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.
3. Section 15970, "Basic Commissioning Requirements."

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. Schedule of Mechanical Submittals and Closeout Procedures.

C. During Construction: Submit at earliest possible date but not later than 50% completion of mechanical work as determined by schedule of values.
1. Operation and Maintenance 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 (15) days before requesting site review for Substantial Completion.
   1. Project Record Documents; as-builts.
   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. General: The design is based on a business office use and occupancy. A 20% diversity for the load profiles and mechanical was used based on time of day calculations and building orientation. Occupancy is based on 160 people with 20% diversity. Time day schedules were used with night setback for all equipment. Each pumping system has 100% redundancy with each pump sized for full flow and the design head. Pumps are on a lead/lag sequence of operation. Equipment performance criteria as scheduled on the drawings.

   2. HVAC system design to be based on 2001 ASHRAE Fundamentals Handbook Climatic design conditions data for Portland, Maine.
      a. 99.6% Winter Frequency of Occurrence: -3 deg. F. db.
      b. 0.4% Summer Frequency of Occurrence: 86 deg. F. db / 71 deg. F. wb.

   2. Indoor design conditions:
      a. Winter: 70 – 74 deg. F db, 40-60% relative humidity
      b. Summer: 72 – 75 deg. F db, 40-60% relative humidity

C. HVAC Systems Description:

   1. Rooftop Air Handlers: Modular systems with chilled water cooling and low temperature hot water heating. Each unit shall be variable air volume, furnished with double wall construction, sound attenuating plenum roof curb, economizer, minimum 35% efficient

filters, humidifier, supply and return fans, and unit mounted variable frequency drives. The humidifiers will be gas-fired roof mounted units supplying humidification for each of the three air handlers.

2. Air-cooled Chillers: Two remote air-cooled chillers will provide chilled water to each of the air handlers. A variable primary piping/control arrangement will be utilized with based mounted pumps. Flow will be controlled using variable frequency drives. A third chiller will be dedicated to the server room air conditioning units. Each chilled water loop will be a glycol/water solution at a concentration sufficient to provide burst protection. A glycol fill station will be located in the first floor mechanical room. Compressors shall have a minimum 5-year manufacturers warranty. Chilled water pumps to be located in the mechanical room.

3. Heating System: Natural gas fired hot water system will provide low temperature heating hot water to roof top modular air handler heating coils as well as providing reheat capability for zone temperature control utilizing VAV boxes with hot water reheat coils. Each hot water coil in the air handlers will have a freeze protection pump to provide constant water flow in the coil. The shall be a domestic heating demand over ride that will temporarily raise the hot water supply temperature to 160°F. Perimeter radiant heating slab will provide perimeter skin heating loads. Boilers, boiler pumps with variable frequency drives, circulating pumps with variable frequency drives, and associated hydronic specialties to be located in first floor mechanical room. Provide double wall AL-29C vent stack with termination above the roof. Combustion air will be provided using 6" PVC connected to each sealed combustion boiler. Piping to be schedule 40 steel or type L copper. Supply and return loop to be piped in a reverse/return configuration on each floor. A snowmelt system will be used for the main entrance and chiller/generator pad located outside the mechanical room.

4. Building Air distribution: HVAC system ductwork to be galvanized or aluminum sheet metal fabricated and installed in accordance with ASHRAE and SMACNA standards. Air distribution systems to be designed in accordance with ASHRAE and SMACNA standards to meet maximum NC40 noise levels in the occupied space. Supply and return air from each rooftop unit will be distributed in vertical duct shafts located adjacent to each stairwell and in the center of the building as indicated on the Architectural floor plans. Supply and return ductwork branches will penetrate each chase at their respective floor. Branch take-offs from the duct chase shall include fire dampers, access doors, and volume dampers. The air handling system will incorporate ducted return for each level. Supply air ductwork shall be insulated in accordance with ASHRAE standards.

