

SECTION 15000

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section. It expands and supplements the requirements specified in sections of Division 1.
- B. Related Sections include the following:
  - 1. Section 13900, "Basic Fire Protection Materials and Methods" for Fire Protection Contractor coordination drawing requirements.
  - 2. Section 15075, "Mechanical Identification" for valve tag schedules.

1.3 DEFINITIONS

- A. Complete and Operational System: A Mechanical system that has been installed, tested, cleaned, signed-off by appropriate Authority and made operational. Completion of Owner training to be part of this requirement.
- B. Mechanical Contractor: The project Contractor responsible for the installation of the Mechanical systems and equipment. This designation refers to the a Contractor who performs HVAC and/or Plumbing work.

1.4 SUBMITTALS

- A. General: See Division 1 for general submittal and product substitution requirements.
- B. Pre-Construction Submittals: Submit the following items prior to commencing with installations.
  - 1. Coordination Drawings.
  - 2. Schedule of Mechanical Submittals and Closeout Procedures.
- C. During Construction: Submit at earliest possible date but no later than 50% completion of mechanical work as determined by schedule of values.
  - 1. Operation and Mechanical Manual Table of Contents.

2. Schedule of Mechanical Submittals and Closeout Procedures with updated current status information.

D. Post Construction: Submit the following at least fifteen days before requesting review for Substantial Completion.

1. Project Record Documents: as built.
2. Operation and maintenance manuals.
3. Warranties.
4. Completed Schedule of Mechanical Submittals and Closeout Procedures.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: All work shall be performed by qualified journeymen of their respective trades who are employed by a firm that can demonstrate successful experience with work similar in type, quality and extent to the work required by this project.

## 1.6 BASIS OF MECHANICAL DESIGNS

- A. General: The following information is intended to provide an overview of the intent and operation of the project Mechanical systems. It is not intended that each and every project Mechanical scope item be captured herein. The absence of a specific item or system in the descriptions below does not absolve the Mechanical Contractor(s) from providing the work identified by other Sections and the Drawings.

1. The Mechanical Contractor(s) shall provide a complete and operational systems and installations.

B. Mechanical Design Criteria:

1. Operating Room:
  - a. Design Temperatures:
  - b. Inside: 68-73 degrees F
  - c. Indoor Relative Humidity: 30 to 60% RH.
  - d. 25 air changes per hour total airflow during occupied hours.
  - e. 500 CFM total airflow during unoccupied hours.
  - f. Constant +0.01 in. wg. room pressure.
  - g. Filtration: 30% pre-filter and 99.97% HEPA final filter.

C. HVAC Systems Description:

1. The Operating Room will be served by a dedicated modular air handler, consisting of; double walled construction, a pre-filter, chilled water cooling coil, hot water heating coil, supply fan with variable speed drive, and final filter. The unit will receive both central air handling system air and room return air and will deliver conditioned air to the OR. A constant amount of central air handling system air will be ducted to the return of the OR air handler from a new variable air volume terminal. The supply to the OR will be humidified using a clean steam humidifier and dehumidified through cooling and reheat. Controls will allow for reduced supply airflow during unoccupied hours. Room control of occupied/unoccupied mode, temperature and humidity will be provided.
2. The remaining rooms and corridor within the project scope will be served by variable air volume, hot water reheat terminal units and central air handling system.

D. Plumbing Systems Description:

1. Local supply, DWV and Medical Gas systems will be demolished, replaced, and reworked to meet the requirements of the new layouts.
  - a. A new local medical gas alarm panel and zone valve box will be added to serve the operating room. The following gases will be piped to the OR:
    - 1) Oxygen
    - 2) Medical Air
    - 3) Medical Vacuum
    - 4) WGAD (connected to Medical Vacuum System)
    - 5) Nitrous Oxide
    - 6) Nitrogen

1.7 CODES, STANDARDS AND AUTHORITIES

A. General: The following listing is intended to identify the major Codes, Standards, and Authorities Having Jurisdiction, (AHJ's) for the project. This information is at least partially provided on the G-000 series Drawings as well. In the event that there is a discrepancy between the information contained herein and that on the G-000 Drawings, the information herein shall govern.

1. In the event that an item is included on the G-000 Drawings and is not listed herein, compliance with the requirements of said item is required.
2. The exclusion of an applicable Code, Standard, or AHJ in the list below does not absolve the Contractor from meeting the requirements of said Code, Standard or AHJ.

B. Codes: Work performed on the project must comply with the requirements of the following Codes:

1. BOCA National Building Code 1999.
2. BOCA National Mechanical Code 1993.
3. National Fire Protection Code Association (NFPA) 101, 2000 edition.
4. State of Maine Internal Plumbing Rules, latest edition

C. Standards: Work performed on the project must comply with the requirements of the following Industry Standards:

1. Sheet Metal and Air Conditioning Contractors' National Association, Inc (SMACNA) HVAC Duct Construction Standards
2. AIA Guidelines for Design and Construction of Hospital and Health Care Facilities 2001 Edition.
3. UL – Underwriters' Laboratories
4. ASME – American Society of Mechanical Engineers
5. NFPA – National Fire Protection Association
6. ANSI – American National Standards Institute
7. ASHRAE – American Society of Heating, Refrigerating, and Air Conditioning Engineers
8. ARI – American Refrigeration Institute
9. ASTM – American Society of Testing and Materials
10. NEMA – National Electrical Manufacturers' Association
11. NEC – National Electrical Code
12. FM – Factory Mutual
13. ASTM – American Society for Testing and Materials
14. OSHA – Occupational Safety and Health Act

15. NEMA National Electrical Manufacturer's Association
16. AABC – Associated Air Balance Council
17. AMCA – Air Movement and Control Association
18. NEBB – National Environmental Balancing Bureau

- D. Authorities Having Jurisdiction: Work performed on the project must comply with the requirements of the following AHJ's:
1. Maine State Fire Marshal
  2. Fire Chief, City of Portland
  3. Maine Public Utilities Commission
  4. State Board for the Licensing and Regulation of Plumbers
  5. Maine Department of Labor

## 1.8 DRAWINGS AND SPECIFICATIONS

- A. General: The drawings and specifications are complimentary.
1. What is shown or noted on the drawings, but not mentioned in the specifications, automatically becomes a part of the specifications.
  2. What is noted in the specifications, but not shown on the drawings, automatically becomes a part of the drawings.
  3. Conflicts between the requirements of the drawings and the specifications must be brought to the immediate attention of the Architect/Engineer.
    - a. The more stringent requirement will apply, unless ruled otherwise by the Architect/Engineer.
    - b. When conflicts or discrepancies are noted, no work shall proceed until the conflict or discrepancy has been resolved by the Architect/Engineer.
- B. Mechanical Drawings and Division 15 Specification Sections: The Mechanical Contractor shall bear the responsibility of determining full extent of work required by Contract Documents. The Mechanical Contractor shall refer to site, architectural, structural, electrical and other Drawings and Specification Sections that indicate types of construction with which work of this Section must be coordinated. The Mechanical Contractor shall review the work with the General Contractor / Construction Manager to establish the extent of work for their trade, and to determine whether there will be any interference with the work of other trades. If the work is later found to include work required to complete and coordinate the work or another trade, or to interfere with the work of another trade then the changes required to complete the work or to eliminate the interference shall be made without additional cost to the Owner.
1. The Drawings schematically indicate the order of connection of the various system components. Each and every nuance and detail is not indicated. Whether specifically shown or not, all items shall be connected in accordance with Code, the details provided, accepted trade practices, and the intent of the Contract Documents. Coordinate with the other trades.
- C. Exact locations of ceiling mounted items shall be as shown and detailed on the Architectural reflected ceiling plans.
- D. System components (thermostats, sensors, volume dampers, access doors, etc.) are identified throughout the Drawings for proper system operation. If any component is inadvertently omitted from the drawings, provide that component as per a similar location.

1.9 COORDINATION

- A. This Contractor shall give full cooperation to other trades and to the General Contractor and shall furnish any information necessary to permit the work of all trades to be installed satisfactorily and with least possible interference or delay. If this Contractor installs his work before coordinating with other trades, he shall make the necessary changes in his work to correct the condition, without extra charge. In areas, if due to construction conditions, more than one trade is required to use common openings in beams, conduits, etc., this Contractor must plan and locate the positions of the items of piping, ducts, conduits, etc., which are under the scope of his Contract with that of items under the scope of other Contractors, in order that all items are properly located and may be accommodated within the space available. Location and positioning shall be done prior to installation and to the satisfaction of the Architect and/or Engineer.

1.10 COORDINATION DRAWINGS

- A. General: Mechanical Contractor(s) to generate coordination drawings for:
1. Operating Room 100
  2. Scrub Area 101
  3. Storage 108
  4. House Keeping B053
  5. Sterile Corridor 102
- B. Prepare a set of drawings in conjunction with the Fire Protection and Electrical Contractors. In the event that Plumbing and HVAC work is performed by separate Contractors, the HVAC Contractor shall take the lead and initiate the generation of the drawings. Plumbing, Electrical, and Fire Protection work shall be subsequently applied to the drawings.
1. Drawings are intended to prevent installation conflicts.
  2. Drawings to indicate piping, ductwork, equipment and other system components in relation to each other, along with electrical fixtures, conduits, busses, cable trays, supports and structural members.
- C. After each drawing has been coordinated between these trades, each trade shall sign each Drawing indicating acceptance of the installation coordination. The coordination original shall then be printed and these prints submitted through the General Contractor to the Architect for review and comment, similar to shop drawings.
- D. Drawings to be CADD generated or manually drafted.

1.11 SUBSTITUTIONS

- A. General: See Division 1 for product substitution requirements.
1. No substitute materials or equipment shall be incorporated in the work without the written approval of the Architect/Engineer.
- B. Substitute materials and equipment submitted for approval must fit within the spaces available with neither substantial alteration nor increased pressure drops or friction losses.

- C. Approval of substitute materials or equipment by the Architect/Engineer shall not relieve the contractor from his responsibility to provide a complete and operational mechanical system.
- D. The Architect/Engineer's decision as to the equality or acceptability of proposed substitutions for the materials and equipment specified shall be final.
  - 1. Any additional costs incurred by such substitutions, including additional costs to other trades, or engineering design costs, shall be borne by the Contractor. This includes costs associated with the design and installation of infrastructure and support systems to facilitate a proposed substitution. This cost will be borne by the Mechanical Contractor.

