gauge (0.035 inch) housing, minimum 22 gauge (0.029 inch) housings will be acceptable provided they have strengthening embossed rib and break formations, and meet the rigidity test requirements of Fed. Spec. W-F-1662.

4. When installed, any exposed fixture housing surface, trim frame, door frame and lens frame shall be free of light leaks; lens doors shall close in a light tight manner.

5. Hinged door closure frames shall operate smoothly without binding when the fixture is in the installed position, and latches shall function easily by finger action without the use of tools.

F. LED Drivers shall be serviceable while the fixture is in its normally installed position and shall not be mounted to removable reflectors or wireway covers unless so specified.

G. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.

H. Light fixtures with louvers or light transmitting panels shall have doors with hinges, latches and safety catches to facilitate safe, convenient cleaning and relamping. Vaportight fixtures shall have pressure clamping devices in lieu of the latches.

I. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

J. Metal Finishes:

1. The manufacturer shall apply a standard finish (unless otherwise specified) over a corrosion resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking.

2. Interior light reflecting finishes shall be white with not less than 85 percent reflectances, except where otherwise shown on the drawing.

3. Exterior finishes shall be as shown on the drawings.

K. LED Drivers:

1. Driver shall be serviceable while the fixture is in its normally installed position and shall not be attached to removable reflectors or wireway covers unless so specified.

2. Disconnecting Means: Each LED fixture installed in an indoor location shall have a disconnecting means either internal or external to the fixture, to disconnect simultaneously from the source of supply all conductors of the ballast/driver, including the grounded (neutral) conductor if any. The line side terminals of the disconnecting means shall be guarded. The disconnecting means shall be located so as to be accessible to qualified persons before servicing or maintaining the ballast/driver. The disconnecting means is required for new light fixtures, when an existing driver is replaced, when an existing light fixture is relocated, and when an existing light fixture is recircuited. The disconnecting means shall not be required for fixtures installed in hazardous (classified) locations or for cord-and-plug-connected fixtures.

3. All drivers shall be labeled or listed by UL or ETL. Case marking shall also indicate the required supply voltage, frequency, RMS current, current surge during starting, input watts, and power factor at the designed voltage, open circuit voltage, crest factor and efficacy.

4. Submit, simultaneously with shop drawings, a certified test report by an independent testing laboratory showing that the ballasts/drivers meet or exceed all the performance requirements in this specification.

5. LED Drivers:

a. General Requirements: Unless otherwise indicated, features include the following:

1) Voltage Range: +/- 10 percent of rated input.

2) Total Harmonic Distortion Rating: ≤ 20 percent.

3) Power Factor: ≥ 95 Percent.

4) UL Class 2 output.

5) Line Frequency: 60 Hz.

6) Inrush Current: Per NEMA 410.

7) Ambient Temperature Range: 0°C to 25°C.

8) Maximum Case Temperature: 90°C.

9) Sound Rating: Class A or better.

10) Integral Short Circuit, Open Circuit, and Overload Protection: IEEE C82.41.2

11) Electromagnetic Compliance: FCC Title 47, Park 15, Class A.

L. Provide all lighting fixtures with a specific means for grounding their metallic wireways and housings to an equipment grounding conductor.

M. Lighting Transmitting Components for LED Fixtures:

1. Shall be 100 percent virgin acrylic plastic and nominal .125 inch thick. Styrene lenses shall not be provided for any fixture.

2. Unless otherwise specified lenses and diffusers shall be retained firmly in a metal frame by clips or clamping ring in such a manner as to allow expansion and contraction of the lens without distortion or cracking. At final inspection, all lens that sag or do not lay down flat and lens that sag shall be replaced by the manufacturer.

2.2 LED MODULES:

A. LED Modules:

1. LED modules shall include the following features unless otherwise indicated:

a. Comply with IES LM-79, LM-80, LM-82 and TM-21 requirements.

b. Minimum CRI 80 and color temperature [3500] K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.

c. Minimum Rated Life: IES L70 = [50,000] hours.

d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

e. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.

2. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

3. Color shift over 6,000 hours shall be <0.007 change in U'V' as demonstrates in the IES LM-80-08 testing report.

2.3 LIGHTING CONTROL EQUIPMENT:

A. See the drawings for the arrangement and method of control.

B. Contactors and Relays:

1. Shall be as manufactured by Cutler-Hammer, Allen Bradley, G.E., Westinghouse or Square D by Schneider Electric. They shall be as sized on the drawings.

2. All contactors and relays shall be Tungsten rated.

C. Photo Electric Controls:

1. Photo Electric Controls by Tork, Intermatic and Paragon equal to those indicated below and approved by the Engineer will be acceptable.

2. Photo Electric Controls (Photo switches; Photo cells) shall be Intermatic #K4133 rated at 3000W, 277 volts, or #K4121 rated at 1800W, 120 volts, weatherproof. Mount on roof and orient photo electric controls to the north. Photo-electric controls supplied as a part of a fixture assembly shall be as provided by fixture manufacturer.

D. When a photo cell and time clock are specified for combination control, they shall be connected in series. The time clock to be on during the day, the photo cell will turn the lights on during the day if a storm passes over and at dusk. Set the time clock to turn the lights off in the evening and back on before sunrise per the owners requirements. At sunrise, the photo cell will turn the light off.

2.4 EMERGENCY LIGHTING AND POWER:

A. When emergency battery power packs are optional to the specified exit signs and emergency fixtures and are not included in the model number in the light fixture schedule, the emergency battery power packs shall be included as part of the specified fixture when they are not connected to an emergency generator system. Verify on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Installation shall be in accordance with the NEC, and as shown on the drawings.

B. Align, mount and level the lighting fixtures uniformly.

C. Avoid interference with and provide clearance for equipment. Where the indicated locations for the lighting fixtures conflict with the locations for equipment, change the locations for the lighting fixtures by the minimum distances necessary as approved by the Engineer.

D. For suspended lighting fixtures, the mounting heights shall provide the clearances between the bottoms of the fixtures and the finished floors as shown on the drawings. Verify all heights with the Architect prior to mounting.

E. Lighting Fixture Supports:

1. Provide adequate support for light fixtures. Supports may be anchored to channels of the ceiling construction, to the structural slab or to structural members above a suspended ceiling or to structural members within a partition (for wall mounting).
2. Maintain the fixture positions after cleaning and relamping.
3. Support the lighting fixtures without causing the ceiling or partition to deflect.
4. Hardware for recessed LED fixtures:
    a. For suspended ceiling systems and plaster frame construction, hardware devices such as bolts, screws or rivets shall be used to secure the fixture to the ceiling system structural members. Listed clips identified for use with the type of ceiling framing member(s) and light fixture(s) shall also be permitted.
    b. Fixtures shall be secured to the ceiling system at not less than each of the four corners with additional support and/or connection as required to resist spreading of the support members and to safely lock the fixture into the ceiling system.
5. Hardware for surface mounting LED fixtures to suspended ceilings:
    a. In addition to being secured to any required outlet box, fixtures shall be bolted to a grid ceiling system at four points spaced near the corners of each fixture. The bolts shall be not less than 1/4-inch secured to channel members attached to and spanning the tops of the ceiling structural grid members. Nonturning studs may be attached to the ceiling structural grid members or spanning channels by special clips designed for the purpose, provided they lock into place and require simple tools for removal.
    b. In addition to being secured to any required outlet box, fixtures shall be bolted to a plaster ceiling at four points spaced near the corners of each fixture. Prepositioned 1/4-inch studs or threaded plaster inserts secured to ceiling structural members shall be used to bolt the fixtures to the ceiling.

In lieu of the above, 1/4-inch toggle bolts may be used on new or existing ceiling provided the plaster and lath can safely support the fixtures without sagging or cracking.

6. Provide safety supports from fixture housing up to structure above for all fixtures weighing more than 15 lbs. Supports shall be chains, aircraft cable, factory or field fabricated and rated in excess of twice the weight of the fixture.

F. Provide and install new lamps for each new lighting fixture installed and for each existing lighting fixture reinstalled.

G. Contractor shall coordinate between the electrical and ceiling trades to ascertain approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges), to match the ceiling system being installed. Lay-in type fixture installed in sheet rock ceilings shall be provided with a flange and bolted to the ceiling.

H. Connection to all fixtures mounted in lay-in ceilings shall be as follows: Provide J-Box supported from structure at 12-inches above fixtures for connections. Install UL listed 3/8-inch or 1/2-inch flexible conduit whip down to each fixture. Each whip shall be field cut to length to allow fixture to be relocated 4-foot-0-inches in any direction. Whips shall include 2 or 3 #12 Cu. THHN/THWN conductors (numbers as indicated) and a #12 ground. Fixtures supplied with UL listed whip shall be supplied with ground conductors. Length shall allow mounting fixtures 12-foot-0-inches on center in any direction.

END OF SECTION

SECTION 27 05 01
COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMS CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

B. Installation of raceways, conduit sleeves etc. as required for routing of low voltage systems cabling shall be per specifications Section "RACEWAY SYSTEMS".

1.2 SUMMARY:

A. The extent of the low voltage systems cabling work is indicated by drawings, details and other specification sections. Low voltage systems cabling installation is hereby defined to include, but not be limited to the installation of cabling for voice, data, video, CATV, CCTV, security, nurse call, code blue, fire alarm, access control, public address (P.A.), lighting, and temperature control systems.

B. All cabling materials, cabling, jacks, patch panels, racks, etc. are specified in other sections and shall be provided by the Contractor. The Contractor shall be responsible for all testing as specified in individual specifications sections.

C. It is the intent of the Drawings and Specifications to provide a complete workable telecommunication cabling system ready for the Owner's use. Any item not specifically shown on the Drawings or called for in the Specification, but normally required for a complete system, are to be considered a part of the contract.

1.3 SUBMITTALS:

A. Product Data: Provide submittals for each type of product specified with this section, including but not limited to cable supports, cable wraps, fire rated sleeves, etc.

B. Statement of Warranty

C. Manuals and Technical "Documents

D. Record Drawings

1.4 COORDINATION:

A. The Contractor will cooperate and coordinate with the Owner to minimize conflict with Owner's operations.

B. Coordinate with other building trades and electrical work including wires and cables, electrical boxes and fittings, and raceways to properly interface installation of systems with other work.

C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

D. Sequence installation of low voltage systems cabling with other work to minimize possibility of damage and soiling during remainder of construction.

E. Contractor will be responsible for ceiling tile replacement, wall repainting, etc. due to damage caused by installation of this equipment and cabling.