5. Zoning: Building HVAC zones to include spaces as indicated on the Architectural floor plans. Each zone will consist of 3 spaces maximum depending on load and size of box required for those spaces. Conference rooms will be zone individually. All spaces will be served by variable air volume boxes with hot water reheat coils, supply distribution ductwork including diffusers, return grilles, and ducted return system. Hot water unit heaters will serve the mechanical room, shipping and receiving, and vehicle sallyport areas. Recessed cabinet unit heaters will serve the first floor vestibules and the main entrance. Server rooms will have CRAC units equal to Data Aire or Stulz.

6. Building Exhaust Systems:
   a. Toilet Rooms: A roof mounted centrifugal exhaust fan system will serve Toilet Rooms and Janitor's Closets.

b. Shower / Locker Rooms: A roof mounted centrifugal exhaust fan system will serve the shower and locker rooms. Shower exhaust branch ductwork to be aluminum.

c. Elevator Machine Room (First Floor): An exhaust fan will serve the elevator machine room. Exhaust fan to be located in the File Storage room. Make up air will be provided using a ducted gravity intake ventilator. The exhaust fan will be controlled using a room thermostat.

d. Electrical Rooms (Floors 1 through 3): A roof mounted centrifugal exhaust fan system will serve the core Electrical Rooms.

e. Vehicle Sallyport: A dedicated centrifugal exhaust fan for the sallyport will be located on the roof. The fan will be controlled using a wall mounted CO sensor. Make up air will be provided through a roof mounted gravity intake ventilator.

f. Secure Evidence: A dedicated centrifugal exhaust fan will be located on the roof and will operate continuously.

g. Armory: A dedicated centrifugal exhaust fan will be located on the roof and will operate continuously. Make up air will be provided through the same gravity ventilator used for the vehicle sallyport.

7. Automatic Temperature Controls: Provide complete Direct Digital Control (DDC) to serve all base building HVAC systems and equipment. System to have night setback capability. System to be manufactured, furnished and installed by Invensys, Andover Controls, Johnson Controls, Siemens, Trane, or approved equal.

D. Plumbing Systems Description:

1. Plumbing fixtures to be Kohler, American Standard, Eljer, or approved Equal. All toilets to be flush valve type.

2. Sanitary and Vent: Piping to be no-hub cast iron above grade and PVC below grade. Fixtures located on Levels 1 through 3 will be piped and exit the Building by gravity.

3. Storm Drain: Piping to be no-hub cast iron above grade and PVC below grade. Roof drains will be provided in locations as indicated on the Architectural roof plans. Several roof drain leaders will collect all roof drains. Horizontal roof drain piping will be insulated. Leaders to be located adjacent to columns or stairs, drop below grade, and pitch to a new site catch basin.

4. Natural gas: Natural gas system to be installed in accordance with NFPA 54, National Fuel Gas Code. Natural gas meter to be located at the Northeast corner of the Building adjacent to the loading dock, (exact location to be coordinated with site, Civil Engineer, and Utility). Natural gas will be piped into the first floor mechanical then to the boilers, water heaters, and humidifiers.

5. Water Service: The domestic water service will enter the building in mechanical room as indicated on the Site plans. Water service equipment including meter and backflow prevention devices will be located in this room. Provide 2" water line for irrigation with deduct meter. Domestic cold water to serve plumbing fixtures located on the all levels will be supplied by utilizing city water pressure. Piping to be Type L copper and insulated per ASHRAE standards.

6. Domestic Hot Water: Two Amtrol BoilerMate, or approved equal, indirect fired water heaters, a recirculation piping loop, and associated pump will serve all plumbing fixtures including the showers and locker room facilities. Water will be heated to 145°F and then tempered with a thermostatic mixing valve before being supplied to the fixtures. Piping to be Type L copper and insulated per ASHRAE standards.

1.7 COMMISSIONING

A. Commissioning of Mechanical systems is part of this project. See Section 15970 series Sections for Mechanical Contractor requirements with regards to this process.