#### 1.12 SCHEDULE OF MECHANICAL SUBMITTALS AND CLOSEOUT PROCEDURES

- A. General: In conjunction with submittal scheduling requirements detailed in Section 01320, prepare a separate Schedule of Mechanical Submittals and Closeout Procedures.
- B. Schedule shall list the following information for each required submittal:
  - 1. Specification Section number and title.
  - 2. Product Name or Description of Work Covered
  - 3. Submittal Tracking Number
  - 4. Required submission relative to construction:
    - a. Pre-construction (prior to fabrication/installation of product)
    - b. During construction
    - c. Post-construction
  - 5. Submittal Status:
    - a. NC: Final Approval Not Complete
    - b. A: Approved
  - 6. Owner Training: Indicate if Owner Training is required.
    - a. NC: Training not performed or not completed.
    - b. A: Approved/Training Completed.
  - 7. Spare Materials and Parts

#### 1.13 MECHANICAL SUBMITTALS

- A. General: Refer to Division 1 for submittal definitions, requirements and procedures.
- B. Submittal of shop drawings, certified performance data, and samples will be accepted only when submitted per Division 1. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed.
- C. Submittals for each mechanical trade shall be complete, including all items for which submission and approval is required, and each sheet containing performance data shall be clearly highlighted and marked for the appropriate model or type of equipment to be reviewed. Intended use shall be written on each submittal sheet for each different type of equipment or material to be reviewed (i.e. valves for domestic water or heating hot water, etc.). Incomplete or unmarked submittals WILL BE RETURNED to the Contractor without action.

- D. Submittals shall be organized by specification Section and shall be clearly labeled. Submittals for HVAC and Plumbing items covered by a "shared" Mechanical specification Section, (i.e., hangers and supports, insulation) shall be separate and clearly labeled as to the trade intended.
  - 1. Unclear and/or mixed submittals will not be processed.
- E. When two or more items of the same material or equipment are required, (i.e., plumbing fixtures, pumps, valves, air handling units, fans, diffusers, registers and grilles.) they shall be products of the same manufacturer insofar as possible.
  - 1. This does not apply to raw or bulk materials such as pipe and fittings, sheet metal, etc.

#### 1.14 RECORD DOCUMENTS

- A. General: Refer to Division 1 for requirements.
- B. As work progresses, mark Drawings to indicate revisions to piping and ductwork, size and location including locations dampers and other control devices, filters, boxes and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned for column lines; mains and branches of piping systems, with valves and control devices located and numbered; Change Orders; concealed control system devices.
- C. Mark specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.
- D. At completion of work and prior to final request for payment, the Mechanical Subcontractor(s) shall submit a complete set of reproducible record drawings showing all systems as actually installed. Drawings submitted shall be in the following format:
  - 1. Neatly hand marked up copies of SMRT design drawings.
  - 2. Valve Tags: Record drawings to include valve tag markers which correspond to the valve tag chart provided under the O&M Manual Section.

#### 1.15 OPERATION AND MAINTENANCE, (O&M) MANUALS

- A. General: Refer to Division 1 for procedures and requirements for preparation and submittal of O&M Manuals.
- B. Table of Contents: Prepare Table of Contents of O&M Manual and submit in accordance with Section 1.4.
- C. Systems Descriptions: Provide description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
- D. Operating Procedures: Provide manufacturer's printed data, including start-up, break-in, routine and normal operating instructions; regulation control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
- E. Maintenance Procedures: Provide for routine preventive maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

- F. Servicing Instructions: Provide instructions, lubrication charts and schedules.
- G. Product Data: Provide copies of all approved submittals.
- H. Valve Schedules: Include valve tag charts in the O&M Manuals. Valve tag charts are as per Section 15075, "Mechanical Identification."

#### 1.16 OWNER TRAINING

- A. General: Refer to Division 1 for general requirements.

#### 1.17 WARRANTIES

- A. Refer to Division 1 for project requirements for warranties. Individual warranties are required for each item of power driven or other mechanical equipment having moving parts, and wherever else specified in Division 15.
  - 1. Submit the warranties specified in Division 15 in a vinyl covered, three ring binder, tabulated and indexed for easy reference.
- B. Provide complete warranty information for each item, to include date of commencement; duration; and the names, addresses, and telephone numbers and procedures for filing claims and obtaining warranty services.
- C. Duration of warranties shall be not less than one year from the date of substantial completion of the facility unless prior approval has been granted in writing by the Architect/Engineer. If the manufacturer's warranty expires less than one year from the date of substantial completion, that warranty service and replacement of parts shall be provided by the mechanical subcontractor at no cost to the Owner.

#### 1.18 DELIVERY, STORAGE AND HANDLING

- A. General: Refer to Division 1 for material procurement requirements.
- B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
- D. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

#### 1.19 ENERGY EFFICIENCY



- A. All equipment shall have minimum efficiency as described in ASHRAE Standard 90.1-2001, requirements. All equipment suppliers must be aware of the requirements and submitted equipment shall meet these minimum requirements.

1.20 REFRIGERANTS AND OTHER HAZARDOUS MATERIALS

- A. The Mechanical Contractor shall be responsible for the capture, removal, and disposal of materials resulting from the Work.
  - 1. Comply with the requirements of applicable Codes, Standards and Authorities.

1.21 DIVISION OF MECHANICAL AND ELECTRICAL RESPONSIBILITY

- A. General: Line voltage switches, fused switches, outlets, motor starters, power wiring and fuses necessary to connect and operate all electrically powered equipment specified herein will be furnished and installed as a part of the total project. Coordinate work with Division 16. The intent is to have a complete and operational system. The Mechanical Contractor shall be responsible for furnishing and installing the equipment necessary to provide for the complete and operational system.
- B. Motor Starters: Where not specified in Division 15, shall be furnished and installed under Division 16.
- C. Power Wiring: Wiring for equipment shall be furnished and installed as specified under Division 16.
- D. Temperature Control Wiring: Wiring and interlocks shall be furnished and installed under Division 15.
- E. Disconnect Switches: Where not specified in Division 15, shall be furnished and installed under Division 16.

**PART 2 - PRODUCTS – NOT USED**

**PART 3 - EXECUTION**

3.1 EXAMINATION OF SITE

- A. Refer to General Conditions

3.2 EXISTING CONDITIONS

- A. Contractor shall verify all measurements and existing conditions in the field. Offsets, obstructions, and existing configurations and constraints must be field verified.

- B. Renovation work will take place in occupied areas of the hospital. Installations shall not affect ongoing operations. Hours available to perform work and disruption to operation of systems and utilities will need to be coordinated with Maine Medical Center.

### 3.3 WORK RESTRICTIONS

- A. Refer to Section 01140, WORK RESTRICTIONS, for requirements.

### 3.4 START UP AND TESTING

- A. General: Contractor shall provide all fuel for startup and testing of all equipment provided in this section. Refer to Division 1 for responsibility of electrical power.
- B. The Mechanical Contractor is responsible for startup of all equipment provided in Division 15 Sections.
- C. The Mechanical Contractor shall verify that systems are complete and operational before commencing with balancing work.
- D. Prior to balancing, ensure the following conditions:
  - 1. Systems are started and operating in a 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.
  - 5. Duct systems are clean of debris.
  - 6. Fans and pumps are rotating correctly.
  - 7. Air outlets are installed and connected.
  - 8. Duct system leakage is minimized.
  - 9. Hydronic systems are flushed, filled and vented.
  - 10. Proper strainer baskets are cleaned and in place.
  - 11. Service and balance valves are open.
- E. Power Outage Test: Entire control system and all mechanical equipment shall be run through a simulated site power outage with emergency generator operation and shall regain standard operation sequences when normal power is restored.
- F. Owner Witness of Test: The Owner shall witness final power outage test. Entire control system and all mechanical equipment shall pass power outage test prior to Owner witness.

### 3.5 FUNCTIONAL TESTING AND COMMISSIONING

- A. General: The entirety of the Mechanical Equipment and Controls System shall be tested for functional performance for specified operation and control sequences.

### 3.6 FINAL CLEANING

- A. General: Refer to Division 1 for general requirements regarding final cleaning.
- B. Refer to Division 15 Section, "Testing, Adjusting and Balancing" for requirements of cleaning filters, strainers, and other mechanical systems prior to final acceptance.

**END OF SECTION**



SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The requirements of Section 15000, "Basic Mechanical Requirements" apply to work defined by this Section.

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Transition fittings.
  - 3. Dielectric fittings.
  - 4. Mechanical sleeve seals.
  - 5. Sleeves.
  - 6. Escutcheons.
  - 7. Grout.
  - 8. Mechanical demolition.
  - 9. Equipment installation requirements common to equipment sections.
  - 10. Painting and finishing.
  - 11. Supports and anchorages.
  - 12. Access panels and doors.
  - 13. Motors for Mechanical Equipment
- B. Related Sections include the following:
  - 1. Division 7 Section, "Firestopping."
  - 2. Division 8 Section, "Access Panels."
  - 3. Division 9 Section, "Painting."

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
  - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
  - 2. CPVC: Chlorinated polyvinyl chloride plastic.
  - 3. PE: Polyethylene plastic.
  - 4. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
  - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
  - 2. NBR: Acrylonitrile-butadiene rubber.

#### 1.4 SUBMITTALS

- A. General: See Division 1 for general submittal and product substitution requirements.
- B. Pre-Construction Submittals: Submit the following items prior to commencing with installations.
  - 1. Product Data: For transition fittings, dielectric fittings, mechanical sleeve seals, escutcheons.
  - 2. Welding certificates.

#### 1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."
  - 1. Provide access panels per the requirements of Division 8 Sections. Installation of the panels to be as directed by the General Contractor / Construction Manager.
- D. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:
  - 1. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed below.
- B. AWWA Transition Couplings:
  - 1. Cascade Waterworks Mfg. Co.
  - 2. Dresser Industries, Inc.; DMD Div.
  - 3. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
  - 4. JCM Industries.
  - 5. Smith-Blair, Inc.
  - 6. Viking Johnson.
- C. Plastic-to-Metal Transition Fittings:
  - 1. Eslon Thermoplastics.
- D. Plastic-to-Metal Transition Adaptors:

1. Thompson Plastics, Inc.
- E. Plastic-to-Metal Transition Unions:
1. NIBCO, Inc.
- F. Flexible Transition Couplings for Underground Non-pressure Drainage Piping:
1. Cascade Waterworks Mfg. Co.
  2. Fernco, Inc.
  3. Mission Rubber Company.
  4. Plastic Oddities, Inc.
- G. Dielectric Unions:
1. Capitol Manufacturing Co.
  2. Central Plastics Company.
  3. Eclipse, Inc.
  4. Epcos Sales, Inc.
  5. Hart Industries, International, Inc.
  6. Watts Industries, Inc.; Water Products Div.
  7. Zurn Industries, Inc.; Wilkins Div.
- H. Dielectric Flanges:
1. Capitol Manufacturing Co.
  2. Central Plastics Company.
  3. Epcos Sales, Inc.
  4. Watts Industries, Inc.; Water Products Div.
- I. Dielectric Flange Kits:
1. Advance Products & Systems, Inc.
  2. Calpico, Inc.
  3. Central Plastics Company.
  4. Pipeline Seal and Insulator, Inc.
- J. Dielectric Couplings:
1. Calpico, Inc.
  2. Lochinvar Corp.
- K. Dielectric Nipples:
1. Perfection Corp.
  2. Precision Plumbing Products, Inc.
  3. Sioux Chief Manufacturing Co., Inc.
  4. Victaulic Co. of America.
- L. Mechanical Sleeve Seals:
1. Advance Products & Systems, Inc.
  2. Calpico, Inc.
  3. Metraflex Co.
  4. Pipeline Seal and Insulator, Inc.
  5. Thunderline/Link-Seal



## 2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 15 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 15 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
  - 1. ABS Piping: ASTM D 2235.
  - 2. CPVC Piping: ASTM F 493.
  - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  - 4. PVC to ABS Piping Transition: ASTM D 3138.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

## 2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
  - 1. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
  - 2. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
  - 3. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: One-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

## 2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
- D. 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.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  - 1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- G. 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).