1.5 PERFORMANCE AND QUALITY ASSURANCE:

A. National Fire Protection Association:

1. NFPA 70: National Electrical Code.
2. NFPA 75: Standard for the Fire Protection of Information Technology Equipment.

B. UL LLC (UL):

1. UL 486A: Wire connectors and soldering lugs for use with copper conductors.
2. UL 1449: Transient voltage surge suppressors.
3. UL 1863: Communications - Circuit Accessories
4. UL 813: Commercial Audio Equipment

C. Telecommunications Industry Association (TIA):
1. ANSI/TIA-568-C.0-1 and addenda "Generic Telecommunications Cabling for Customer Premises".
2. ANSI/TIA-568-C.1-2 and addenda "Commercial Building Telecommunications Cabling Standard".
3. ANSI/TIA-568-C.2 and addenda "Balanced Twisted-Pair Telecommunications Cabling & Component Standard".
4. TIA-160: Sound Systems.
5. TIA-299A: Loudspeakers, Dynamic Magnetic Structures and Impedance.
6. CEA-310-E "Design Requirements for Cabinets, Panels, Racks, and sub-Racks".
7. SE-101-A: Amplifier for Sound Equipment.
8. SE-103: Speakers for Sound Equipment.

D. Federal Communications Commission (FCC):
1. FCC Regulations, Part 15 Title 47.

E. FM Global:
1. FM Global Property Loss Prevention Data Sheet 5/32 (2012).

F. Maintenance Qualifications:
1. Experienced in manufacturing equipment of the types and capacities specified for this project.
2. Equipment has a record of successful in-service performance.

G. Contractor Qualifications:
1. Established communications and electronics contractor for at least five (5) years.
2. Authorized distributor for the equipment supplied with full manufacturer's warranty privileges.
3. Maintains a fully equipped service organization capable of providing full maintenance and service of the installed system within twenty-four (24) hours.
4. Maintains the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being installed.

H. Manufacturer's Instructions: Comply with all installation instructions and methods recommended or required by the manufacturer.

1.6 EQUIPMENT AND MATERIALS:

A. Contractor shall install low voltage systems cabling per the system manufacturer recommendations or requirements or as otherwise specified on the drawings or elsewhere in the specifications.
1. The Manufacturers and Products specified in this document are to be used. No substitutions of components specifically referenced will be allowed without approval prior to bid.
2. All products and materials shall be new, clean, free of defects and free of damage and corrosion.

3. All products installed will meet or exceed the minimum performance requirement as listed in the technical specification of this document and its corresponding addendums.

1.7 WORKMANSHIP:

A. All work shall be done in a workman like fashion. All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed. Workers must clean any debris and trash at the close of each workday.

B. No substitution of product or services will be accepted without prior approval from both the Owner and the Manufacturer providing the Application warranty.

1.8 DELIVERY, STORAGE, AND HANDLING:

A. Delivery: Deliver low voltage system equipment and components in factory-fabricated containers or wrappings, which properly protect equipment from damage.

B. Storage: Store low voltage system equipment and components in original packaging. Store inside in a well-ventilated space protected from weather, moisture, soiling, humidity, extreme temperatures and vandalism. Protection against vandalism will be at the Contractor's expense. Storage recommendations by manufacturer shall be followed.

C. Handling: Handle low voltage system equipment and components carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

1.9 AS-BUILT DRAWINGS:

A. Show on black line prints in red ink all low voltage cable system jack identification numbers, actual cable routing paths, as well as all changes from original plans made during the installation. Separate As-Built drawings shall be provided for each low voltage system installed. Return the "as-built" red lined drawings, specifications and addenda, as set forth in the General conditions, to the Architect/Engineer upon completion of the project.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. All low voltage cabling shall be installed in raceway systems when located in concealed, non-accessible locations. In general, raceways are required for outlets in walls up to above accessible ceilings, above non accessible ceilings, all wall penetrations etc. Provide bushings at all raceway terminations. Fire stop and fire seal all penetrations of fire rated walls.

B. Surface Raceway:

1. Surface raceway shall only be used with prior approval in remodels and modifications to existing spaces where wall and ceiling voids do not permit concealed installation. Surface raceway shall not be used at any other location unless called for on the drawings. All surface raceway and outlets must be painted to match the surface it is attached to. Use outlets and fittings by the same Manufacturer and approved for use with the raceway.

2. Surface raceways shall be Wiremold #500 or #700 series or approved equal. In all cases, do not exceed the fill per the Manufacturers published data.

2.2 CABLE SUPPORTS:

A. Appropriate cable supports shall be used at all times to prevent unnecessary tension or slag in the cable bundles. Support spacing and size shall be as required to comply with applicable ANSI Standards and manufacturers recommendations.

B. Cable Tray: Wire mesh basket cable tray shall be provided as shown on the drawings. Cable tray shall be sized to support all cable with a maximum fill of 40%. Wire mesh spacing

shall not exceed 2 inches (5 cm) by 4 inches (10 cm). Refer to section "COMMUNICATIONS CABLE TRAY".

C. J-Hooks: J-Hooks shall be sized to support all cable with a maximum fill of 40%.

D. Cable Wraps: All cable wraps shall be plenum rated re-enterable hook and loop type, sized as required.

2.3 CONDUIT SLEEVES:

A. Conduit sleeves shall be one of the following:

1. Rigid steel or IMC conduit with threaded ends and non-metallic bushings on each end.
2. EMT conduit with U.L. Listed slide on non-metallic bushings on each end.

B. Fire rated conduit sleeves shall be:

1. Provided at fire rated walls or penetrations and as indicated on the drawings.
2. 'Hilti' #CP 653, or approved equal.

2.4 CABLE LABELS:

A. Shall meet the legibility, defacement, exposure, and adhesion requirements of UL 969. Cable labels shall be preprinted or computer printed type. Handwritten labels are not acceptable. Labels shall be flexible vinyl, laminating type resistant to moderate amounts of oil, dirt, and temperature ranges from -40°F to 158°F. Label color shall contrast with cable jacket color to make labels easily distinguishable. (Brady material B-427 or equal thermal transfer printable vinyl tape.)

B. Labeling of cable shall consist of lettering or numbering as required by Owner to coordinate with existing labeling schemes. Contractor to coordinate exact labeling scheme of cables with Owner.

2.5 GROUNDING AND BONDING: REFER TO "GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS".

PART 3 - EXECUTION

3.1 REQUIREMENTS FOR LOW VOLTAGE SYSTEMS CABLE INSTALLATION:

A. General: Examine areas and conditions under which low voltage cabling systems are to be installed. Notify the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

B. Cable Pathways:

1. Pathways shall be designed and installed to meet applicable local and national building and electrical codes or regulations.
2. All pathway components shall be installed according to manufacturer's specifications.
3. Grounding/Earthing and bonding of pathways shall comply with applicable codes and regulations.
4. Pathways shall not have exposed sharp edges that may come into contact with low voltage systems cables.
5. The number of cables placed in a pathway shall not exceed manufacturer specifications, nor, shall the geometric shape of a cable be affected.
6. Pathways shall not be located in elevator shafts.
7. Vertically routed cables through chases must be supported per manufacturers and applicable ANSI Standards to prevent cable tension from occurring.

8. All cables above accessible ceilings shall be supported by cable trays and/or j-hooks located approximately 6" above lay-in ceilings below all mechanical and other electrical equipment.
9. Cable Tray: All cabling should be installed in low voltage cable trays where possible. Power cable must never reside in the same cable tray as the low voltage system cabling. All cabling installation procedures shall also adhere to the recommended "Do's and Don'ts" in TIA 568.
10. J-Hooks: J-Hooks shall be used in common areas where cable trays are not available and/or as indicated on the plans. J-Hooks shall be located with a maximum spacing of 4'-0" on center. Cables shall not contact the ceilings, piping, light fixtures, ducts, etc. All cables must be suspended independently from other supports.
11. Cable Wraps: Cable wraps shall be used at appropriate intervals to secure cable between j-hooks or cable trays, and to provide strain relief at termination points. These wraps shall not be over tightened to the point of deforming or crimping the cable sheath. Cable wraps should rotate 360 degrees when applied correctly. Spacing shall be a maximum of 4'-0". Placement shall not be over cable labels. Cable wraps (zip-tie type or Velcro type) shall not be used as a means of support.
12. Conduit Sleeves: Conduit sleeves shall be provided where cables are indicated to pass through walls and at other locations as indicated on the plans. Sleeves shall be 2-inch conduit minimum extending 6-inches on either side of walls. Where possible, sleeves shall be located 6-inches above ceiling. See paragraph "FIRESTOPPING" for sleeves located in fire rated partitions or floors.

C. Bend Radius:
1. The maximum cable bend radii shall not exceed manufacturer's specifications.

D. Wiring Methods
1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
a. Install plenum rated cable in environmental air spaces, including plenum ceilings.
2. Bundle, lace and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.2 FIRESTOPPING:

A. Properly installed fire stop systems shall be installed to prevent or retard the spread of fire, smoke, water, and gases through all floors, and fire/smoke walls. Fire stops shall be UL listed for the wall rating and construction method. This requirement applies to openings designed for low voltage systems cabling use that may or may not be penetrated by cables, wires, or raceways.
1. Raceways: Completely fill and seal clearances between raceways and openings with fire stop material.
2. Fire Rated Sleeves: Completely fill and seal clearances between sleeves and openings with fire stop material. Fire rated conduit sleeves shall comply with paragraph "CONDUIT SLEEVES".

B. Fire stops shall be installed according to applicable codes.

C. Documentation of fire stops shall be in accordance with the latest edition of TIA-606.

3.3 ADJUSTING AND CLEANING:

A. Cleaning: Clean all equipment and components of dirt and construction debris upon completion of installation. Remove scrap cable components off site as required.

B. Touch-up: Touch-up scratched or marred enclosure surfaces to match original finishes.

C. Protection: Protect installed equipment, cabling and components from damage during remainder of construction period.

3.4 LABELING:

A. Labeling of cable shall consist of lettering or numbering as required by Owner to coordinate with existing labeling schemes. Contractor to coordinate exact labeling scheme of cables with Owner.

B. Documentation of labeling shall be in accordance with the latest edition of TIA-606

END OF SECTION

SECTION 27 05 02
COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

B. Refer to section "COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMS CABLING" for additional information.

1.2 SUMMARY:

A. The extent of the communications system work is indicated by drawings and details, and is hereby defined to include, but not be limited to the installation of voice, data, fiber, video, CATV, and CCTV.