1.8 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. International Building Code – 2003
2. NFPA 1 – 1997, with amendments
3. NFPA 13 – 1996
4. NFPA 24 – 1995
5. NFPA 101 – 2003, with amendments

C. Standards: Work performed on the project must comply with the requirements of the following Industry Standards:
1. ASHRAE 90.1 – 2004 and 62.1 – 2004.
2. ASME – American Society of Mechanical Engineers
3. ANSI – American National Standards Institute
4. ASHRAE – American Society of Heating, Refrigerating, and Air Conditioning Engineers
5. ARI – American Refrigeration Institute
6. ASTM – American Society of Testing and Materials
7. NEBB – National Environmental Balancing Bureau
8. NFPA – National Fire Protection Association
9. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association Duct Construction
10. UL - Underwriters' Laboratories

D. Authorities Having Jurisdiction: Work performed on the project must comply with the requirements of the following AHJ's:
1. State of Maine Fire Marshal's Office
2. Maine State Plumbing Inspector

3. Portland Fire Department
4. Owner's Insurance Agent
5. Municipal Water Supplier, (for backflow prevention requirements)

1.9 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 in 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.

1.10 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.

1.11 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.

1.12 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.

1.13 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 dampers and other control devices, filters, boxes and similar units requiring periodic maintenance or repair; actual equipment locations dimensioned from column lines; actual main and branch locations 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. CADD generated.
a. SMRT design Drawing files may be available as a starting point for CADD generated drawings. A release form will need to be signed to facilitate this.
b. CADD generated drawings shall be ultimately delivered in AutoCAD 2000 format on CD.
2. Valve Tags: Record drawings to include valve tag markers which correspond to the valve tag chart provided under the O&M Manual Section.

1.14 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."

1.15 OWNER TRAINING

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

B. Commissioning: Provide Owner Training in conjunction with commissioning requirement identified in 15970 series Sections.

1.16 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.

1.17 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.

1.18 ENERGY EFFICIENCY

A. All equipment shall have minimum efficiency as described in ASHRAE Standard 90.1-2004. All equipment suppliers must be aware of the requirements and submitted equipment shall meet these minimum requirements.

1.19 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.

1.20 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.

1.21 TEMPORARY HEATING

A. Refer to Division 1 requirements regarding temporary facilities during construction.

B. The Mechanical Contractor shall provide necessary heating equipment, fuel sources, water treatment, and related items as necessary to meet the intent of the requirements.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 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.

3.2 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.

B. Additional functional testing and commissioning requirements are as identified in 15970 series Sections.

3.3 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 15000

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. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Supports and anchorages.
11. Access panels and doors.
12. Motors for Mechanical Equipment

B. Related Sections include the following:
1. Division 3 Section, "Cast-In-Place Concrete."
2. Division 7 Section, "Firestopping."
3. Division 8 Section, "Access Panels."
4. 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. Epco 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. Epco 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 maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

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

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

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

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

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

H. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

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

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.

2. Underground Piping NPS 2 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 minimum working pressure at 180 deg F.

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

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

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

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

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

2.6 MECHANICAL SLEEVE SEALS

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

1. 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 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, 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 furnished per the requirements of Division 8 Section, "Access Doors."

2.11 MOTORS FOR MECHANICAL EQUIPMENT

A. Motor Characteristics:
1. Motors 3/4 HP and Larger: Three phase except where indicated differently.
2. Motors Smaller Than 3/4 HP: Single phase except where indicated differently.
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 and at altitude of 3300 feet 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: Premium efficiency.
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 or G.
   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.

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.

PART 3 - EXECUTION

3.1 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.

3.2 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.

3.3 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.

3.4 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 where 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 above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 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. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

3.5 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.

3.6 PIPING CONNECTIONS

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

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

3.7 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.

3.8 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.

3.9 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.

3.10 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project. Use materials as specified in Division 3.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

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 15050

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.

1.5 SUBMITTALS

A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.