## 2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Plastic, include two for each sealing element.
  - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.7 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.

## 2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening. Escutcheon finishes to be as follows:
  - 1. Finished area, exposed to view: Polished chrome-plated.
  - 2. Unfinished areas: Rough brass or similar finish.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass.
- C. One-Piece, Cast-Brass Type: With set screw.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

## 2.9 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, 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.

## 2.10 ACCESS PANELS AND DOORS

- A. Panels and doors are to be furnished to provide access to items required in Division 15 Sections and the Mechanical Drawings. Panels and doors are to be furnished per the requirements of Division 8 Section, "Access Doors."

## 2.11 MOTORS FOR MECHANICAL EQUIPMENT

- A. Motor Characteristics:
  - 1. Motors 1/2 HP and Larger: Three phase.
  - 2. Motors Smaller Than 1/2 HP: Single phase.
  - 3. Frequency Rating: 60 Hz.
  - 4. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
  - 5. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
  - 6. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.
  - 7. 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.
  - 8. Enclosure: Open dripproof.
  
- B. Polyphase Motors:
  - 1. Description: NEMA MG 1, Design B, medium induction motor.
  - 2. Efficiency: In conformance with the Energy Code requirements. See Section 15000 for Code.
  - 3. Stator: Copper windings, unless otherwise indicated.
    - a. Multispeed motors shall have separate winding for each speed.
  - 4. Rotor: Squirrel cage, unless otherwise indicated.
  - 5. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.
  - 6. Temperature Rise: Match insulation rating, unless otherwise indicated.
  - 7. Insulation: Class F, unless otherwise indicated.
  - 8. Code Letter Designation:

- a. Motors 15 HP and Larger: NEMA starting Code F.
- b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
9. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.
  - a. Finish: Gray enamel.
  
- C. Polyphase Motors with Additional Requirements:
  1. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
    - a. Designed with critical vibration frequencies outside operating range of controller output.
    - b. Temperature Rise: Matched to rating for Class B insulation.
    - c. Insulation: Class H.
    - d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
  
- D. Single-Phase Motors:
  1. Type: One of the following, to suit starting torque and requirements of specific motor application:
    - a. Permanent-split capacitor.
    - b. Split-phase start, capacitor run.
    - c. Capacitor start, capacitor run.
  2. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
  3. 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.
  4. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.
  5. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:
    - a. Measure winding resistance.
    - b. Read no-load current and speed at rated voltage and frequency.
    - c. Measure locked rotor current at rated frequency.
    - d. Perform high-potential test.

## 2.12 PIPE EXPANSION FITTINGS AND LOOPS

- A. Application: When the length of a piping run and the temperature range that the piping will experience will require expansion compensation refer to the ASHRAE 2000 Handbook – HVAC Systems and Equipment and ASME B31.9 for the proper application of expansion compensation.

## PART 3 - EXECUTION

### 3.1 MECHANICAL DEMOLITION

- A. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
  - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
  - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
  - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
  - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
  
- B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

### 3.2 CUTTING AND PATCHING

- A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
  
- B. Refer to Division 16 for requirements for cutting and patching electrical equipment, components, and materials.
  
- C. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
  
- D. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.
  
- E. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.
  
- F. 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. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

- G. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- H. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

### 3.3 ROUGH-IN

- A. General: Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment and fixtures to be connected. Refer to equipment and fixture specifications in Divisions 2 through 16, and to approved shop drawings, for rough-in requirements.

### 3.4 GENERAL INSTALLATION REQUIREMENTS

- A. General: Coordinate equipment and materials for installation with other building components.
- B. Verify dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- D. Coordinate the installation of required supporting devices.
  - 1. Support suspended equipment from walls or from structural frames. Do not support equipment from metal roof deck.
- E. Sequence, coordinate and integrate installations of mechanical materials and equipment for efficient flow of the work.
- F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Refer to Division 1.
- G. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- H. Install access panels to allow access to equipment and other system components which require servicing or adjustment per the requirements of Division 8.
- I. Coordinate the installation of mechanical materials and equipment above ceilings with suspension system, lighting fixtures, and other installations.

### 3.5 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.

- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following. Use One-piece escutcheons wherever possible in new construction. Split-casting units acceptable for installation on existing piping systems.
  - 1. Piping with Fitting or Sleeve Protruding from Wall: Deep-pattern type.
  - 2. Chrome-Plated Piping: Cast-brass type with polished chrome-plated finish.
  - 3. Insulated Piping: Stamped-steel type with spring clips.
  - 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Cast-brass type with polished chrome-plated finish.
  - 5. Bare Piping at Ceiling Penetrations in Finished Spaces: Cast-brass type with polished chrome-plated finish.
  - 6. Bare Piping in Unfinished Service Spaces and Equipment Rooms: Cast-brass type with rough-brass finish.
  - 7. Bare Piping at Floor Penetrations in Equipment Rooms: Floor-plate type.
- M. Sleeves are not required for core-drilled holes. When installing a pipe thru a core-drilled hole core drill the hole to provide for the 1" annular space around the pipe and use a mechanical sleeve seal as indicated in paragraphs O and P below.
- 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 7 Section "Sheet Metal Flashing and Trim" for flashing.
      - 1) Seal space outside of sleeve fittings with grout.
  4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

### 3.6 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
  - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
  - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
  - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
  - 1. Plain-End Pipe and Fittings: Use butt fusion.
  - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### 3.7 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 unions and flanges to connect piping materials of dissimilar metals.
  - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.8 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical 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.

### 3.9 CLEAN CONSTRUCTION MEASURES

- A. General: Take care during construction to maintain the integrity and cleanliness of duct, pipe and equipment systems.
- B. Ductwork must be capped during construction, dust and debris in ductwork is not acceptable. Interior of ductwork and air systems must be completely cleaned.
- C. Exposed ends of piping systems and equipment/fixture connection ports shall be capped, plugged, or otherwise covered during construction.

### 3.10 PAINTING

- A. Painting of mechanical systems, equipment, and components is specified in Division 9 Section "Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

### 3.11 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. 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 mechanical 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 mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

**END OF SECTION**

SECTION 15060

HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The requirements of Section 15000, "Basic Mechanical Requirements" apply to work defined by this Section.
- C. The requirements of Section 15050, "Basic Mechanical Materials and Methods" apply to work defined by this Section.

1.2 SUMMARY

- A. This Section includes hangers and supports for mechanical system piping and equipment.
- B. Related Sections include the following:
  - 1. Division 5 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.
  - 2. Division 13 Sections on fire-suppression piping for fire-suppression pipe hangers.
  - 3. Division 15 Section "Mechanical Vibration Controls and Seismic Restraints" for vibration isolation and seismic restraint devices.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- C. Design seismic restraint hangers and supports for piping and equipment.

- D. Design and obtain approval from authorities having jurisdiction for seismic restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

- A. General: See Division 1 for general submittal and product substitution requirements.
- B. Pre-Construction Submittals: Submit the following items prior to commencing with installations.
  - 1. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
  - 2. Welding Certificates: Copies of certificates for welding procedures and operators.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.
  - 1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Pipe Hangers:
    - a. AAA Technology and Specialties Co., Inc.
    - b. B-Line Systems, Inc.
    - c. Carpenter & Patterson, Inc.
    - d. Empire Tool & Manufacturing Co., Inc.
    - e. Globe Pipe Hanger Products, Inc.
    - f. Grinnell Corp.
    - g. GS Metals Corp.
    - h. Michigan Hanger Co., Inc.
    - i. National Pipe Hanger Corp.
    - j. PHD Manufacturing, Inc.

- k. PHS Industries, Inc.
- l. Piping Technology & Products, Inc.
- 2. Channel Support Systems:
  - a. B-Line Systems, Inc.
  - b. Grinnell Corp.; Power-Strut Unit.
  - c. GS Metals Corp.
  - d. Michigan Hanger Co., Inc.; O-Strut Div.
  - e. National Pipe Hanger Corp.
  - f. Thomas & Betts Corp.
  - g. Unistrut Corp.
  - h. Wesanco, Inc.
- 3. Thermal-Hanger Shield Inserts:
  - a. Carpenter & Patterson, Inc.
  - b. Michigan Hanger Co., Inc.
  - c. PHS Industries, Inc.
  - d. Pipe Shields, Inc.
  - e. Rilco Manufacturing Co., Inc.
  - f. Value Engineered Products, Inc.
- 4. Powder-Actuated Fastener Systems:
  - a. Gunnebo Fastening Corp.
  - b. Hilti, Inc.
  - c. ITW Ramset/Red Head.
  - d. Masterset Fastening Systems, Inc.

## 2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
  - 1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
  - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
  - 1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
  - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100-psi (690-kPa) minimum compressive-strength insulation, encased in sheet metal shield.

1. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
2. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.
3. Material for Cold Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
4. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
5. Material for Hot Piping: ASTM C 552, Type I cellular glass.
6. Material for Hot Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate.
7. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
8. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
9. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

### 2.3 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
  1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
  2. Properties: Nonstaining, noncorrosive, and nongaseous.
  3. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN15 to DN750).



2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN100 to DN400), 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 24 (DN20 to DN600), 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 (DN15 to DN600), if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN15 to DN100), 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 (DN20 to DN200).
7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN15 to DN200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN15 to DN200).
9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN15 to DN50).
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN10 to DN200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN10 to DN80).
12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30 (DN15 to DN750).
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 (DN100 to DN900), with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36 (DN65 to DN900), 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 (DN25 to DN750), 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 20 (DN65 to DN500), 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 (DN50 to DN1050), 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 (DN50 to DN600), 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 (DN50 to DN750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

- D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500).
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500), if longer ends are required for riser clamps.
- E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, 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.
- F. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb (340 kg).
    - b. Medium (MSS Type 32): 1500 lb (675 kg).
    - c. Heavy (MSS Type 33): 3000 lb (1350 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 head room is limited.