B. All cabling materials, cabling, jacks, patch panels, racks, etc. are specified in other sections and shall be provided by the Contractor. The Contractor shall be responsible for all testing as specified in individual specifications sections.

C. It is the intent of the Drawings and Specifications to provide a complete workable telecommunication cabling system ready for the Owner's use. Any item not specifically shown on the Drawings or called for in the Specification, but normally required for a complete system, are to be considered a part of the contract.

1.3 SUBMITTALS:

A. Installers qualifications (including references).

B. Statement of Warranty

C. Manuals and Technical Documents

D. Record Drawings

1.4 QUALITY ASSURANCE:

A. Codes and Standards: Refer to section "COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMS CABLING" in addition to the following:

1. Rural Utilities Service (RUS): Comply with Rural Utilities Service specifications pertaining to construction and installation of telephone cabling.

B. System Manufacturers Application Warranty: The system manufacturer shall provide a total application assurance warranty per Part 3 of this section. Contractors shall be certified by the manufacturer to be an approved system installer. The manufacturer and the certified installer shall take full responsibility for a quality installation complying with all applicable standards.

C. Contractor Qualifications and Training:

1. The Contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to data, voice and imaging network systems. The Contractor shall at a minimum possess the following qualifications:

a. Licenses/permits required performing telecommunications installations in the specified jurisdiction.

b. Personnel trained and certified by the proposed Cabling System Manufacturer.

c. All installation Personnel on site must be under the supervision of an individual trained and certified to install the approved manufacturers cabling System.

d. The Designer and Installers shall show proof of current certification of the proposed Cabling System Manufacturer via a current card given after attending a minimum 5- day course or a re-certification class. This card must be current and be in the possession at all times they are on the project.

e. Provide (3) previous references of the type of installation provided in this specification.

f. Personnel trained and certified in fiber optic cabling, splicing, termination and testing techniques. Personnel must have experience using a light meter and OTDR.

g. Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.

h. Personnel knowledgeable in local, state, province and national codes, and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall be followed.

i. Have at least (5) years successful installation experience with projects utilizing telephone, data, video and other low voltage systems and wiring similar to that required for this project to ensure system is compliant with standards.

j. Must be a Building Industry Consulting Service International (BICSI) member and have an RCDD or BICSI certified ITS Technician on staff.

k. Must possess current liability insurance certificates.

1.5 EQUIPMENT AND MATERIALS:

A. Refer to section "COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMS".

B. All products installed will meet or exceed the minimum performance requirement as listed in the technical specification of this document and its corresponding addendums.

1.6 WORKMANSHIP AND SUBSTITUTIONS:

A. Refer to section "COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMs".

B. All work shall be done in a workman like fashion of the highest standards in the telecommunications industry. All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed.

C. No substitution of product or services will be accepted without prior approval from both the Owner and the Manufacturer providing the Application warranty.

1.7 AS-BUILT DRAWINGS:

A. See Section "COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMS".

1.8 SUPPORT AND WARRANTY:

A. Applications Supported:

1. Existing and future applications supported for a channel model warranty include those approved by the Institute of Electronic and Electrical Engineers (IEEE), the Asynchronous Transfer Mode (ATM) Forum, the American National Standards Institute (ANSI) or the International Organization of Standards (ISO) that specify compatibility with the cable referenced herein. Additional applications that are covered by this warranty include all future applications developed for the specified structured cabling system.

B. Basic Warranty:

1. Either a basic link or channel model configuration may be applied to the horizontal and/or backbone sub-systems of the structured cabling system. Applications assurance is only applied to a channel model configuration.

C. Applications Assurance Warranty:

1. A twenty (20) year warranty shall be provided for an end-to-end channel model installation which covers applications assurance, cable, connecting hardware and the labor cost for the repair or replacement.

D. Product Warranty:

1. The manufacturer of passive telecommunications equipment used in a manner not associated with the Systems Warranty must have a minimum five (5) year Component Warranty on its entire product. The Products Warranty covers the components against defects in material or workmanship under normal and proper use.

PART 2 - PRODUCTS

2.1 BACKBOARDS:

A. See Section "COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMS".

2.2 RACEWAYS

A. Refer to section "COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMS" Execution and section "RACEWAY SYSTEMS".

2.3 REQUIREMENTS FOR COMMUNICATIONS INSTALLATION:

A. General: Examine areas and conditions under which systems are to be installed. Notify the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

B. Horizontal Cable Routing:

1. All horizontal cables, regardless of media type, shall not exceed 295 ft (90 m) in total length from the telecommunications outlets in the work area to the horizontal cross connect. This does not include the allowable distances for equipment cords and patch cords as listed below.

2. The length of patch cords in the telecommunications room/closet shall not exceed 16 ft (4.9 m) and equipment cords in the work area shall not exceed 16 ft (4.9 m) unless used in conjunction with a multi-user telecommunications outlet assembly (MUTOA).

3. Horizontal pathways shall be installed or selected such that the minimum bend radius of horizontal cables is kept within manufacturer specifications both during and after installation.

   a. Minimum conduit bend radius shall not be less than 6 times the diameter for 2" conduit and smaller.

   b. Minimum conduit bend radius shall not be less than 10 times the diameter for conduits larger than 2".

4. Cables shall be supported by means that are structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 4 ft apart.

5. The installation of telecommunications cabling installed in grounded metallic conduit shall maintain a 12 inch minimum distance from all sources of Electrical Magnetic Interference (EMI), such as; fans, motors, fluorescent fixtures, transformers, etc. Cabling installed in cable tray or j-hooks shall maintain a 24 inch minimum distance from all sources of EMI. All cables shall maintain a 48 inch minimum distance from transformers. Engineer shall be notified in advance if these clearances cannot be met.

6. The installation of telecommunications cabling shall maintain a minimum clearance of 10 ft from power cables in excess of 480 Vrms. No telecommunications cross-connects shall be physically located within 20 ft (6 m) of electrical distribution panels, step down devices, or transformers, which carry voltages in excess of 480 Vrms. Engineer shall be notified in advance if these clearances cannot be met.
7. Cables shall be run using a star topology from the telecommunications room serving that floor to every individual telecommunications outlet.
8. The Contractor shall observe the bending radius and pulling strength requirements of the 4-pair UTP and fiber optic cable during handling and installation.
    a. Pulling force on 4-pair UTP cable shall not exceed 25lb/f.
    b. Pulling force on 2 or 4-strand optical fiber shall not exceed 50lb/f.
9. Each run of UTP cable shall not contain splices between the horizontal portion of the cross-connect in the telecommunication room and the telecommunications outlet.
10. In the telecommunications room where cable trays or cable racking are used, the contractor shall provide appropriate means of cable management such as hook and loop cable managers to create a neat appearance and practical installation.
11. Continuous conduit runs installed by the contractor should not exceed 100 ft (30.5 m) or contain more than two (2) 90 degree bends without utilizing appropriately sized pull boxes.
12. All horizontal pathways shall be installed and grounded to meet applicable local and national building and electrical codes.
13. The number of horizontal cables placed in a cable support or pathway shall not exceed manufacturer's recommendations and shall not cause a change in the geometric shape of the cables.
14. Maximum conduit pathway capacity shall not exceed a 40% fill. Perimeter and furniture fill shall be limited to 60% fill for moves, adds and changes.
15. Horizontal distribution cables shall not be exposed in the work area or other locations with public access.
16. Cables routed in a suspended ceiling shall not be draped across the ceiling tiles. Cable supports shall be mounted as close as possible to 6 in (15 cm) above the ceiling grid supporting the tiles.

C. Work Area Termination:
1. All UTP cables wired to the telecommunications outlet/connector shall have 4-pairs terminated in eight-position eight conductor (8P8C) modular outlets in the work area. All pairs shall be terminated.
2. The telecommunications outlet/connector shall be securely mounted.
3. The height of the telecommunications faceplates shall be to applicable codes and regulations, and/or the same height of nearby electrical faceplates.
4. Provide specialized outlets for the specific systems furniture manufacturer. Outlets must be fully compatible. Verify systems furniture manufacturer with Architect or Owner.

D. Tightening: Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors.

E. Bend Radius:
1. The maximum cable bend radii shall not exceed manufacturer's specifications.
2. In spaces with UTP cable terminations, the maximum bend radius for 4-pair cables shall not exceed four times the outside diameter of the cable. The maximum bend

radius for multi-pair cables shall not exceed ten times the outside diameter of the cable. Manufacturer specifications shall be followed if more stringent.

3. During the actual installation, bend radius on 4-pair cables shall not exceed eight times the outside diameter of the cable and multi-pair cables shall not exceed ten times the outside diameter of the cable. Manufacturer specifications shall be followed if more stringent.

4. The bend radius of 2 or 4-strand optical fiber cable shall be 1" (2.5 cm) minimum under no load and 2" (5 cm) minimum under load. Manufacturer specifications shall be followed if more stringent.

F. Slack:

1. In the work area, a minimum of 12 in (30 cm) shall be left for UTP cables. A minimum of 3 ft (1 m) shall be left for fiber cables.

2. In telecommunications room/closets a minimum of 10 ft (3 m) of slack shall be left for all fiber cables and a minimum of 3 ft (1 m) of slack shall be left for all UTP cables. This slack must be neatly managed on trays or other support types.

2.4 GROUNDING: SEE SECTION "GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

PART 3 - EXECUTION

3.1 TESTING PROCEDURES:

A. Testing of each system shall be performed in accordance with the manufacturer's specifications and as outlined in the other individual low sections of this specification.

B. All installed channels shall perform equal to or better than the minimum standards.

3.2 LABELING

A. Labeling of data outlets shall consist of non-permanent lettering indicating a "data" port and extension located above the port. Numbering shall be as required by owner to coordinate with existing labeling schemes. Contractor shall coordinate exact labeling of outlets with Owner. The label shall consist of 2 lines. Line 1 shall be 6 characters (Example "A2A05K") as follows; 1st character – Zone, 2nd character - Floor; 3rd -5th characters - area location, 6th character - multiple jack designation at that location. Line 2 shall be 11 characters (Example "WC2NE-01447") as follows; 1st & 2nd characters-room/closet type (WC stands for wiring closet); 3rd character – floor, 4th & 5th characters - closet location, 7th & 8th characters - rack #; 9th character - panel designation, 10th & 11th character - Port #.