C. 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. Manufacturers: Subject to compliance with requirements, provide products by one of 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.

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 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 Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
5. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

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

C. 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, 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.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 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, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

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 for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

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.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where 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 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.
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 mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

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

G. 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.

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

I. 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.

J. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.
   a. Use thermal-hanger shield insert with clamp sized to match OD of insert.
   b. 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 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 and larger if pipe is installed on rollers.

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

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure 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.

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.

D. The requirements of Section 15060, "Hangers and Supports" apply to work defined by the Section.

1.2 SUMMARY

A. This Section includes the following:

1. Pipe Isolators.
2. 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.
3. 15700 – 15739 Series Sections for vibration isolators supplied with roof mounted equipment.

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."

D. 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 and the unit will be fully operational after the seismic event."

1.4 SEISMIC REQUIREMENTS

A. General: Performance requirements to be used in the design of seismic controls are as identified herein;
1. Seismic Use Group: Group II.
2. Seismic Design Category: B.
3. S_{DS}: 0.25

B. Applicability: Seismic controls are required on fuel gas systems only.
1. See Part 3 paragraph, "Seismic Controls Installation" for exceptions.

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: Include load deflection curves for each vibration isolation device.
2. Shop Drawings: Signed and sealed by a qualified professional engineer where required by applicable Code. Include the following:
   a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   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. 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.
   d. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.
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.

1.6 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."

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. Amber/Booth Company, Inc.
2. B-Line Systems, Inc.
3. Mason Industries, Inc.
4. Vibration Mountings & Controls/Korfund.

C. 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: The following applies to items specified in the paragraphs below.
1. Minimum static deflections are identified in the schedule at the end of Part 3.
2. Vibration Isolators which have a seismic function as well, (those which incorporate limit stops and/or snubbers) shall not be constructed of aluminum of cast iron materials.

B. 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.

2.3 PIPE ISOLATORS

A. 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 movement at start and stop.
   8. Basis of Design: Mason Industries, Inc. Types WBD.

B. Pipe Riser Resilient Support (Mason Spec. R): All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.
   1. Basis of Design: Mason Industries, Inc. Type ADAH.

C. Resilient Pipe Guides (Mason Spec. S): Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2-inch thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.
   1. Basis of Design: Mason Industries, Inc. Type VSGH.

D. 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.

E. 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.

F. 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.

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. Suspended Equipment and Piping 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. 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.

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. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 HIGH-RISE RISER INSTALLATION

A. General: Where piping risers are installed in high-rise structures, and are subject to thermal expansion, provide riser isolation as follows.

B. Isolation: Isolation of vertical riser-through-floor penetrations shall be accomplished using pairs of isolators at each floor which transmit riser load from a heavy duty riser clamp, (welded to the pipe) or welded attachments to each of the floor levels.
   1. Isolator types shall consist of anchors, guides, and springs. These items shall be arranged in accordance with the Isolator manufacturer's recommendations.
      a. Anchors: Type ADAH.
      b. Guides: Type VSGH.
      c. Springs: Type SLR.

3.3 PIPING SYSTEMS INSTALLATION

A. General: Piping systems shall be supported in accordance with their respective Sections as well as the requirements of Section 15060, "Hangers and Supports." In addition to those requirements, described herein are requirements to address vibration and seismic forces.

B. Connections to Equipment, General: Piping connections to isolated pieces of Mechanical equipment shall include the following means of limiting vibration transmissions to the piping.
   1. Equipment Connections: Install pipe isolators at the inlet and outlet connections to each piece of isolated equipment. Exact locations of isolators as detailed on the Drawings.
      a. Types SFDEJ, BSS-GU-MN, BSS-GU-RF-150, BBF & Duct Type.
   2. Suspended Piping Either Side: Isolate pipe runs leading to and/or away from each piece of isolated equipment for a distance of 50 feet. Pipe and duct support isolator types to

match those used on the isolated equipment. Minimum static deflection to be one-half that of the equipment isolator.

a. Pipes serving equipment isolated by elastomeric pads or mounts;
   1) Seismic & Non Seismic Applications: Types HD & WHD.

b. Pipes serving equipment isolated by springs;
   1) Seismic Application: Type PC30N.
   2) Non-Seismic Application: Type 30N.