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

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi (690-kPa) minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

H. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification 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 absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
  - a. Horizontal (MSS Type 54): Mounted horizontally.
  - b. Vertical (MSS Type 55): Mounted vertically.
  - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

### 3.2 HANGER AND SUPPORT INSTALLATION

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

- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
  - 1. Field assemble and install according to manufacturer's written instructions.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- E. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
- F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- K. Insulated Piping: Comply with the following:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits according to ASME B31.9.

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 (DN100) 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 arc of 180 degrees.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) 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 (DN8 to DN90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
  - b. NPS 4 (DN100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
  - c. NPS 5 and NPS 6 (DN125 and DN150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
  - d. NPS 8 to NPS 14 (DN200 to DN350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
  - e. NPS 16 to NPS 24 (DN400 to DN600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN200) and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

### 3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

### 3.5 ADJUSTING

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

### 3.6 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 Section "Painting."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION 15060**

SECTION 15071

MECHANICAL VIBRATION AND SEISMIC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The requirements of Section 15000, "Basic Mechanical Requirements" apply to work defined by the Section.
- C. The requirements of Section 15050, "Basic Mechanical Materials and Methods" apply to work defined by the Section.

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Vibration Isolators.
  - 2. Duct and Pipe Isolators.
  - 3. Seismic Restraint Devices.
- B. Related Sections include the following:
  - 1. Section 15050, "Basic Mechanical Materials and Methods" for thermal expansion compensation in piping systems.
  - 2. Section 15060, "Hangers and Supports" for piping, duct, and equipment hangers and supports as well as requirements for strut components.

1.3 DEFINITIONS

- A.  $A_v$ : Effective peak velocity related acceleration coefficient.
- B. OSHPD: Office of Statewide Health Planning & Development for the State of California. OSHPD assigns a unique anchorage preapproval "R" number to each seismic restraint it tests. The number describes a specific device applied as tested.
- C. Withstand: The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 INTENT

- A. Mechanical equipment, piping and ductwork shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.
- B. Mechanical systems shall remain in place without separation of any part when subjected to the seismic forces specified and the systems will be fully operational after the seismic event. Mechanical systems include all equipment, ductwork, and piping.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. Applicable Code: BOCA National Building Code, 1999.
- B. General: Performance requirements to be used in the design of seismic controls shall use design forces calculated as follows:
  - 1. Seismic Performance Category: C
  - 2. Seismic Hazard Exposure Group: III.
  - 3.  $A_v = 0.12$
- C. Applicability: Seismic control and vibration isolation is required on mechanical systems.

#### 1.6 SUBMITTALS

- A. General: See Division 1 for general submittal and product substitution requirements.
- B. Pre-Construction Submittals: Submit the following items prior to commencing with installations.
  - 1. Product Data: Include load deflection curves for each vibration isolation device.
    - a. Provide Project specific catalog cuts and/or data sheets on the vibration isolators and restraints proposed for inclusion on this Project. Reference each and every "TYPE" and detail each compliance with this specification.
    - b. Provide an itemized list of all isolated and non-isolated equipment. Provide detailed schedules showing isolator and seismic restraints proposed for each piece of equipment, referencing material and seismic calculation drawing numbers.
    - c. Show base construction for equipment; include dimensions, structural member sizes and support point locations.
    - d. Indicate isolation devices selected with complete dimensional and deflection data before condition is accepted for installation.
    - e. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
    - f. For ceiling suspended equipment provide minimum/maximum installation angle allowed for restraint system as well as braced and unbraced rod lengths at each allowable installation condition.
    - g. For pad type isolators serving floor-mounted equipment provide layout of pad location for each individual unit.
  - 2. Shop Drawings and Calculations: Signed and sealed by a qualified professional engineer registered to practice in the State of Maine, with at least five years of seismic design experience. Include the following:



- a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases. Calculations must indicate specific code paragraph references for each acceleration criteria. Seismic calculations shall indicate the component values required to determine the force to be restrained. Seismic restraint calculations must be provided for all connections of equipment to structure. Performance of all products (such as: strut, cable, anchors, clips, etc.) associated with restraints must be supported with manufacturer's data sheets or certified calculations.
  - b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
  - c. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
  - d. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
  - e. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch (13-mm) deflection in x, y, and z planes.
  - f. Piping and Ductwork Spacing Tables: Submit spacing and other installation specific requirements or submit copies of the Construction Documents clearly marked with brace types and locations.
3. Welding certificates.
  4. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:
    - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
    - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
    - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
    - d. An in-force, \$1,000,000.00 coverage limit Seismic Design Errors and Omissions insurance certificate must accompany submittals. Manufacturer's product liability insurance certificates are not an acceptable substitution.
- C. Post Construction: Submit the following at least fifteen (15) days before requesting site review for Substantial Completion.
    1. A letter report signed and sealed by the Professional Engineer who designed the components, stating that the system components have been installed to their satisfaction.

## 1.7 QUALITY ASSURANCE

- A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage pre-approval "R" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-

restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer. Testing and calculations must include both shear and tensile loads and 1 test or analysis at 45 degrees to the weakest mode.

- B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

## 1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed below.
- B. Vibration Isolators:
  - 1. Ace Mounting Co., Inc.
  - 2. Amber/Booth Company, Inc.
  - 3. B-Line Systems, Inc.
  - 4. Isolation Technology, Inc.
  - 5. Kinetics Noise Control, Inc.
  - 6. Mason Industries, Inc.
  - 7. Vibration Mountings & Controls/Korfund.
- C. Duct and Pipe Vibration Isolators
  - 1. Mason Industries, Inc.
  - 2. Mason-Mercer, (Mason Industries, Inc. – Mercer Rubber Co.)
  - 3. The Metraflex Co.
  - 4. Amber/Booth Company, Inc.
- D. Seismic Restraint Devices:
  - 1. Amber/Booth Company, Inc.
  - 2. B-Line Systems, Inc.
  - 3. Kinetics Noise Control, Inc.
  - 4. Loos & Co., Inc.; Cableware Technology Division.
  - 5. Mason Industries, Inc.
  - 6. TOLCO Incorporated.
  - 7. Unistrut Diversified Products Co.; Wayne Manufacturing Division.
  - 8. Vibration Mountings & Controls/Korfund.

## 2.2 VIBRATION ISOLATORS

- A. General: Floor span distance for use in Minimum Static Deflection calculations:
- B. Elastomeric Grommet, (Bushing): Oil- and water-resistant elastomer, bolt-isolating bushing.
  - 1. Material: Bridge Bearing Neoprene.
  - 2. Basis of Design: Mason Industries, Inc. Type HG.
- C. Elastomeric Isolator Pads: Oil- and water-resistant elastomer, arranged in single or multiple layers, molded with a non-slip pattern, factory cut to sizes that match requirements of supported equipment.
  - 1. Material: Standard neoprene.
  - 2. Shims, (between multiple layers): 16 ga. Steel.
  - 3. Basis of Design: Mason Industries, Inc. Types W, SW & layered combinations thereof.
- D. Fiberglass Isolator Pads: High density precompressed molded glass fibers, individually coated with a flexible, moisture-impervious elastomeric membrane. The media shall be non-corrosive, non-combustible, non-absorbent, and shall resist rust, ozone, mildew and fungus.
  - 1. Basis of Design: Kinetics Noise Control, Model KIP.
- E. Elastomeric Isolator Pads & Plates: Oil- and water-resistant elastomer, arranged in single or multiple layers, molded with a non-slip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
  - 1. Material: Standard neoprene or bridge-bearing neoprene, complying with AASHTO M 251.
  - 2. Shims, (between multiple layers): 16 ga. Steel.
  - 3. Basis of Design: Mason Industries, Inc. Type SWM & layered combinations thereof.
- F. Elastomeric Mounts (Mason Spec. A): Double-deflection type, with molded, oil-resistant 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. Vibration Isolating Material: Neoprene.
  - 2. Basis of Design: Mason Industries, Inc. Type ND.
- G. Restrained Elastomeric Mounts: All-directional elastomeric mountings with seismic restraint.
  - 1. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.
  - 2. Shock-absorbing materials: Neoprene.
  - 3. Basis of Design: Mason Industries, Inc. Type BR.
- H. Spring Isolators (Mason Spec. B): 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 the 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, elastomeric isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig (690 kPa).
  6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
  7. Basis of Design: Mason Industries, Inc. Type SLF and SLFH.
- I. Restrained Spring Isolators (Mason Spec. D): Freestanding, steel, open-spring isolators with seismic restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  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 the rated vertical stiffness.
  5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  6. Basis of Design: Mason Industries, Inc. Type SLR.
- J. Housed Spring Isolators: 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 before contacting a resilient collar.
  4. Basis of Design: Mason Industries, Inc. Type SSLFH.
- K. Elastomeric Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
1. Basis of Design: Mason Industries, Inc. Type HD & WHD.
- L. Spring Hangers (Mason Spec. F): 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 the 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. Basis of Design: Mason Industries, Inc. Type 30N.
- M. Spring Hangers with Vertical-Limit Stop (Mason Specs. G & H): 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 the rated vertical stiffness.
  5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  6. Elastomeric Element: Molded, oil-resistant neoprene.
  7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
  8. Basis of Design: Mason Industries, Inc. Type PC30N.

### 2.3 DUCT AND PIPE ISOLATORS

- A. General: Hanger isolators listed in above are applicable to duct and piping applications as well as suspended equipment. Additionally, items identified below are specific to duct and piping installations.
- B. Thrust Limits (Mason Spec. I): Combination coil spring and elastomeric insert with spring and insert in tension, and with a load stop. Include rod and angle-iron brackets for attaching to equipment.
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. 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 the rated vertical stiffness.
  5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  6. Elastomeric Element: Molded, oil-resistant neoprene.
  7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.
  8. Basis of Design: Mason Industries, Inc. Types WBD.

- C. Acoustical Wall, Ceiling or Floor Seal (Mason Spec Q): Split steel sleeve held in place by stainless steel band clamps. Isolating material between sleeve and service pipe to be closed cell neoprene sponge.
  - 1. Basis of Design: Mason Industries, Inc. Type SWS.
  - 2. Acceptable Option: Field fabricated seals consisting of sheet metal sleeve, stainless steel band clamps, and mineral wool or fiberglass isolating packing.
    - a. Seal ends of wool with silicone sealant.
  