B. Cables:

1. Horizontal and backbone cables shall be labeled at each end. The cable or its label shall be marked with its identifier

2. All cables shall be appropriately labeled in all junction boxes.

3. No cabling identifier will duplicate any previous, active cable identifier.

C. Faceplates:

1. A unique identifier shall be marked on each faceplate to identify it as connecting hardware.

2. Each port in the faceplate shall be labeled with its identifier.

D. Racks, Panels, Blocks:

1. A unique identifier shall be marked on each piece of connecting hardware to identify it as connecting hardware.

2. Each port on the connecting hardware shall be labeled with its identifier.

a. Telecommunications outlets/connectors.

b. Backbone cable routing and terminations.

c. Horizontal cable routing and terminations.

E. Documentation of labeling shall be in accordance with the latest edition of TIA-606.

3.3 RECORDS:

A. All records shall be created by the installation contractor and turned over at the completion of work. The format shall be computer based. Both soft copies and hard copies shall be included as part of the As-Built package. The minimum requirements include:

1. Cable records must contain the identifier, cable type, and termination positions at both ends, splice information as well as any damaged pairs/conductors.

2. Connecting hardware and connecting hardware position records must contain the identifier, type, damaged position numbers, and references to the cable identifier attached to it.

3. Test documentation on all cable types shall be included as part of the As-built package.

3.4 DOCUMENTATION/AS-BUILTS/RECORDS:

A. All cables shall be labeled in accordance with the Owner's labeling standards.

B. All cables shall be labeled at minimum with-in 12-inches of each end of the cable jacket, ((to include each end in the telecom space, at the work area, and at the consolidation point (CP) if present) per the latest edition of the ANSI/TIA-606 Standard. Prior to bidding, Contractor shall verify with Designer of Record whether a higher class of labeling is required for the project, per the latest edition of the ANSI/TIA-606 Standard.

C. No cabling identifiers shall duplicate any previous active cable identifier.

D. All documentation, such as, As-Builts and records shall be kept on file by the Certified Installer for the entire term of the warranty.

E. As-built drawing shall be supplied by the contractor showing the locations of and identifiers for all components.

END OF SECTION

SECTION 27 15 00
COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

A. Section Includes:

1. UTP cabling.
2. Multiuser telecommunications outlet assemblies.
3. Cable connecting hardware, patch panels, and cross-connects.

1.3 DEFINITIONS:

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways. Refer to TIA standards.

D. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

E. EMI: Electromagnetic interference.

F. IDC: Insulation displacement connector.

G. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

H. LAN: Local area network.

I. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors. Refer to TIA standards.

J. NRTL: Nationally recognized testing laboratories.

K. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

L. RCDD: Registered Communications Distribution Designer.

M. UTP: Unshielded twisted pair.

N. VoIP: Voice over internet protocol.

1.4 PERFORMANCE AND QUALITY ASSURANCE:

A. Installer Qualifications: See section "COMMON WORK RESULTS FOR COMMUNICATIONS".

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

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. NFPA 75: Standard for the Fire Protection of Information Technology Equipment.

E. Telecommunications Pathways and Spaces: ANSI/TIA-569-B and addenda "Commercial Building Standard for Telecommunications Pathways and Spaces".

F. Grounding: See section "COMMON WORK RESULTS FOR COMMUNICATIONS".

G. General Performance:

1. ANSI/TIA-568-B.1-2-2011 and addenda "Commercial Building Telecommunications Cabling Standard".
2. ANSI/TIA-568-B.2 and addenda "Balanced Twisted-Pair Telecommunications Cabling & Component Standard".
3. ANSI/TIA-568-B.3-1-2011 and addenda "Fiber Optic Cabling Components Standard".

H. FM Global:

1. FM Global Property Loss Prevention Data Sheet 5/32 (2012).

1.5 HORIZONTAL CABLING DESCRIPTION:

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the work area telecommunications outlet/connector and the horizontal cross-connect located in the telecommunications room/closet. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

1. ANSI/TIA-568-C.1-2-2011 and addenda "Commercial Building Telecommunications Cabling Standard" requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Horizontal cabling shall be connected to a telecommunications room/closet located on the same floor as the work area being served, unless otherwise allowed on the plans.
5. If telecommunications closets are shown on the plans to serve multiple floors, provide separate racks to serve each floor shown.

B. If work areas are not sufficiently designed on the plans, a work area shall be approximately 100 sq. ft. (9.3 sq. m) and shall include the components that extend from the telecommunications outlet/connectors to the station equipment.

C. A minimum of two horizontal cables shall be routed to each work area.

D. The maximum allowable horizontal cable length is 295 feet (90 m) for all cable types. This maximum allowable length does not include an allowance for equipment cords to the workstation equipment or an allowance for patch cords in the horizontal cross-connect.

1.6 SUBMITTALS:

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

B. Shop Drawings:

1. Submit horizontal labeling convention for approval by Owner prior to installation. See section "COMMON WORK RESULTS FOR COMMUNICATIONS" for additional labeling information.
2. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.
3. System Labeling Schedules: Electronic copy of labeling schedules, in software or format selected by Owner.

4. Cabling administration drawings and printouts.

C. Qualification Data: Refer to Section "COMMON WORK RESULTS FOR COMMUNICATIONS".

D. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 DELIVERY, STORAGE AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end.
2. Test each pair of UTP cable for open and short circuits.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 COORDINATION:

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

PART 2 - PRODUCTS

2.1 UTP CABLE:

A. HCA has a group pricing arrangement for all low voltage and structured cabling materials and other solutions through HealthTrust Group Purchasing (HGP), with vendor Accu-Tech (www.accu-tech.com).

B. The contractor shall utilize Accu-Tech for all pricing of material. Accu-Tech's HGP contract #6715 – only when previous approvals have been made should you purchase outside of HGP pricing.

C. Accu-Tech Contract:

1. Tim Flannagan, Director of Healthcare, 615-585-3972; Tim.Flannagan@accu-tech.com.
2. Buddy Strader, Account Executive, 615-804-9697; Buddy.Strader@accu-tech.com.

D. Description: 100-ohm, Cat. 6, 4-pair UTP, color as noted below.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with ANSI/TIA-568-C.1-2-2011 and addenda "Commercial Building Telecommunications Cabling Standard" for performance specifications.
3. Comply with ANSI/TIA-568-B.2-10 "Transmission Performance Specifications for 4-Pair 100 OHM Augments Cat. 6 Cabling".
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    a. Communications, General Purpose: Type CM or CMG.
    b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
    c. Communications, Riser Rated: Type CMR, complying with UL 1666.
    d. Communications, Limited Purpose: Type CMX.
    e. Multipurpose: Type MP or MPG.

f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.

g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

5. All cables shall be plenum rated unless otherwise noted on the drawings.

6. All UTP cables shall meet the following requirements:

E. Cable Colors:

1. Date/Network: Black

2. Wireless: Yellow

Cat. 6 - VoIP				
	Max / Min Units	**100 MHz**	**200 MHz**	**250 MHz**
Attenuation: (Insertion Loss)	Max dB	21.3	31.5	35.9
NEXT Loss: (Near end Crosstalk Loss)	Min dB	39.3	34.8	33.1
PSNEXT Loss: (Power Sum Near-end Crosstalk Loss)	Min dB	37.1	31.9	30.2
ELFEXT Loss: (Equal level far-end crosstalk)	Min dB	---	---	---
Return Loss:	Min dB	12.0	9.0	8.0
Propagation Delay	Max ns	548	547	546
Attenuation to Crosstalk Ratio:	Min dB	23.3	17.2	15.3
PSACR: (Power Sum Attenuation to Crosstalk Ratio)	Min dB	20.3	14.2	12.3

Cat. 6a – Wireless Infrastructure					
	Max / Min Units	**100 MHz**	**200 MHz**	**250 MHz**	**500 MHz**
Attenuation: (Insertion Loss)	Max dB	20.9	30.1	33.9	49.3
NEXT Loss: (Near end Crosstalk Loss)	Min dB	39.9	34.8	33.1	26.1
PSNEXT Loss: (Power Sum Near-end Crosstalk Loss)	Min dB	37.1	31.9	30.2	23.2
ELFEXT Loss: (Equal level far-end crosstalk)	Min dB	---	---	---	---
Return Loss:	Min dB	12.0	9.0	8.0	6.0
Propagation Delay	Max ns	548	547	546	546
Attenuation to Crosstalk Ratio:		23.3	17.2	15.3	9.3

	Min dB				
PSACR: (Power Sum Attenuation to Crosstalk Ratio)	Min dB	20.3	14.2	12.3	6.3

2.2 UTP CABLE HARDWARE:

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

1. ADC Telecommunications, Inc.
2. Belden
3. Hubbell Premise Wiring.
4. Leviton Voice & Data Division.
5. Ortronics/Legrand
6. Panduit Corp.
7. The Siemon Company
8. Superior Essex, Inc.

B. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA-568-C.2 and addenda "Balanced Twisted-Pair Telecommunications Cabling & Component Standard", IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables. Panels shall have the following characteristics:

1. Be sized to fit a standard, 19-inch rack, or be capable of mounting to a wall.
2. Be made of black anodized aluminum in 24- and 48- port configurations.
3. Have cutouts to fit the variety of information outlets used at the work area, supporting UTP, SC, ST, MT-RJ, and LC fiber adapters, as well as coaxial applications.
4. Have cutouts, which allow terminated jacks to pass through the panel for easy rearrangement.
5. Have changeable ports, which are removed from the front of the panel to allow custom configuration or modification to the panel.
6. Have port identification numbers provided on both the front and rear of the panel.
7. Have mounting slots compatible with CEA-310-E "Design Requirements for Cabinets, Panels, Racks, and Sub-Racks".
8. Allow modular insert to accept 110-style patch plugs as a means of termination.

D. Jacks and Jack Assemblies: Modular, color-coded, 8P8C eight-position modular receptacle units with integral IDC-type terminals. Jacks and jack assemblies shall have the following characteristics:

1. Provide in black.
2. Accommodate a minimum of two 8-position / 8-conductor modular jacks.
3. Utilize 110 style IDC connectors, category to match cabling.
4. Termination shall be accomplished with a single conductor impact tool.
5. Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.

6. Have rear protective strain relief caps with side or rear entry, which can be installed onto cable before or after termination.
7. Allow for a minimum of 200 re-terminations without signal degradation below standards compliance limit.
8. Have 45 degree angled design available with angled shroud to protect connection and help control bend radius.
9. Provide universal application / multi-vendor support.
10. Support industry standards for T568A or T568B wiring options.