- D. Molded Rubber Pipe Expansion Joint (Mason Spec. O): Double sphere shaped with steel flanged end connections; peroxide or sulfur cured EPDM cover, reinforced with multiple layers of Kevlar or nylon cord; molded reinforcing ring. Unit to be designed to allow for tensile, compressive, angular and transverse movement. Units to be rated for minimum continuing operating pressures of 250psig at 170°F and 215 psig at 250°F.
  - 1. Control Rods: Rods or cables and associated hardware as recommended by unit manufacturer.
  - 2. Basis of Design: Mason Industries, Inc. – Mercer Rubber Co. Type SFDEJ.
  
- E. Stainless Steel Hose (Mason Spec. P): Type 321 corrugated stainless steel hose with overbraid; Male NPT ends for 2-inch and smaller, 150# flanged for 2-1/2-inch and larger.
  - 1. Basis of Design: Mercer Rubber Co. Type BSS-GU-MN & BSS-GU-RF-150.
  - 2. Acceptable Option: Bronze corrugated hose with overbraid; for use with copper piping systems; soldered ends.
    - a. Basis of Design: Mercer Rubber Co. Type BBF.
  
- F. Molded Rubber Duct Expansion Joint: Flexible duct connectors constructed of natural rubber or synthetic liner, nylon or steel reinforced as necessary to meet operating pressures and/or vacuum conditions; 304 stainless steel bands or flanged end connections.
  - 1. Basis of Design: Mercer Rubber Co. Duct Type Expansion Joints.
  - 2. Acceptable Option: Expansion Joints fabricated by the ductwork supplier as acceptable pending performance standards are equal to Basis of Design.

#### 2.4 SEISMIC-RESTRAINT DEVICES

- A. General: Certain items identified in paragraphs above have seismic control capabilities in addition to vibration isolation, (duct thrust restraints, restrained mounts and springs, etc.). The items identified in the following paragraphs are components specific to seismic control.
  - 1. Base Mounted Equipment: Items identified above and herein comprise restraint systems for base mounted equipment.
  - 2. Suspended Equipment, Piping and Ductwork Restraint Systems: Restraint systems for these items shall consist of tension and compression, (strut) components, or tension only, (cable) components. In either case, provide necessary ancillary appurtenances as required to meet seismic restrain design criteria. Each and every component is not identified herein.
    - a. Systems and their components shall be provided by a single manufacturer.
    - b. Components shall be intended and listed for use with each other, (do not mix and match components not intended for use with each other).
    - c. Systems may include:
      - 1) Attachments to structure.

- 2) Braces and other means of augmenting standard hanger and support assemblies.
  - 3) Threaded rod stiffeners.
  - d. Restraint devices constructed of aluminum or cast iron materials are not acceptable.
- B. Strut Restraint Systems: Strut components, (channel support systems) are as identified in Section 15060, "Hangers and Supports."
1. Basis of Design: As manufactured by B-Line Systems, Inc.
- C. Restraining Cable Systems: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.
1. Basis of Design: As manufactured by Mason Industries, Inc.
- D. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251, with a flat washer face.
1. Basis of Design: Mason Industries, Inc. Types PB & HG.
- E. Seismic Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
  2. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251.
  3. Basis of Design: Mason Industries, Inc. Types Z-1225 & Z-1011.
- F. Anchor Bolts: Seismic-rated, drill-in, and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M.
1. Basis of Design: Mason Industries, Inc. Types SAS & SAB.

## 2.5 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for field painting.
- B. 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 electro-galvanized. Hot-dip galvanize metal components for exterior use.
  3. Baked enamel for metal components on isolators for interior use.
  4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 EQUIPMENT VIBRATION ISOLATOR APPLICATION

- A. General: Provide isolators of sufficient size, arrangement and configuration to support the weight and forces generated by the equipment, per isolator manufacturer requirements.

### 3.3 SEISMIC CONTROLS INSTALLATION

- A. General: Seismic controls for equipment and distribution systems shall be as per the requirements of approved submittals.

### 3.4 FIELD QUALITY CONTROL

- A. Vibration Isolator Testing: Perform the following field quality-control testing:
  - 1. Isolator seismic-restraint clearance.
  - 2. Isolator deflection.
  - 3. Snubber minimum clearances.
- B. Seismic Controls Verifications: The Professional Engineer who designed the seismic controls shall provide site supervision and assistance during construction and shall review on-site installations as necessary to certify the successful completion of installations.
  - 1. Submit verification per the requirements of Section 1, "Submittals."

### 3.5 ADJUSTING

- A. Adjust isolators after piping systems have been filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.



- F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
- G. CLEANING
  - 1. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

**END OF SECTION 15071**



SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The requirements of Section 15000, "Basic Mechanical Requirements" apply to work defined by this Section.
- C. The requirements of Section 15050, "Basic Mechanical Materials and Methods" apply to work defined by this Section.

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
  - 1. Equipment nameplates.
  - 2. Equipment markers.
  - 3. Equipment signs.
  - 4. Access panel and door markers.
  - 5. Pipe markers.
  - 6. Duct markers.
  - 7. Stencils.
  - 8. Valve tags.
  - 9. Valve schedules.
  - 10. Warning tags.

1.3 SUBMITTALS

- A. General: See Division 1 for general submittal and product substitution requirements.
- B. Pre-Construction Submittals: Submit the following items prior to commencing with installations.
  - 1. Product Data: For each type of product indicated.
  - 2. Valve numbering scheme.
- C. Post Construction Submittals: Submit the following items upon completion of system installations
  - 1. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 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 location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed below.
- B. Identification Systems:
  - 1. Seaton Name Plate Co.
  - 2. Brady: Signmark Div.; W.H. Brady Co.
  - 3. Kolbi Industries, Inc.

2.2 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
  - 1. Data:
    - a. Manufacturer, product name, model number, and serial number.
    - b. Capacity, operating and power characteristics, and essential data.
    - c. Labels of tested compliances.
  - 2. Location: Accessible and visible.
  - 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
  - 1. Terminology: Match schedules as closely as possible.
  - 2. Data:

- a. Name and plan number.
  - b. Equipment service.
  - c. Design capacity.
  - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
3. Size: 2-1/2 by 4 inches (64 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.
- C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
1. Data: Instructions for operation of equipment and for safety procedures.
  2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
  3. Thickness: 1/8 inch (3.2 mm), unless otherwise indicated.
  4. Thickness: 1/16 inch (1.6 mm) for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) in length, and 1/8 inch (3.2 mm) for larger units.
  5. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.
- D. Access Panel and Door Markers: 1/16-inch- (1.6-mm-) thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch (3.2-mm) center hole for attachment.
1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

### 2.3 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
  2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
  3. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers extending 360 degrees around pipe at each location.
  4. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
  5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

- D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils (0.08 mm) thick with pressure-sensitive, permanent-type, self-adhesive back.
  - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch (19 mm) minimum.
  - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: 1-1/2 inches (38 mm) minimum.

#### 2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches (32 mm) for ducts; and minimum letter height of 3/4 inch (19 mm) for access panel and door markers, equipment markers, equipment signs, and similar operational instructions.
  - 1. Stencil Material: Metal.
  - 2. Stencil Paint: Exterior, gloss, alkyd enamel black, unless otherwise indicated. Paint may be in pressurized spray-can form.
  - 3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.

#### 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, with numbering scheme approved by Architect. Provide 5/32-inch (4-mm) hole for fastener.
  - 1. Material: 0.032-inch- (0.8-mm-) thick brass.
  - 2. Material: 0.0375-inch- (1-mm-) thick stainless steel.
  - 3. Material: 3/32-inch- (2.4-mm-) thick laminated plastic with 2 black surfaces and white inner layer.
  - 4. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

#### 2.6 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size 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.

### PART 3 - EXECUTION

### 3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

### 3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Humidifiers.
2. Air Handlers.
3. Zone-type units.
4. Medical Gas Zone Valve Boxes.

- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 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.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
  - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.

- C. Stenciled Equipment Marker Option: Stenciled markers may be provided instead of laminated-plastic equipment markers, at Installer's option, if lettering larger than 1 inch (25 mm) high is needed for proper identification because of distance from normal location of required identification.

- D. Install access panel markers with screws on equipment access panels.

### 3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Pretensioned pipe markers. Use size to ensure a tight fit.
  2. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch (19 mm) wide, lapped at least 1-1/2 inches (38 mm) at both ends of pipe marker, and covering full circumference of pipe.
  3. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
  4. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches (38 mm) wide, lapped at least 3 inches (75 mm) at both ends of pipe marker, and covering full circumference of pipe.
- B. Stenciled Pipe Marker Option: Stenciled markers may be provided instead of manufactured pipe markers, at Installer's option. Install stenciled pipe markers with ASME A13.1 on each piping system.
1. Identification Paint: Use for contrasting background.
  2. Stencil Paint: Use for pipe marking.
- C. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
1. Near each valve and control device.
  2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
  4. At access doors, manholes, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.
  6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

### 3.4 DUCT IDENTIFICATION

- A. Install duct markers with permanent adhesive on air ducts in the following color codes:
1. Green: For cold-air supply ducts.
  2. Yellow For hot-air supply ducts.
  3. Blue For exhaust-, outside-, relief-, return-, and mixed-air ducts.
  4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
  5. Letter Size: Minimum 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.



- B. Stenciled Duct Marker Option: Stenciled markers, showing service and direction of flow, may be provided instead of laminated-plastic duct markers, at Installer's option, if lettering larger than 1 inch (25 mm) high is needed for proper identification because of distance from normal location of required identification.
- C. Locate markers 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; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

### 3.6 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

### 3.7 CLEANING

- A. Clean faces of mechanical identification devices.

**END OF SECTION 15075**



SECTION 15081

DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The requirements of Section 15000, "Basic Mechanical Requirements" apply to work defined by this Section.
- C. The requirements of Section 15050, "Basic Mechanical Materials and Methods" apply to work defined by this Section.

1.2 SUMMARY

- A. This Section includes semi-rigid and flexible duct, plenum, and breeching insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
- B. Related Sections include the following:
  - 1. Division 7 Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
  - 2. Section 15082 "Equipment Insulation" for insulation materials and application for pumps, tanks, hydronic specialties, and other equipment.
  - 3. Section 15083 "Pipe Insulation" for insulation for piping systems.
  - 4. Section 15815 "Metal Ducts" for duct liner.

1.3 SUBMITTALS

- A. General: See Division 1 for general submittal and product substitution requirements.
- B. Pre-construction Shop Drawings: Show fabrication and installation details for metal ducts as follows prior to commencing with fabrication and installation:
  - 1. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
  - 2. Shop Drawings: Show fabrication and installation details for the following:
    - a. Application of field-applied jackets.
    - b. Applications at linkages for control devices.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
  - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate clearance requirements with duct installer for insulation application.

1.7 SCHEDULING

- A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed below.
- B. Fiber Glass Insulation:
  - 1. CertainTeed.
  - 2. Knauf FiberGlass.
  - 3. Owens-Corning Fiberglas Corp.
  - 4. Schuller International, Inc. / Johns Manville Insulations
- C. Calcium Silicate Insulation:
  - 1. Owens-Corning Fiberglas Corp.

2. Pabco.
3. Schuller International, Inc.

- D. Ceramic Fiber Blanket Insulation:
1. 3M

## 2.2 INSULATION MATERIALS

- A. Fiber Glass Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket (FSK) manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film. 'K' value: 0.24 Btu\*in/(hr\*sqft\*degree F) at 75 degree F. Based on Johns Manville 800 Series Spin-Glas.
- B. Fiberglass Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket (FSK) manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film. 'K' value: 0.29 Btu\*in/(hr\*sqft\*degree F) at 75 degree F. Based on Johns Manville Microlite.
- C. Calcium Silicate Insulation: Flat, curved, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a nonasbestos fibrous reinforcement. Comply with ASTM E 814, Type I. Insulation used for grease duct enclosure shall be UL listed for that application. Based on Johns Manville Firetemp L.
- D. Flexible blanket grease duct insulation: Ceramic fiber inorganic blanket encapsulated in scrim reinforced foil, UL 1978, ASTM E 814. Two layers suitable for grease duct installation and zero clearance to combustibles. Thermal conductivity 1.69 Btu\*in/(hr\*sqft\*degreeF) at 1500 degrees F. Based on 3M Fire Barrier Duct Wrap 15A.

## 2.3 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
- C. Aluminum Jacket: Deep corrugated sheets manufactured from aluminum alloy complying with ASTM B 209 (ASTM B 209M), and having an integrally bonded moisture barrier over entire surface in contact with insulation. Metal thickness and corrugation dimensions are scheduled at the end of this Section.
1. Finish: Smooth finish.
  2. Moisture Barrier: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.

## 2.4 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd. (270 g/sq. m).

1. Tape Width: 4 inches (100 mm).
  - B. Bands: 3/4 inch (19 mm) wide, in one of the following materials compatible with jacket:
    1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch (0.5 mm) thick.
    2. Galvanized Steel: 0.005 inch (0.13 mm) thick.
    3. Aluminum: 0.007 inch (0.18 mm) thick.
    4. Brass: 0.010 inch (0.25 mm) thick.
    5. Nickel-Copper Alloy: 0.005 inch (0.13 mm) thick.
  - C. Wire: 0.080-inch (2.0-mm), nickel-copper alloy; 0.062-inch (1.6-mm), soft-annealed, stainless steel; or 0.062-inch (1.6-mm), soft-annealed, galvanized steel.
  - D. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.
    1. Welded Pin Holding Capacity: 100 lb (45 kg) for direct pull perpendicular to the attached surface.
  - E. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
    1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb (45 kg) for direct pull perpendicular to the adhered surface.
  - F. Self-Adhesive Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
- 2.5 VAPOR RETARDERS
- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

### **PART 3 - EXECUTION**

#### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

### 3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply multiple layers of insulation with longitudinal and end seams staggered.
- E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- F. Keep insulation materials dry during application and finishing.
- G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- H. Apply insulation with the least number of joints practical.
- I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
- K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- L. Apply insulation with integral jackets as follows:
  - 1. Pull jacket tight and smooth.
  - 2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
  - 3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.

- M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.
- N. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.
  - 1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
  - 2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.
- O. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
  - 1. Seal penetrations with vapor-retarder mastic.
  - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
  - 3. Seal insulation to roof flashing with vapor-retarder mastic.
- P. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- Q. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.
- R. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.
  - 1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

### 3.4 FIBER GLASS INSULATION APPLICATION

- A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.
  - 1. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions larger than 24 inches (450 mm). Space 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
    - b. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - c. Do not overcompress insulation during installation.
  - 2. Impale insulation over anchors and attach speed washers.
  - 3. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.



4. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch (13-mm) staples, 1 inch (25 mm) o.c., and cover with pressure-sensitive tape having same facing as insulation.
  5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches (450 mm) o.c.
  6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- (150-mm-) wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches (150 mm) o.c.
  8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.
  9. Terminate insulation around duct access doors and seal insulation edges.
- B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Space anchor pins as follows:
    - a. On duct sides with dimensions 18 inches (450 mm) and smaller, along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    - b. On duct sides with dimensions larger than 18 inches (450 mm). Space 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
    - c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
  4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch (13-mm) staples, 1 inch (25 mm) o.c., and cover with pressure-sensitive tape having same facing as insulation.
  6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- (150-mm-) wide strips of the same material used to insulate duct. Secure on

alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches (150 mm) o.c.

8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.
9. Terminate insulation around duct access doors and seal insulation edges.

### 3.5 CALCIUM SILICATE INSULATION APPLICATION

- A. Apply insulation according to the manufacturer's written instructions.

### 3.6 FIELD-APPLIED JACKET APPLICATION

- A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
  1. Apply jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
  2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of jacket manufacturer's recommended adhesive.
  3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

### 3.7 DUCT SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.
- C. Insulate the following plenums and duct systems:
  1. Supply ductwork except where located in conditioned space.
  2. Return and relief ductwork in mechanical rooms and in unconditioned space.
  3. Exhaust ductwork within 10 feet of exterior opening.
  4. Outdoor exposed supply and return ductwork.
  5. Cooking Hood exhaust duct.
  6. Outdoor air intake and combustion air ductwork.
- D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
  1. Metal ducts with duct liner.
  2. Factory-insulated flexible ducts.
  3. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
  4. Flexible connectors.
  5. Vibration-control devices.
  6. Testing agency labels and stamps.

7. Nameplates and data plates.
8. Access panels and doors in air-distribution systems.
9. Cooking hood exhaust ducts installed in rated chase in accordance with applicable code.

### 3.8 INDOOR DUCT AND PLENUM APPLICATION SCHEDULE

- A. Service: Rectangular and round, supply-air ducts, above ceilings, concealed, in mechanical rooms, and in unconditioned space.
  1. Material: Fiberglass blanket or fiberglass board.
  2. Thickness: 1 ½ inches.
  3. Number of Layers: one.
  4. Factory-Applied Jacket: FSK or vinyl-film. Vapor retarder required on ducts conveying air below ambient temperature.
- B. Service: Rectangular and round, return-air and relief air ducts, in mechanical rooms and in unconditioned space. Exhaust ducts within 10' of exterior opening.
  1. Material: Fiberglass blanket or fiberglass board.
  2. Thickness: 1 inch.
  3. Number of Layers: one.
  4. Factory-Applied Jacket: FSK or vinyl-film.
- C. Service: Rectangular and round, outside-air intake / combustion air ducts.
  1. Material: Fiberglass blanket or fiberglass board.
  2. Thickness: 2 inches.
  3. Number of Layers: one.
  4. Field-Applied Jacket: FSK or vinyl-film.
  5. Vapor Retarder Required.
- D. Service: Cooking hood exhaust ducts.
  1. Material: Calcium silicate.
  2. Material: Ceramic fiber blanket.
  3. Thickness: As required to provide a fire resistance rating of 1 hour [2 hours].

**END OF SECTION**



SECTION 15083

PIPE INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The requirements of Section 15000, "Basic Mechanical Requirements" apply to work defined by this Section.
- C. The requirements of Section 15050, "Basic Mechanical Materials and Methods" apply to work defined by this Section.

1.2 SUMMARY

- A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
- B. Related Sections include the following:
  - 1. Division 7, Section 07270 "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
  - 2. Section 15081 "Duct Insulation" for insulation for ducts and plenums.
  - 3. Section 15082 "Equipment Insulation" for insulation materials and application for pumps, tanks, hydronic specialties, and other equipment.
  - 4. Pipe insulation shields and protection saddles - see appropriate piping section.

1.3 SUBMITTALS

- A. General: See Division 1 for general submittal and product substitution requirements.
- B. Pre-Construction Submittals: Submit the following items prior to commencing with installations.
  - 1. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
  - 2. Shop Drawings: Show fabrication and installation details for the following:
    - a. Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.
    - b. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
    - c. Removable insulation at piping specialties and equipment connections.
    - d. Application of field-applied jackets.

1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
  - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in the appropriate piping section.
- B. Coordinate clearance requirements with piping Installer for insulation application.

1.7 SCHEDULING

- A. Schedule insulation application after testing piping systems and, where required. Insulation application may begin on segments of piping that have satisfactory test results.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed below.
- B. Fiber Glass Insulation:
  - 1. CertainTeed Manson.
  - 2. Knauf FiberGlass GmbH.
  - 3. Owens-Corning Fiberglas Corp.
  - 4. Schuller International, Inc. / Johns Manville Insulations

2.2 INSULATION MATERIALS

- A. Fiber Glass Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

1. Thermal conductivity: 0.23 Btu\*in/(hr\*sq ft\*degree F) at 75 degrees F.
2. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket complying with ASTM C 1136. Based on Johns Manville Micro-Lok.
3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
  - a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
  - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.

### 2.3 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
- C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils (0.5 mm) thick; roll stock ready for shop or field cutting and forming.
  1. Adhesive: As recommended by insulation material manufacturer.
  2. PVC Jacket Color: White or gray.
- D. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-(0.5-mm-) thick, high-impact, ultraviolet-resistant PVC.
  1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
  2. Adhesive: As recommended by insulation material manufacturer.

### 2.4 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd. (270 g/sq. m).
  1. Tape Width: 4 inches (100 mm).
- B. Bands: 3/4 inch (19 mm) wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch (0.5 mm) thick.
2. Galvanized Steel: 0.005 inch (0.13 mm) thick.
3. Aluminum: 0.007 inch (0.18 mm) thick.
4. Brass: 0.010 inch (0.25 mm) thick.
5. Nickel-Copper Alloy: 0.005 inch (0.13 mm) thick.

- C. Wire: 0.080-inch (2.0-mm), nickel-copper alloy; 0.062-inch (1.6-mm), soft-annealed, stainless steel; or 0.062-inch (1.6-mm), soft-annealed, galvanized steel.

## 2.5 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

### 3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.



- G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
  - 1. Apply insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches (300 mm) from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
  - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
  - 1. Pull jacket tight and smooth.
  - 2. Circumferential Joints: Cover with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches (100 mm) o.c.
  - 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches (40 mm). Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.
    - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
  - 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.

5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- P. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- Q. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section 07270 "Firestopping."
- R. Floor Penetrations: Apply insulation continuously through floor assembly.
1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

### 3.4 FIBER GLASS INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
  2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet (4.5 to 6 m) to form a vapor retarder between pipe insulation segments.
  3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
  4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
1. Apply preformed pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
  4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch (25 mm), and seal joints with vapor-retarder mastic.
- C. Apply insulation to fittings and elbows as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
  2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.