2.3 UTP CABLE PATCH CORDS

A. Patch Cords: Factory-made, 4-pair cables in lengths as directed by Owner. Jacket color shall be as directed by Owner.

1. Modular Patch Cords: All modular plugs shall be equipped with a matching Cat. 6 patch cord.
   a. Minimum cord length at work area plugs shall be 9 ft (2.7 m).
   b. Patch cords shall be backwards compatible with lower performing categories.
   c. Modular plugs shall exceed FCC CFR 47 part 68 subpart F and IEC 60603-7 specifications, and have 50 micro-inches minimum of gold plating over nickel contacts.
   d. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure category performance. Patch cords shall have latch guards to protect against snagging.
   e. Patch cords shall be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants and shall exhibit PSNEXT performance.

PART 3 - EXECUTION

3.1 HORIZONTAL CABLE ROUTING: REFER TO SECTION "COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMS CABLING".

3.2 WIRING METHODS: REFER TO SECTION "COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMS CABLING".

3.3 FIRESTOPPING: REFER TO SECTION "COMMON WORK RESULTS FOR LOW VOLTAGE SYSTEMS CABLING".

3.4 LABELING: REFER TO SECTION "COMMON WORK RESULTS FOR COMMUNICATIONS".

3.5 FIELD QUALITY CONTROL:

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with ANSI/TIA-568-B.1-2-2011 and addenda "Commercial Building Telecommunications Cabling Standard".
2. Visually confirm category, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

4. End-to-end cabling will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

C. UTP Performance Tests:

1. Test Equipment Parameters
   a. All UTP field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate shall be provided for review prior to the start of the testing.
   b. Auto test settings provided in the field tester, for testing the installed cabling, shall be set to the default parameters.
   c. Test settings selected from options provided in the field testers shall be compatible with the installed cable under test.
   d. All field testing shall be performed with an approved level IIe or III UTP field test device.
2. All installed channels shall perform equal to or better than the minimum requirements as specified in the table below:

Worst Case Channel Performance at Highest Frequency		
Parameters	**Cat. 6**	**Cat. 6a**
Frequency Range	1-600 MHz	1-600 MHz
Attenuation	53.0 dB	50.1 dB
NEXT Loss	39.6 dB	32.6 dB
Power Sum NEXT Loss	36.6 dB	31.1 dB
ELFEXT	16.9 dB	29.2 dB
Power Sum ELFEXT	15.2 dB	26.4 dB
Return Loss	17.6 dB	14.7 dB
Delay Skew	35 ns	35 ns
ACR	0 dB	-
Power Sum ACR	0 dB	-

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report and submitted to the Owner.

E. Remove and replace cabling, at no cost to the Owner, where test results indicate that they do not comply with specified requirements.

END OF SECTION

SECTION 28 31 00
FIRE ALARM – ADDRESSABLE

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section of the specifications includes the furnishing, installation, and connection of a solid-state, low voltage, modular, hardwire, supervised fire alarm system to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm indicating devices, auxiliary control devices, power supplies, and wiring as shown on the drawings and specified. The setting of all addressable devices shall be performed by the manufacturer.

B. Equipment and devices shall be compatible with the existing fire alarm system.

C. Fire Alarm systems shall comply with requirements of NFPA 70, 72, (including appendices) 90A, 101 for local building systems except as modified and supplemented by this specification. This is a performance specification. The devices shown on the drawings indicate design intent and shall be the minimum provided. Provide all other devices as required by other governing laws, codes, standards, and local inspectors.

D. The Electrical Contractor shall prepare design drawings (including plans showing device locations and riser diagram), calculations, documents, and catalogs cut sheets on all components and submit as shop drawings for approval. The system designer shall be identified on the system design documents. The system designer and installer shall provide evidence of their qualifications and/or certifications when required by the AHJ or engineer of record. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculations, and single-line connection diagram.

1. The system supplier shall submit fire alarm system drawings and calculations sealed by a licensed professional engineer for approval. After approval, shop drawings to be submitted to the State Fire Marshal for approval.

1.2 CONTROL PANELS:

A. Audio/visual signals shall only sound upon any alarm within the building served.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL:

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by Underwriters Laboratories, Inc., and Factory Mutual Research Corporation. The authorized representative of the manufacturer of the major equipment such as control panel, annunciator, transmitters, and initiating devices, shall install and be responsible for satisfactory total system operation and its certification. Manufacturer shall provide NICET certified personnel to test equipment.

B. Approved Manufacturers: Siemens Infrastructure and Cities (Siemens IC).

2.2 WIRING:

A. Conduit and Wire Sections RACEWAY SYSTEMS and LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES shall apply:

1. This contractor shall furnish and install all wiring, conduit, junction boxes and outlet boxes required for the installation of a complete system. All wiring shall be installed in red colored metallic conduit; wiring shall be color coded throughout and shall test free and clear of opens, grounds and shorts between conductors. All wiring shall be #18 gauge or minimum size as determined by the manufacturer, copper,

with the exception of audio and visual alarm devices which shall have #14 gauge copper. All wiring shall have a minimum insulation rating of 300V. All equipment shall be grounded with an approved earth ground wire being supplied at the control panel. All wiring shall be in conformance with Article 760 of the National Electric Code. Audible and visual devices shall be capable of being controlled individually.

2. Contractor and equipment supplier shall jointly provide a proposed riser diagram for the fire alarm system indicating all devices, equipment, and wiring with the submittals prior to construction. If changes are made during construction a corrected riser diagram shall be submitted with the operating and maintenance manuals upon project completion. Riser diagram shall use symbols as shown on the drawings and shall have room numbers adjacent to all devices. All wiring shall be in conduit.

3. Wires in junction boxes and cabinets shall be permanently tagged and identified with metal or phenolic tags attached by nylon ties.

B. Terminal Boxes, Junction Boxes and Cabinets:

1. Shall be galvanized steel and in accordance with UL.

2. Paint box and cover red and identify with letters of white paint stenciled as "Fire Alarm System" in accordance with Section PAINTING.

3. Junction boxes shall have a volume 40 percent greater than required by the NEC. Minimum sized wire shall be considered as 14 AWG for calculation purposes.

4. Terminal cabinets shall have identified pressure type terminal strips and shall be located at the base of each riser as shown on the drawings.

C. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted.

D. Audible indicating devices and visual indicating devices shall be capable of being controlled individually.

2.3 FIRE ALARM CONTROL PANEL:

A. Existing to Remain

B. Power Supply:

1. Provide additional power supplies as required.

C. Circuit Arrangement:

1. Provide means whereby any device or signal circuit may be disconnected from the system. Removing any initiation or alarm circuit shall leave the remainder of the system in normal operating condition and light an individual trouble lamp which shall remain lighted until the circuit is restored to normal operating condition.

2. Arrange circuits so that if an open circuit occurs in the signal coil, it shall not prevent other audible signals on the same circuit from sounding.

3. Each circuit shall be individually fused.

D. Circuit Supervision:

1. Each alarm initiating circuit, alarm indicating circuit, and local energy transmitter trip circuit, and sprinkler and standpipe valve circuit shall be supervised against the occurrence of a break or ground fault condition in the field wiring. These conditions shall cause a trouble signal to sound in the control panel until manually silenced by an off switch.

E. Trouble signals:

1. Arrange the trouble circuit for ring back operation to prevent switch disarrangement during normal supervisory condition. Automatic reset arrangement is acceptable in lieu of ring back operation.

2. System trouble switch off and on lamps shall be visible through the control panel door.

2.4 AUDIO/VISUAL FIRE ALARM SIGNAL DEVICES:

A. Shall be electrical supervised, vibrating, horn type, flush mounted at 80" AFF per ADA. Audio devices shall use the ANSI S3.41 Three-Pulse Temporal Code Standard Evacuation Signal.

B. Unless otherwise shown on the drawings, shall have a nominal rating of 87 dB at ten feet.

C. Mount on removable adapter plates on conduit boxes.

D. Provide surface mounted box adapter for surface mounted devices in finished spaces.

E. Audio signals located outdoors shall be weatherproof type with metal housing and protective grille.

F. Visual Signal: Shall be integral with the audio signal and shall have clear dome. Lettering on housing to read "FIRE" and be visible from all viewing directions. Lettering shall be white for red appliances and red for white appliances. Dome to be high impact non-yellowing plastic. Lamps shall be low voltage type for flashing service with a xenon flasher that meets ADA and UL 1971 requirements. Lamp circuits shall be supervised.

G. Provide all additional devices as required to meet all codes, inspector's requirements and ADA.

H. Strobes shall be synchronized.

I. Strobes shall be located per NFPA 72.

J. Strobe intensity shall be per the following:

Minimum Required Light Output, Candela (cd) (Effective Intensity) Wall Mounted Visual Signal			
Maximum Room Size	One Light Per Room (cd)	Two Lights per Room (Located On Opposite Walls) (cd)	Four Lights per Room (One Light per Wall) (cd)
20' x 20'	15	-	-
30' x 30'	34	15	-
40' x 40'	60	30	15
50' x 50'	94	60	30
60' x 60'	135	95	30
70' x 70'	184	95	60
80' x 80'	240	135	60
90' x 90'	304	185	95
100' x 100'	375	240	95

2.5 ADDRESSABLE MANUAL STATIONS:

A. Furnish and install a double action, non-coded, manual fire alarm station, flush mounted.

B. This station shall be connected to a remote interface monitor module as required, for addressable operation. Each module will have an engraved nameplate, acceptable to the engineer, with the same name setup in programming.

C. To operate the station you must push the face panel and manually pull down which in turn activates the associated remote interface monitor module. The face panel locks in the down position providing a positive indication that the station has been operated. The station can be reset to the normal position by the use of a special reset key.

D. The station shall be constructed of a die cast metal or fire retardant polycarbonate, finished in red enamel with raised white lettering. The station shall be jam-proof and shall be surface or semi-flush mountable. The station shall offer a break rod feature which shall not be necessary for station operation.

2.6 SMOKE/HEAT DETECTORS:

A. Addressable Ceiling Smoke Detectors:

1. Furnish and install as indicated a ceiling mounted photoelectric detector. This detector shall be environmentally compensated, and calibrated and adjusted for sensitivity at the manufacturer's factory to U.L. Standard 268 (Nominal 2.3% per foot smoke obscuration level). Each detector shall utilize solid state components and be equipped with a fully regulated LED light source for long life reliability and an insect screen to minimize nuisance alarms. The detector shall provide a multiple pulse coincidence circuit to minimize false alarms from transient smoke conditions. When the alarm threshold value is exceeded for the first time, the detector shall go into alarm only after at least 2 more consecutive sample pulses have exceeded the alarm threshold values. The detector shall be able to transmit obscuration information to FACP. Detector shall have environmental compensation circuits and shall maintain constant sensitivity even when maintenance required messages are produced.