3. Cover fittings with standard PVC fitting covers.

D. Apply insulation to valves and specialties as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

### 3.5 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.

1. Apply jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

B. Foil and Paper Jackets: Apply foil and paper jackets where indicated.

1. Draw jacket material smooth and tight.
2. Apply lap or joint strips with the same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Apply jackets with 1-1/2-inch (40-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

### 3.6 FINISHES

A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Division 9 Section "Painting."

### 3.7 PIPING SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
1. Flexible connectors.
  2. Vibration-control devices.
  3. Fire-suppression piping.
  4. Drainage piping located in crawl spaces, unless otherwise indicated.
  5. Below-grade piping, unless otherwise indicated.
  6. Chrome-plated pipes and fittings, unless potential for personnel injury.
  7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.
  8. Flanges and unions at equipment on hot piping systems conveying fluids 140 degrees F or less. Bevel and seal ends of insulation.

### 3.8 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

### 3.9 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic hot and recirculated hot water.
1. Operating Temperature: 60 to 140 deg F (15 to 60 deg C).
  2. Insulation Material: Fiberglass with jacket.
  3. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Piping up to 1 1/4": 0.5" thickness.
    - b. Piping 1-1/4" and greater: 1" thickness.
  4. Vapor Retarder Required: No.
  5. Finish: None.
- B. Service: Domestic cold water.
1. Operating Temperature: 35 to 60 deg F (2 to 15 deg C).
  2. Insulation Material: Fiberglass with jacket.
  3. Insulation Thickness: Apply the following insulation thicknesses:
    - a. Piping up to 1 1/4": 0.5" thickness.
    - b. Piping 1-1/4" and greater: 1" thickness.
  4. Vapor Retarder Required: Yes.
  5. Finish: None.
- C. Service: Condensate drain piping from cooling coils.

1. Operating Temperature: 35 to 75 deg F (2 to 24 deg C).
2. Insulation Material: Fiberglass with jacket.
3. Insulation Thickness: ½”.
4. Vapor Retarder Required: Yes.
5. Finish: none.

D. Service: Chilled-water supply and return.

1. Operating Temperature: 40 to 65 deg F (2 to 24 deg C).
2. Insulation Material: Fiberglass with jacket.
3. Insulation Thickness: Apply the following insulation thicknesses:
  - a. Piping up to 1 1/4”: 0.5” thickness.
  - b. Piping 1-1/4” and greater: 1” thickness.
4. Vapor Retarder Required: Yes.
5. Finish: None.

E. Service: Heating hot-water supply and return.

1. Operating Temperature: 100 to 200 deg F (38 to 93 deg C).
2. Insulation Material: Fiberglass with jacket.
3. Insulation Thickness: Apply the following insulation thicknesses:
  - a. Piping up to 4”: 1.0” thickness.
  - b. Piping 4”and greater: 1.5” thickness.
  - c. Piping insulation is not required between the control valve and coil on run-outs when the control valve is located within 4 feet of the coil and the pipe size is 1 inch or less.
4. Vapor Retarder Required: No.
5. Finish: none.

F. Service: Low Pressure Steam (up to 15 psig) and condensate.

1. Operating Temperature: 212 to 250 deg F (232 deg C).
2. Insulation Material: Fiberglass with jacket.
3. Insulation Thickness: Apply the following insulation thicknesses:
  - a. Piping up to 1”: 1.5” thickness.
  - b. Piping 1.25” and greater: 2.0” thickness.
4. Vapor Retarder Required: No.
5. Finish: None

**END OF SECTION**



SECTION 15122

METERS AND GAGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The requirements of Section 15000, "Basic Mechanical Requirements" apply to work defined by this Section.
- C. The requirements of Section 15050, "Basic Mechanical Materials and Methods" apply to work defined by this Section.

1.2 SUMMARY

- A. This Section includes the following meters and gages for mechanical systems:
  - 1. Thermometers.
  - 2. Gages.
  - 3. Test plugs.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.

1.4 SUBMITTALS

- A. General: See Division 1 for general submittal and product substitution requirements.
- B. Pre-Construction Submittals: Submit the following items prior to commencing with installations.
  - 1. Product Data: For each type of product indicated; include performance curves.
  - 2. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed below.
- B. Thermometers:
  - 1. Palmer - Wahl Instruments Inc.
  - 2. Terice, H. O. Co.
  - 3. Weiss Instruments, Inc.
  - 4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- C. Thermowells
  - 1. Palmer - Wahl Instruments Inc.
  - 2. Terice, H. O. Co.
  - 3. Weiss Instruments, Inc.
  - 4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- D. Pressure gages
  - 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
  - 2. Palmer - Wahl Instruments Inc.
  - 3. Terice, H. O. Co.
  - 4. Weiss Instruments, Inc.
  - 5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- E. Test plugs
  - 1. Flow Design, Inc.
  - 2. MG Piping Products Co.
  - 3. National Meter, Inc.
  - 4. Peterson Equipment Co., Inc.
  - 5. Sisco Manufacturing Co.
  - 6. Terice, H. O. Co.
  - 7. Watts Industries, Inc.; Water Products Div.

2.2 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

- A. Stem type complying with ASTM E1.
  - 1. Case: Die-cast aluminum, 9 inches long.
  - 2. Tube: Blue reading, organic-liquid filled, with magnifying lens.
  - 3. Tube Background: Satin-faced, non-reflective aluminum with permanently etched scale markings.
  - 4. Window: Glass or plastic.
  - 5. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.



6. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
7. Accuracy: Plus or minus 1 scale division to maximum of 1.5 percent of range.
8. Basis of Design: Trerice Model BX91-SPB

### 2.3 THERMOWELLS

- A. Manufacturers: Same as manufacturer of thermometer being used or see list of acceptable manufacturers above.
- B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

### 2.4 TEST PLUGS

- A. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.
- B. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
- C. Core Inserts: One or two self-sealing rubber valves.
  1. Insert material for air, water, oil, or gas service at 20 to 200 deg F (minus 7 to plus 93 deg C) shall be CR.
  2. Insert material for air or water service at minus 30 to plus 275 deg F (minus 35 to plus 136 deg C) shall be EPDM.

### 2.5 STATIC PRESSURE GAGES

- A. Gage: 4¾ inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- B. Accessories: Provide air filter gage accessory package including mounting brackets, tubing, static pressure tips, vent valves, and compression fittings.

### 2.6 Based on Dwyer Model 2000.

## PART 3 - EXECUTION

### 3.4 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.

- C. Install differential static pressure gages at the pre-filter and final filter banks in the Air Handling Unit.

3.5 ADJUSTING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjust faces of meters and gages to proper angle for best visibility.

**END OF SECTION**

SECTION 15140  
PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The requirements of Section 15000, "Basic Mechanical Requirements" apply to work defined by this Section.
- C. The requirements of Section 15050, "Basic Mechanical Materials and Methods" apply to work defined by this Section.

1.2 SUMMARY

- A. This Section includes the following piping systems to a point 10-feet outside the building wall, unless otherwise noted;
  - 1. Water Supply Piping.
    - a. Domestic Cold, Hot and Recirculated Hot Water.
  - 2. Drainage, Waste and Vent, (DWV).
    - a. Sanitary Waste and Vent.
- B. Related Sections include the following:
  - 1. Division 7, Section 07270 "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
  - 2. Section 15071, "Mechanical Vibration and Seismic Controls."
  - 3. Section 15083, "Pipe Insulation" for system insulation requirements.
  - 4. Section 15122, "Meters and Gauges" for thermometers, pressure gages, and fittings.
  - 5. Section 15430, "Plumbing Specialties" for water distribution piping specialties.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer.
- B. DWV: Drainage, Waste and Vent piping systems.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide components and installations capable of producing piping systems with the following minimum working pressure ratings, unless otherwise noted.
  - 1. Water Supply Systems, Above Ground: 125 psig.
  - 2. DWV, (Gravity) Systems: 10 foot of head of water.

#### 1.5 SUBMITTALS

- A. General: See Division 1 for general submittal and product substitution requirements.
- B. Pre-Construction Submittals: Submit the following items prior to commencing with installations.
  - 1. Product Data: For pipe, tube, fittings, valves and couplings.
- C. Submittals During Construction: Submit the following items at the intervals indicated.
  - 1. Pressure test results after system rough-ins.
    - a. Test results to include Plumbing Inspector sign-off.
    - b. If systems are tested in portions, submit results as each portion is tested.
- D. Post Construction Submittals: Submit the following items upon completion of system installations.
  - 1. Water Disinfection statement and final water quality test results.
  - 2. Final Plumbing Inspector Sign-off.

#### 1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed below.
- B. No-hub Couplings:
  - 1. Husky Technologies.
  - 2. Ideal; A Gates Group Company.
  - 3. Tyler Pipe Co.
  - 4. Charlotte Pipe and Foundry.
- C. Ball Valves:
  - 1. Conbraco Industries, Inc.; Apollo Div.
  - 2. Crane Co.; Crane Valve Group; Jenkins Valves.

3. Crane Co.; Crane Valve Group; Stockham Div.
4. NIBCO INC.
5. Watts Industries, Inc.; Water Products Div.
6. Hammond Valve.
7. Milwaukee Valve Company.

## 2.2 PIPING MATERIALS

- A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

## 2.3 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
  1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
  2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
  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.

## 2.4 CAST-IRON SOIL PIPE AND FITTINGS

- A. Hubless Pipe and Fittings: ASTM A 888 or CISPI 301.
  1. Couplings: ASTM C 1277 assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral, center pipe stop.
    - a. Heavy-Duty, Type 304, Stainless-Steel Couplings: ASTM A 666, Type 304, stainless-steel shield; stainless-steel bands; and sleeve.
      - 1) NPS 1-1/2 to NPS 4: 3-inch wide shield with 4 bands.
      - 2) NPS 5 to NPS 10: 4-inch wide shield with 6 bands.

## 2.5 VALVES

- A. Balancing and drain valves are specified in Division 15 Section "Plumbing Specialties."
- B. Refer to Part 3 "Valve Applications" Article for applications of valve types.
- C. General Requirements:

1. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
  2. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
  3. Lever Handle: For quarter-turn valves NPS 6 (DN 150) and smaller.
  4. Extended Valve Stems: On insulated valves.
  5. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
  6. Solder Joint: With sockets according to ASME B16.18.
    - a. Caution: Use solder with melting point below 840 deg F (454 deg C) for angle, check, gate, and globe valves; below 421 deg F (216 deg C) for ball valves.
  7. Threaded: With threads according to ASME B1.20.1.
  8. Valve Bypass and Drain Connections: MSS SP-45.
- D. Ball Valves:
1. MSS SP-110, 600# W.O.G., forged brass, two piece body, hard chrome plated forged brass ball, standard or full port, true adjustable packing nut, (O-ring only type stem seal not acceptable) blow-out proof stem.
  2. Acceptable end connections;
    - a. Soldered for NPS 3 and smaller.
  3. Basis of Design: Apollo 70 Series.