2. Either the detector head itself or the detector base shall use magnetic (switchless), binary dipswitches, or rotary decimal (hexadecimal) switches for the assignment of its individual address number when it is being field programmed. It shall also have a data communication line/alarm (flashing/steady) LED and terminals for making data communication line circuit connections. The detector/base assembly shall draw its power from the fire alarm control panel via the data communication line. The detector/base shall flash its LED, to assure communication, as it is being polled for status from the fire alarm control panel and shall report alarm or trouble status changes to it.

3. Outlet boxes for detectors shall be flush mounted. Each detector will have a label to coordinate with control panel description, acceptable to the engineer, with the same name setup in programming.

4. Smoke detectors shall not be located within 36" of any air diffuser or sprinkler head.

B. Addressable Duct Mounted Smoke Detectors:

1. Furnish and install photoelectric type, duct mounted smoke detectors at all supply and return ducts, all fire/smoke dampers, where indicated on the drawings, and where required by code. Duct mounted detectors shall operate similar to ceiling smoke detectors and are to be equipped with suitable duct housings from the manufacturer. Sampling tubes are to be sized according to the actual duct they are placed across in the facility. The detector housing shall have a local test capability and status indicator LED, and provisions for connecting a remote status indicator LED. The detector shall be able to transmit obscuration information to FACP.

2. Duct mounted smoke detectors shall be UL listed for their intended use and shall be compatible with the Fire alarm equipment installed. Sampling tubes shall extend across the entire width of the duct and be secured properly on each end.

3. Each detector and duct housing shall be self-compensating for the effects of air velocity (from 500 to 3,000 feet per minute), temperature, humidity, and atmospheric pressure. It shall not be necessary to field adjust the sensitivity to compensate for the above effects.

4. Each detector shall be a 2-wire or 4-wire, 24 VDC type duct smoke detector utilizing solid state components. Detectors providing integral relay initiation shall be 4-wire type detectors. Each detector shall be listed for U.L. Standard 268A.

5. The 24 VDC power to the duct detectors and the number of duct detectors on each 24 VDC power loop is completely dependent on the alarm current of the duct detector and the fused capacity of the supervised power loop and these requirements shall be designated and shown on the fire alarm submittal.

6. All duct mounted smoke detectors shall be installed in accordance with the standards and requirements set out in NFPA 90A, Installation of Air Conditioning and Ventilating Systems. The Installing contractor will be responsible for installing any additional duct mounted smoke detectors that are needed to meet the latest requirements of NFPA 90A.

7. Provide a remote alarm indicator for each duct smoke detector. For duct smoke detectors in supply and return ducts of mechanical equipment, locate remote alarm indicators at mechanical unit mounted at 46" AFF. For duct smoke detectors at fire/smoke dampers, locate remote alarm indicators as close as possible to duct detectors locations, flush mounted in ceiling.

C. Addressable Heat Detectors:

1. Furnish and install heat detectors flush mounted as indicated on the drawings. Detectors shall be combination rate-of-rise and fixed temperature. Each detector shall utilize solid state components and the activation of the rate-of-rise or fixed temperature alarm functions shall be capable of being reset from the fire alarm control panel.

2. Either the detector head itself or the detector base shall use magnetic (switchless), binary dipswitches, or rotary decimal (hexadecimal) switches for the assignment of its individual address number when it is being field programmed. It shall also have a data communication line/alarm (flashing/steady) LED and terminals for making data communication line circuit connections. The detector/base assembly shall draw its power from the fire alarm control panel via the data communication line. The detector/base shall flash its LED, to assure communication, as it is being polled for status from the fire alarm control panel and shall report alarm or trouble status changes to it.

3. *****Outlet boxes for detectors shall be flush mounted. Each detector will have a label to coordinate with control panel description, acceptable to the Engineer, with the same name setup in programming.

2.7 AIR HANDLING UNIT SHUT DOWN RELAYS:

A. 24 VDC operation, mounted in surface cabinet. These relays shall be controlled and powered from the fire alarm control panel and must be supervised. Contacts shall be 2P D.T. rated at 2 amps resistive 28 VDC/120VAC.

2.8 ELECTROMAGNETIC DOOR HOLDERS:

A. Provide as part of the fire alarm system individual door holders at all locations as shown on the drawings. Any additional door holders that are specified under Section BUILDERS HARDWARE shall be connected and coordinated into the fire alarm system as specified in this section.

B. Operation shall be by 24 volt DC supplied from the fire alarm control panel. Coordinate door holders as to voltage, ampere drain, and voltage drop with the battery, battery charger, wiring, and fire alarm system for the operation specified.

C. A maximum of eight door holders shall be provided for each circuit with its own fuses, disconnect switch and pilot light.

D. Associated relay control circuits shall be electrically supervised.

E. Smoke detectors shall not be incorporated as an integral part of door holders, but are functionally associated as hereinafter specified.

F. Provide master control switches with pilot light, for maintaining power to door holders during fire alarm tests. A switch shall be located at the fire alarm control panel.

2.9 WATERFLOW SWITCHES:

A. Waterflow switches shall be cane type waterflow detectors with adjustable retard feature and two sets of single-pole, double-throw (SPDT) alarm contacts to be supplied. Remote interface monitor modules will be installed to monitor each individual waterflow switch which is shown on the fire alarm bid document drawings. These modules shall be flush or surface mounted to the wall at an appropriate location below the waterflow switch itself, so that maintenance personnel can readily view the supervisory LED on the module. They will be mounted at the same height as manual stations. Each module shall have an engraved nameplate, acceptable to the Specifying Engineer, with the same custom alphanumeric message setup in programming on this nameplate.

2.10 VALVE SUPERVISORY SWITCHES:

A. Valve supervisory switches shall have die cast housings with integral tamper-proof switches designed to activate when the switch is removed. They will be monitoring Outside Screw & Yoke type valves and have at least one set of single-pole, double-throw (SPDT) trouble contacts. Remote interface monitor modules will be installed to monitor each individual valve supervisory switch. These modules shall be flush, or surface mounted to the wall at an appropriate location below the valve supervisory switch itself, so that maintenance personnel can readily view the supervisory LED on the module. They will be mounted at the same height as manual stations. Each module shall have an engraved nameplate, acceptable to the Specifying Engineer, with the same custom alphanumeric message setup in programming on this nameplate.

2.11 NOTIFICATION APPLIANCE CONTROL (NAC) PANELS:

A. Notification appliance control panels shall be provided as required by the system supplier.

B. Units shall be UL 864 listed for power limited operation.

C. Power supplies shall support a full 8 amps of notification power even if the battery is in a degraded mode and only AC power is connected.

D. The unit shall incorporate a built-in battery charger with automatic switchover to battery back-up in the event of AC power failure.

E. Horn and strobe circuits shall be synchronized.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Installation shall be in accordance with the NEC, as shown on the drawings, and as recommended by the major equipment manufacturer.

B. Install smoke detector heads not more than two weeks prior to final inspection. Test the detectors in place. Cleaning detectors at the time of final inspection is the contractor's responsibility.

C. Field verify location of area smoke detectors and heat detectors. Do not locate within 36-inches of a HVAC diffuser (supply or return), in a direct air flow, within 36-inches of a

sprinkler head, or within 36-inches of the tip of a ceiling fan blade. Smoke detectors for door release shall be located on the centerline of the door and a maximum of 5 feet from the door. The minimum distance from the door is the depth of the wall section above the door, but not less than 12". Provide smoke detectors at all fire alarm control equipment (fire alarm control panels, NAC panels, etc.)

D. Duct smoke detectors should be located in the area between 6 and 10 duct equivalent diameters of straight, uninterrupted run. Duct smoke detectors for fire/smoke dampers should be located between the last inlet or outlet upstream of the damper and the first inlet or outlet downstream of the damper. Coordinate location of duct detectors with humidifier dispersion grids as required.

E. Fan shutdown relay wiring shall be located within 3 feet of the fan controls and the wiring to the relay shall be monitored.

F. All fire alarm control equipment (fire alarm control panels, NAC panels, etc.) shall be connected to emergency power if the building or structure has an emergency power distribution system.

3.2 TYPICAL OPERATION:

A. Normal System Operation: Actuation of any manual station, smoke detector, or water flow switch shall cause the following operations to occur, unless otherwise specified:

1. Operate the audible/visual signals in the building. Audible devices shall be temporal coded.
2. Transmit a separate alarm/trouble signal, via phone line to a central monitoring agency.
3. Duct type smoke detectors and waterflow switches shall, in addition to the above, perform the functions specified in the mechanical specifications or shown on the mechanical drawings.
4. Operation of any sprinkler and standpipe valve supervisory switch shall cause the system to go into trouble condition.
    a. It shall not cause the system to go into alarm condition.
    b. It shall not prevent any flow switch from actuating an alarm.
5. Provide duct detectors in both the supply and return air ducts for air handling equipment, fan coil units; and make-up air unit, 2000 CFM or larger. Provide fan shut down relays to shut down AHU's, make-up air units, relief fans, exhaust fans and fan coil units. Provide control of smoke evacuation exhaust fans. Provide manual control in FACP to turn on fans. Fans shall be automatically controlled by smoke detectors. Detectors shall be cross zoned on alternating zones. Provide selector switch to select smoke evacuation to start upon any alarm or to start upon 2nd detector alarm.

B. System Supervision: System supervision shall include the following conditions:

1. Loss of operating or standby power.
2. A signal ground or open circuit in alarm initiating circuits, alarm indicating circuits, and auxiliarized transmitter trip circuits, and sprinkler and standpipe valve circuits. Each circuit shall have its own supervisory devices.
3. Off-normal position of sprinkler and standpipe valves.
4. Battery and battery charger shall have supervision as specified elsewhere in this section.

C. Trouble Signals:

1. Derangement of any of the above supervised conditions shall be visually and audible annunciated at the fire alarm control panel. Each circuit shall have individual visual annunciation.

2. Operation of the sprinkler and standpipe valves towards the closed position shall cause a supervisory signal.
3. Trouble signals shall be retransmitted, via an individual auxiliarized transmitter, to remote locations.

3.3 TESTS:

A. Provide the service of a competent, NICET certified, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. Make all adjustments and tests in the presence of the engineer.

B. When the systems have been completed and prior to the scheduling of the final inspection, furnish testing equipment and perform the following tests in the presence of the engineer. When any defects are detected, make repairs or install replacement components, and repeat the tests until such time that the complete fire alarm system meets all contract requirements. After the system has passed the test and been approved by the engineer, the contractor may request a final inspection. Final acceptance of system will not be made until retested at final inspection.

1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
2. Test the insulation on all installed cable and wiring by standard methods as recommended by the equipment manufacturer.
3. Run water through all flow switches. Drain the water by hose to the nearest drain. Check to verify whether all codes are coming in clearly and correctly. Check time delay on water flow switches to assure that water surges do not trip transmitters. (Submit a report listing all water flow switch operations and the delay time in seconds.)
4. Open fire alarm station circuits to see if trouble signal actuates.
5. Open audible signal circuits to see if the trouble signal actuates.
6. Ground fire alarm station circuits and verify response of trouble signals.
7. Ground audible signal circuits and verify response of trouble signals.
8. Check transmission of all fire alarm devices.
9. Check installation, supervision, operation and sensitivity of smoke detectors to ascertain that they will avoid false alarm signals and will function as specified. See Article 2.8, SMOKE DETECTORS.
10. Upon completion of Fire Alarm System Testing, submit to engineer one (1) copy of Testing and Inspection Report signed off as 100 percent functioning by the System Supplier and the Electrical contractor. Bind one (1) additional copy in each of the operation and maintenance manuals. A record of completion document, as described in NFPA 72, shall be stored at the fire alarm control panel or other approved location by the AHJ. When not stored at the fire alarm control panel the location of this document shall be identified at the fire alarm control panel. If documents are stored in a separate enclosure or cabinet it shall be prominently labeled "Fire Alarm Documents". Other documents required to be located at the fire alarm control panel include:
    a. Owner's manual and manufacturers published instructions covering all system equipment.
    b. Record drawings.
    c. For software based systems, record copy of the site specific software.
    d. Written sequence of operation.

3.4 FINAL INSPECTION:

A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall perform the tests in Article 3.3 TESTS. In addition the representative shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of the Owners Representative.

3.5 INSTRUCTION:

A. Furnish the services of a competent instructor for not less than two four-hour periods for instructing personnel in the operation and maintenance of the system, on the dates requested by the Engineer.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.2 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises as noted on the Drawings.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion control measures are in place.

E. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.

7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
   1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
   2.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. In addition to the information provide herein, the contractor shall adhere to and enforce all provisions of the SWPPP prepared for this project. Contractor shall maintain a copy of the SWPPP on the site at all times.

B. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion and sedimentation control Drawings and requirements of authorities having jurisdiction.

C. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

D. Inspect, maintain, and repair erosion and sedimentation control measures during construction until permanent vegetation has been established.

E. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to plans.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Unless otherwise noted, Notify Architect not less than 72 hours in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground or as otherwise directed by the Project Geo-technical Engineer.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth determined by the site geo-technical engineer in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

SECTION 32 13 13

CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes the following:

1. Driveways.
2. Roadways.
3. Parking lots.
4. Curbs and gutters.
5. Walks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.3 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

1.4 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 STEEL REINFORCEMENT

A. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

D. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.3 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150/C 150M, portland cement
2. Fly Ash: ASTM C 618,
3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C 595/C 595M

B. Normal-Weight Aggregates: ASTM C 33/C 33M, uniformly graded. Provide aggregates from a single source.

C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

E. Water: Potable and complying with ASTM C 94/C 94M.

2.4 FIBER REINFORCEMENT

A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 inches long.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.6 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to Kansas City Metro Materials Board (KCMMB), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.][Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Slag Cement: 50 percent.

3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement.

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

E. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate.

F. Concrete Mixtures: Normal-weight concrete.

1. KCMMB-4K

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT INSTALLATION

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, to match jointing of existing adjacent concrete paving.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

B. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

D. Screed paving surface with a straightedge and strike off.

E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions.

1. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
2. After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-feet long; unleveled straightedge not to exceed 1/2 inch.
4. Joint Spacing: 3 inches.
5. Contraction Joint Depth: Plus 1/4 inch, no minus.
6. Joint Width: Plus 1/8 inch, no minus.

3.10 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 32 92 00

TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
Seeding.
Hydroseeding.
Sodding.
Plugging.
Sprigging.
Meadow grasses and wildflowers.
Turf renovation.
Erosion-control material(s).
Grass paving.

B. Related Sections:
Section 31 10 00 "Site Clearing" for topsoil stripping and stockpiling.
Section 31 20 00 "Earth Moving" for excavation, filling and backfilling, and rough grading.
Section 32 93 00 "Plants" for border edgings.

1.3 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

1.5 INFORMATIONAL SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
Certification of each seed mixture for turfgrass sod and seed. Include identification of source and name and telephone number of supplier.

B. Qualification Data: For qualified landscape Installer.

C. Product Certificates: For soil amendments and fertilizers, from manufacturer.

D. Material Test Reports: For standardized ASTM D 5268 topsoil, existing native surface topsoil existing in-place surface soil and imported or manufactured topsoil.

E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required initial maintenance periods.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf and meadow establishment.
Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
Experience: Three years' experience in turf installation in addition to requirements in Section 01 40 00 "Quality Requirements."
Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

a. Certified Landscape Technician - Exterior, with installation, maintenance irrigation,specialty area(s), designated CLT-Exterior.
b. Certified Turfgrass Professional, designated CTP.
c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.

Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.

Testing methods and written recommendations shall comply with USDA's Handbook No. 60.

The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.

Report suitability of tested soil for turf growth.

a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Preinstallation Conference: Conduct conference at the Project Site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

C. Bulk Materials:

Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.8 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Planting Completion.
Spring Planting: March 15-May 15
Fall Planting: August 15-October 15

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.9 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
Seeded Turf: 60 days from date of planting completion
a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
Sodded Turf: 60 days from date of planting completion
Plugged Turf: 60 days from date of planting completion

B. Initial Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 60 days from date of planting completion

C. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: State-certified seed of grass species as follows:

C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

a. Proportions by weight: Seed Mix Number 1, Fescue Blend

Kind of Seed	Percentage
Turf Type Tall Fescue 3 way Blend (Falcon, Apache and Arid)	80%
Perennial Ryegrass	20%
Total	100%

12 lbs/1000 sq ft of a 80%- 3 way mix of turf type-Falcon, Apache, Arid and 20% Manhattan perennial rye- all hydro-seeded with 2000 lbs of virgin wood fiber(no paper!) with 3 % tackifier.

2.2 TURFGRASS SOD

A. Turfgrass Sod: Certified Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Turftype Tall Fescue Blend (varieties such as Rebel, Aurora or Houndog = 85%), Certified Bluegrass (Park, Merit, or Farrah = 10%), Perennial Ryegrass = 5%)

2.3 MEADOW GRASSES AND WILDFLOWERS *(See Detention and Native Vegetated Swales section on drawings)*

2.4 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.
Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.
Provide lime in form of ground calcitic limestone or mollusk shells

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.5 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
Organic Matter Content: 50 to 60 percent of dry weight.
Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.6 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 percent nitrogen and 10 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.7 PLANTING SOILS (Specific soil amendment rates should be determined following soil test recommendation)

A. Planting Soil ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth. Mix ASTM D 5268 topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
Ratio of Loose Compost to Topsoil by Volume: 1:4 Ratio of Loose Sphagnum or Muck Peat to Topsoil by Volume: 1:8
Weight of Lime per 1000 Sq. Ft.: (as recommended by soil test results)
Weight of Sulfur per 1000 Sq. Ft.: (as recommended by soil test results)
Weight of Agricultural Gypsum per 1000 Sq. Ft.:(as recommended by soil test results)Volume of Sand Plus 10 Percent Diatomaceous Earth per 1000 Sq. Ft.: (as recommended by soil test results)
Weight of Bonemeal per 1000 Sq. Ft. (as recommended by soil test results)
Weight of Superphosphate per 1000 Sq. Ft. (as recommended by soil test results)Weight of Commercial Fertilizer per 1000 Sq. Ft.: 12-12-12 Commercial Fertilizer applied at manufacturer's recommendations.
Weight of Slow-Release Fertilizer per 1000 Sq. Ft. Applied at manufacturer's recommendations.

2.8 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
Organic Matter Content: 50 to 60 percent of dry weight.
Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

G. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.9 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.10 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3-inchnominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Invisible Structures, Inc.; Slopetame 2.
b. Presto Products Company, a business of Alcoa; Geoweb.
c. Tenax Corporation - USA; Tenweb.

2.11 Submit other alternatives for approval GRASS-PAVING MATERIALS

A. Grass Paving: Cellular, non-biodegradable plastic mats, designed to contain small areas of soil and enhance the ability of turf to support vehicular and pedestrian traffic, of manufacturer's standard nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Grid Technologies, Inc.; Netlon 50.
b. Invisible Structures, Inc.; Grasspave2.
c. NDS, Inc.; Tufftrack or Grassroad Paver8 Plus.

d. Presto Products Company, a business of Alcoa; Geoblock Porous Pavement System.
e. RK Manufacturing, Inc.; Grassy Pavers.
f. Submit other alternatives for approval>.

B. Base Course: Sound crushed stone or gravel complying with [ASTM D 448 for Size No. 8] [Section 31 20 00 "Earth Moving" for base-course material] <Insert requirements>.

C. Sand: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.

D. Proprietary Growing Mix: As submitted and acceptable to Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
Apply superphosphate fertilizer directly to subgrade before loosening.
[spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil].
a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
b. Mix lime with dry soil before mixing fertilizer.
Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
c. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
d. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
Remove existing grass, vegetation, and turf. Do not mix into surface soil.
Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.
a. Apply superphosphate fertilizer directly to surface soil before loosening.
Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, trash, and other extraneous matter.
Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 PREPARATION FOR GRASS-PAVING MATERIALS

A. Reduce subgrade elevation soil to allow for thickness of grass-paving system. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade so that installed paving is within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions.

B. Install base course and sand course and sandy loam soil mix as recommended by paving-material manufacturer for site conditions; comply with details shown on Drawings. Compact according to paving-material manufacturer's written instructions.

C. Install paving mat and fasten according to paving-material manufacturer's written instructions.

D. Before planting, fill cells of paving mat with sandy loam soil mix, and compact according to manufacturer's written instructions.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.6 SEEDING

Sow seed at a total rate of 7 to .12 lbs/1000 sq ft of a 80%- 3 way mix of turf type-Falcon, Apache, Arid and 20% Manhattan perennial rye- all hydro-seeded with 2000 lbs of virgin wood fiber(no paper!) with 3 % tackifier.