### PART 3 - EXECUTION

#### 3.1 PIPE AND FITTING APPLICATIONS

- A. Water Supply Piping, Aboveground:
1. Hard copper tube, Type L; copper pressure fittings; lead-free soldered joints.
- B. DWV Gravity Piping, Aboveground:
1. Service weight cast iron soil pipe; hubless cast iron fittings; no-hub coupled joints.
  2. Option: 2-inch and smaller drain and vent lines may be installed using Copper tube, Type DWV; copper drainage fittings, soldered joints.

#### 3.2 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball valves for piping NPS 2 (DN 50) and smaller.
  2. Throttling Duty: Use ball valves for piping NPS 2 (DN 50) and smaller.
  3. Drain Duty: Hose-end drain valves.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 (DN 50) and smaller.

- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
  - 1. Install hose-end drain valves at low points in water mains, risers, and branches.
  - 2. Install stop-and-waste drain valves where indicated.

### 3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- C. 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."
- D. Make changes in direction for DWV piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- E. Install DWV piping at the following minimum slopes, unless otherwise indicated:
  - 1. Horizontal drainage piping, NPS 3-inch and smaller: 1/4-inch per foot downward in direction of flow.
  - 2. Horizontal drainage piping, NPS 4-inch and larger: 1/8-inch per foot downward in direction of flow.
  - 3. Vent Piping: 1/8-inch per foot down toward vertical fixture vent or toward vent stack.
- F. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

### 3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- C. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
2. Hubless Joints: Make with rubber gasket and sleeve or clamp.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."
- B. Pipe hanger and support devices are specified in Division 15 Section "Hangers and Supports." Install the following:
  1. Vertical Piping: MSS Type 8 or Type 42, clamps.
  2. Individual, Straight, Horizontal Piping Runs: According to the following:
    - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet (30 m): MSS Type 49, spring cushion rolls, if indicated.
  3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 15 Section "Hangers and Supports."
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
- F. Install supports for vertical steel piping every 15 feet (4.5 m).
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
  2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
  3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
  4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
  5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
- H. Install supports for vertical copper tubing every 10 feet (3 m).
- I. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
  1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.



2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

- J. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
- K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

### 3.6 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 the following:
1. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 15 Section "Plumbing Fixtures."
  2. 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.
- D. 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. Refer to Division 15 Section "Plumbing Fixtures."
  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. Refer to Division 15 Section "Plumbing Specialties."
  4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

### 3.7 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
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 24 hours 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 test or inspection, make required corrections and arrange for reinspection.
  4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic water piping as follows:
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 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 to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
  5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
  6. Prepare reports for tests and required corrective action.
- C. Inspect DWV piping as follows:
1. 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.
    - 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 for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
  2. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
  3. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test DWV 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.

### 3.8 ADJUSTING

- A. Perform the following adjustments before operation:
  1. Close drain valves.
  2. Open shutoff valves to fully open position.
  3. Open throttling valves to proper setting.
  4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
  5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
  6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
  7. Check plumbing specialties and verify proper settings, adjustments, and operation.

### 3.9 CLEANING

- A. General: Clean interior of domestic water piping system. Remove dirt and debris as work progresses.
- B. Clean and disinfect potable and non-potable domestic water piping as follows:
  1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
  2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
    - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - b. Fill 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 to stand 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 to stand for three hours.
- c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
3. Prepare and submit reports of purging and disinfecting activities.
- C. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- D. Place plugs in ends of uncompleted piping at end of day and when work stops.

**END OF SECTION**

SECTION 15181

HYDRONIC PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The requirements of Section 15000, "Basic Mechanical Requirements" apply to work defined by this Section.
- C. The requirements of Section 15050, "Basic Mechanical Materials and Methods" apply to work defined by the Section.

1.2 SUMMARY

- A. This Section includes piping, general-duty valves, special-duty valves, and hydronic specialties for hot-water heating, chilled-water cooling, and condensate drain piping.
- B. Related Sections include the following:
  - 1. Division 7, Section 07270 "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
  - 2. Division 7, Section 07900 "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
  - 3. Division 15, Section 15050 "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
  - 4. Division 15, Section 15071 "Mechanical Vibration and Seismic Controls"
  - 5. Division 15, Section 15122 "Meters and Gages" for thermometers, flow meters, and pressure gages.
  - 6. Division 15, Section 15075 "Mechanical Identification" for labeling and identifying hydronic piping.
  - 7. Division 15, Section 15900 "HVAC Instrumentation and Controls" for temperature-control valves and sensors.

1.3 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride.
- B. CWP: Cold working pressure.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.

- D. NBR: Acrylonitrile-butadiene rubber.
- E. PTFE: Polytetrafluoroethylene plastic.
- F. PVC: Polyvinyl chloride
- G. SWP: Steam working pressure.
- H. TFE: Tetrafluoroethylene plastic.

#### 1.4 SUBMITTALS

- A. General: See Division 1 for general submittal and product substitution requirements.
- B. Pre-Construction Submittals: Submit the following items prior to commencing with installations.
  - 1. Product Data: For each type of general-duty valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories
  - 2. Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.
  - 3. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.
- C. Post Construction Submittals: Submit the following items upon completion of system installations.
  - 1. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
    - a. Test procedures used.
    - b. Test results that comply with requirements.
    - c. Failed test results and corrective action taken to achieve requirements.
- D. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 1.

#### 1.5 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

- C. ASME Compliance: ASME B31.9 for building services piping valves.
- D. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

#### 1.6 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe fitting pressure classes with products specified in related Sections.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. 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.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. General-Duty Valves:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Div.
    - d. Hammond Valve.
    - e. Milwaukee Valve Company.
    - f. NIBCO INC.
    - g. Red-White Valve Corp.
  - 2. Calibrated Balancing Valves:
    - a. Armstrong Pumps, Inc.
    - b. Danfoss
    - c. Flow Design, Inc.
    - d. Gerand Engineering Company.
    - e. Griswold Controls.
    - f. ITT Bell & Gossett; ITT Fluid Technology Corp.
    - g. Taco, Inc.

2.2 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).
- B. DWV Copper Tubing: ASTM B 306, Type DWV.
- C. Wrought-Copper Fittings: ASME B16.22.
- D. Wrought-Copper Unions: ASME B16.22.

2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2 (DN 50) and Smaller: ASTM A 53, Type S (seamless) or Type F (furnace-butt welded), Grade B, Schedule 40, black steel, plain ends.
- B. Steel Pipe, NPS 2-1/2 through NPS 12 (DN 65 through DN 300): ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel, plain ends.
- C. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.
- D. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- E. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

2.5 SPECIAL-DUTY VALVES

- A. Refer to Part 3 "Valve Applications" Article for applications of each valve.
- B. Calibrated Balancing Valves, NPS 2 (DN 50) and Smaller: Bronze body, ball type, 125-psig (860-kPa) working pressure, 250 deg F (121 deg C) maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
- C. Calibrated Balancing Valves, NPS 2-1/2 (DN 65) and Larger: Cast-iron or steel body, ball type, 125-psig (860-kPa) working pressure, 250 deg F (121 deg C) maximum operating temperature, and having flanged or grooved connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.



## 2.6 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig (1035-kPa) working pressure; 225 deg F (107 deg C) operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 (DN 6) discharge connection and NPS 1/2 (DN 15) inlet connection.
- B. Y-Pattern Strainers: 125-psig (860-kPa) working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 (DN 65) and larger, threaded connections for NPS 2 (DN 50) and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection.

## 2.7 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: NPS 2 (DN 50) and smaller with threaded ends, unless otherwise indicated.
- C. Ferrous Valves: NPS 2-1/2 (DN 65) and larger with flanged ends, unless otherwise indicated.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Extended Valve Stems: On insulated valves.
  - 1. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

## 2.8 COPPER-ALLOY BALL VALVES

- A. MSS SP-110, Two-Piece, Copper-Alloy Ball Valves: Bronze body with large-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig (4140-kPa) minimum CWP rating and blowout-proof stem. O-ring only stem seals shall not be acceptable.
  - 1. Basis of Design: Hammond 8501/8511.

## 2.9 BRONZE CHECK VALVES

- A. MSS SP-80 Type 4, Class 125, Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.
  - 1. Basis of Design: Hammond IB 940/945.

**PART 3 - EXECUTION**

3.1 PIPING APPLICATIONS

- A. Hot and Chilled Water, NPS 2 (DN 50) and Smaller: Aboveground, use Type L (Type B) drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints.
- B. Hot and Chilled Water, NPS 2-1/2 (DN 65) and Larger: Schedule 40 steel pipe with welded and flanged joints.
- C. Condensate Drain Lines: Type L (Type B) drawn-temper copper tubing with soldered joints.

3.2 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
  - 1. Shutoff Duty: Ball valves.
  - 2. Throttling Duty: Globe and ball valves.
- B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- C. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.
- D. Install check valves as required to control flow direction.
- E. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- F. Chilled-Water and Heating Water Piping: Use the following types of valves:
  - 1. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
  - 2. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
  - 3. Gate Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
  - 4. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, OS&Y, bronze-mounted cast iron.
  - 5. Globe Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
  - 6. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.
- G. Select valves, except wafer and flangeless types, with the following end connections:
  - 1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends.
  - 2. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
  - 3. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends.
  - 4. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends

### 3.3 PIPING INSTALLATIONS

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.
- B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- C. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) 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.
- D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- E. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- F. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- G. Install strainers on supply side of each control valve and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and 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. Anchor piping for proper direction of expansion and contraction.

### 3.4 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install check valves for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.

### 3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 15, Section 15060 "Hangers and Supports." Comply with requirements below for maximum spacing of supports.

- B. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
  2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
  3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
  4. Spring hangers to support vertical runs.
- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4 (DN 20): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
  2. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
  3. NPS 1-1/2 (DN 40): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
  4. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
  5. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (10 mm).
  6. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (10 mm).
  7. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).
- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
  2. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
  3. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
  4. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).

### 3.6 JOINT CONSTRUCTION

- A. Refer to Division 15, Section 15050 "Basic Mechanical Materials and Methods" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping.

### 3.7 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

### 3.8 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be same as for equipment connections.
- B. Install control valves in accessible locations close to connected equipment.

- C. Install ports for pressure and temperature gages at coil inlet connections.

### 3.9 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

- B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
3. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
4. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
5. Prepare written report of testing.

### 3.10 ADJUSTING

- A. Perform these adjustments before operating the system:

1. Open valves to fully open position.
2. Check air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
3. Set temperature controls so all coils are calling for full flow.

### 3.11 CLEANING

- A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

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END OF SECTION