A.

B. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

C. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

D. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.

E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

Anchor straw mulch by crimping into soil with suitable mechanical equipment.

Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

F. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.7 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
Mix slurry with fiber-mulch manufacturer's recommended tackifier.
Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000lb/acre.
ALL SLOPES/DITCHES make sure there is a type 1 ECB straw blanket installed in lieu of fiber-mulch.

3.8 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
Lay sod across angle of slopes exceeding 1:3.
Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.9 PLUGGING (If applicable)

A. Plant plugs in holes or furrows, spaced 18 inches apart in both directions. On slopes, contour furrows to near level.

3.10 TURF RENOVATION

A. Renovate existing turf.

B. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
Reestablish turf where settlement or washouts occur or where minor regrading is required.
Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

J. Apply sod as required for new turf.

K. Water newly planted areas and keep moist until new turf is established.

3.11 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
Mow [[turf-type tall fescue] to a height of 2 to 3 inches.

D. Turf Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.
Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.12 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:
Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.
Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.13 MEADOW

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at a total rate of 6 oz./1000 sq. ft. Brush seed into top 1/16 inch of soil, roll lightly, and water with fine spray.

C. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch and roll surface smooth.

D. Water newly planted areas and keep moist until meadow is established.

3.14 MEADOW MAINTENANCE

A. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch.

Provide materials and installation the same as those used in the original installation.

Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.

In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.

Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

Water meadow with fine spray at a minimum rate of 1/2 inch per week for [**six**] weeks after planting unless rainfall precipitation is adequate.

3.15 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.16 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION

SECTION 22 63 13
GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Carbon dioxide piping and specialties designated "medical carbon dioxide" operating at 50 to 55 psig (345 to 380 kPa).
   2. Nitrogen piping and specialties designated "medical nitrogen" operating at 160 to 185 psig (1100 to 1275 kPa).
   3. Nitrous oxide piping and specialties designated "medical nitrous oxide" operating at 50 to 55 psig (345 to 380 kPa).
   4. Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig (345 to 380 kPa).

B. Owner-Furnished Material:
   1. Patient Service Consoles.
   2. Ceiling columns.
   3. Owner will furnish gases for medical gas concentration testing specified in this Section.

C. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section and the other sections of this Division.
   2. Other sections of this Division, and of other Divisions, may contain requirements that relate to this section.

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 nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.

E. Specialty Gas: Gas, other than medical gas, for nonmedical laboratory facility applications.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Tubes and fittings.
   2. Valves and valve boxes.
   3. Medical gas outlets.
   4. Medical nitrogen pressure control panels.
   5. Ceiling hose assemblies. Include integral outlets.
   6. Gas manifolds.
   7. Medical gas alarm system components.
   8. 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 other Division 22 Sections. 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.

1.4 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. NFPA Compliance:
   1. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.

F. UL Compliance:
   1. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.

1.5 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 Owner no fewer than seven 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.

1.6 COORDINATION

A. Coordinate medical gas outlets with other outlets and inlet terminals, which are specified in other Division 22 sections.

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. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

B. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
   1. PVC Fittings: ASTM D 2466, Schedule 40, ASTM D 2467, Schedule 80; socket type.

2.2 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. Threaded-Joint Tape: PTFE.

C. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

2.3 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Healthcare Products, Inc.
      b. Amico Corporation.
      c. BeaconMedaes.
      d. Conbraco Industries, Inc.
      e. NIBCO INC.
      f. Ohio Medical Co.
      g. Powerex.
      h. Tri-Tech Medical.
   2. Pressure Rating: 300 psig (2070 kPa) minimum.
   3. Ball: Full-port, chrome-plated brass.
   4. Seats: PTFE or TFE.
   5. Handle: Lever type with locking device where indicated
   6. Stem: Blowout proof with PTFE or TFE seal.
   7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Check Valves: In-line pattern, bronze.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Healthcare Products, Inc.
      b. Amico Corporation.
      c. BeaconMedaes.
      d. Conbraco Industries, Inc.
      e. Ohio Medical Co.
      f. Powerex.
      g. Tri-Tech Medical.
   2. Pressure Rating: 300 psig (2070 kPa) minimum.
   3. Operation: Spring loaded.

4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Match existing Hospital equipment.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
8. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Match existing Hospital equipment.
2. Interior Finish: Factory-applied white enamel.
3. Cover Plate: Aluminum or extruded-anodized aluminum, satin-chrome finish steel or Stainless steel with NAAMM AMP 503, No. 4 finish with frangible or removable windows.
4. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Match existing Hospital equipment.
2. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
3. Inlet: Manufacturer-installed, NPS 1 or NPS 1-1/4 (DN 25 or DN 32), ASTM B 819, copper tubing with NPS 1 (DN 25) minimum ball valve and plugged inlet.
4. Safety Valve: Bronze-body, pressure relief valve set at 75 or 80 psig (520 or 550 kPa).
5. Instrumentation: Pressure gage.

G. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

H. Pressure Regulators: Bronze or stainless steel body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig (1725-kPa) minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.

2.4 MEDICAL GAS OUTLETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Match existing Hospital Equipment.

B. 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 (DN 10) 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 Outlets: Pressure outlets for carbon dioxide, nitrous oxide and oxygen 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. Service Connections: 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.
   b. Medical Helium Outlets: D.I.S.S. No. 1060.
   c. Medical Nitrogen Outlets: D.I.S.S. No. 1120.
   d. Medical Nitrous Oxide Outlets: D.I.S.S. No. 1040.
   e. Medical Oxygen Outlets: D.I.S.S. No. 1240.
5. Cover Plates: One-piece, stainless steel, with NAAMM AMP 503, No. 4 finish, metal, with chrome-plated finish or anodized aluminum and permanent, color-coded, identifying label matching corresponding service.

2.5 MEDICAL NITROGEN PRESSURE CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Match existing Hospital Equipment.

B. 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.
   1. Minimum Working Pressure: 200 psig (1380 kPa).
   2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
   3. Pressure Gages: 0- to 300-psig (0- to 2070-kPa) range.
   4. Service Connection: CGA V-5, D.I.S.S. No. 1120, nitrogen outlet.
   5. Before final assembly, provide temporary dust shield and U-tube for testing.
   6. Label cover plate "Nitrogen Pressure Control."

2.6 MEDICAL GAS PIPING ALARM SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Match existing Hospital equipment.

B. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.

C. Components: Designed for continuous service and to operate on power supplied from 120V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

D. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Low-Pressure Operating Range: 0- to 100-psig (0- to 690-kPa).
   2. High-Pressure Operating Range: Up to 250-psig (1725-kPa).

E. 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- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.

F. 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 (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
      b. Medical Nitrogen: Pressure drops below 145 psig (1000 kPa) or rises above 200 psig (1380 kPa) and changeover is made to alternate bank.
      c. Medical Nitrous Oxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
      d. Medical Oxygen: Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, reserve level is low, and reserve pressure is low.
      e. Medical Oxygen: Pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.

G. 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 (275 kPa) or rises above 60 psig (415 kPa).
      b. Medical Helium: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      c. Medical Nitrous Oxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      d. Medical Nitrogen: Pressure drops below 145 psig (1000 kPa) or rises above 200 psig (1380 kPa).
      e. Medical Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).

H. Dental Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
   1. Include alarm signals when the following conditions exist:
      a. Medical Nitrogen: Pressure drops below 145 psig (1000 kPa) or rises above 200 psig (1380 kPa) and changeover is made to alternate bank.
      b. Medical Nitrous Oxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
      c. Medical Oxygen: Pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.

I. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum 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 (275 kPa) or rises above 60 psig (415 kPa).
b. Medical Helium: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
c. Medical Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).

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 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 20 alarm signals.

2.8 NITROGEN

A. Description: Comply with USP 28 – NF 23 for oil-free dry nitrogen.

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 certified installer 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 (0.453 kg) of chemical to 3 gal. (11.3 L) 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 for excavating, trenching, and backfilling and for underground warning tapes.

3.3 PIPING APPLICATIONS

A. Nonhealthcare, Specialty Gas Piping operating at less than 185 psig: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

B. Nonhealthcare, Specialty Gas Piping NPS 2-1/2 (DN 65) and Smaller operating at 185 psig or greater: Type K or Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

C. Nonhealthcare, Specialty Gas Piping NPS 3 (DN 80) and Larger operating at 185 psig or greater: Type K, copper tube; wrought-copper fittings; and brazed joints.

D. Medical Gas Piping for systems operating at less than 185 psig: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

E. Medical Nitrogen Piping NPS 2-1/2 (DN 65) and Smaller operating at more than 185 psig: Type K or Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

F. Medical Nitrogen Piping NPS 3 (DN 80) and Larger operating at more than 185 psig: Type K, copper tube; wrought-copper fittings; and brazed joints.

G. 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, 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 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, unions, 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 medical gas piping to medical gas outlets specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.

L. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.

M. Install seismic restraints on gas piping as indicated or required.

N. Install medical gas outlets recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

O. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.

P. Install unions, in copper tubing adjacent to each valve and at final connection to each piece of equipment and specialty.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors.

R. Install sleeve seals for piping penetrations of concrete walls and slabs.

S. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.5 VALVE INSTALLATION

A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.

B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.

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 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. Ream ends of PVC pipes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing 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. 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. Install nitrogen pressure-control panels in walls. Attach to substrate.

B. 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.

C. Install gas manifolds anchored to substrate.

D. 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 gas piping alarm system and facility computer.

3.9 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in other Division 22 Sections for pipe hanger and support devices.

B. Vertical Piping: MSS Type 8 or 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:
   1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
   2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

D. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) 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.

E. Base of Vertical Piping: MSS Type 52, spring hangers.

F. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
5. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
6. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
7. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
8. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
9. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
10. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
11. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
12. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
13. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
14. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.

I. Install supports for vertical copper tubing every 10 feet (3 m).

3.10 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for specialty gas piping, valves, and specialties.

B. 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.
2. Helium: White letters on brown background.
3. Nitrogen: White letters on black background.
4. Nitrous Oxide: White letters on blue background.
5. Oxygen: White letters on green background or green letters on white background.

3.11 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

A. Perform field tests and inspections of specialty gas piping for nonhealthcare laboratory facilities and prepare test reports.

B. Tests and Inspections:
1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect specialty gas regulators for proper operation.

3.12 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. 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.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.13 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain medical gas alarm system. Refer to Division 01 Section.

END OF SECTION