3. Wall, Floor and Hard Ceiling Penetrations: Where services leading to and/or away from isolated equipment penetrate walls, floors and/or hard ceilings within 50 feet of the equipment, the wall and/or floor penetrations shall be acoustically isolated.

a. Type SWS.
   1) Exception: Where walls and/or floors penetrated are fire rated, provide a sleeve and appropriate fire stopping in lieu of this acoustical isolator. Fire Stopping is specified in Division 7.

4. Riser Isolation: Isolation of vertical riser-through-floor penetrations within 50 feet of isolated equipment shall be accomplished via using pairs of isolators which transmit riser load from a heavy duty riser clamp, (welded to the pipe) or welded attachments.

a. Risers servicing equipment isolated by elastomeric pads or mounts;
   1) Types W & SW with a steel plate between the isolator and riser clamp.

b. Risers servicing equipment isolated by springs;
   1) Type SLR.

5. Base of Riser and Horizontal Floor Supported Services: Isolation of floor supported piping and ductwork within 50 feet of isolated equipment shall be accomplished via using pairs of isolators which transmit load from a service –supporting cross member. Pipe and duct support isolator types to match those used on the isolated equipment. Minimum static deflection to also match that of the equipment isolator.

a. Ducts and pipes serving equipment isolated by elastomeric pads or mounts;
   1) Types HD & WHD.

b. Ducts and pipes serving equipment isolated by springs;
   1) Type SLR.

C. Common Support Requirements: Where piping is intended to be installed on a common, (trapeze) rack, the following shall apply;

1. Do not install isolated and non-isolated services on the same rack.
2. Rack isolation shall be of a type and meet the requirements of the most stringent isolation
3. Services shall be clipped on to the rack, (or attached via guides if the plans specifically call for this). Neoprene isolators shall be installed between the pipe and the rack/clip.

3.4 SEISMIC CONTROLS INSTALLATION

A. General: Install seismic bracing to limit movement of equipment, piping and ductwork in all directions. Provide stiffeners or otherwise augment standard supports at brace locations to accommodate seismic forces imposed.

1. Threaded hanger rod at brace locations shall be capable of supporting both standard working loads as well as seismic tensile and compressive loads.
   a. Where rod length exceeds allowable unbraced rod length, provide standard 12 gauge strut rod stiffeners and clamp reinforcements over the entire length of the rod.

b. The maximum allowable unbraced length or rods shall not exceed 18-inches for 3/8-inch rod and 24-inches for ½ through 7/8-inch rod. Installing contractor to verify maximum unbraced rod lengths allowable via calculations.

B. Equipment Controls, General: Certain seismic control requirements are satisfied by components identified in the vibration isolation schedule at the end of this Section, (limit stops and housings). The installations contained herein are required in addition to those items.
1. Controls must not overload building structural components. Attach controls to major building structural elements such as beams, columns and concrete floors. Avoid attaching to open joints and lighter weight elements.

C. Piping Controls, General: Install sway bracing on pipe systems.
1. Bracing to consist of tension only cable systems where piping includes vibration isolated hangers.
   a. Install cable with ½-inch of slack to accommodate isolator motion.
   b. Provide stiffeners on hanger rods if calculation dictate.
2. Where piping does not include vibration isolated hangers and supports, tension only cable or tension-and-compression strut systems may be used.
   a. Install cable systems taut.
   b. Provide stiffeners on hanger rods if calculation dictate.
3. Multiple Piping Application: At trapeze anchor locations, shackle piping to trapeze.
4. Cable Systems, General: Install cables so they do not bend across sharp edges of adjacent equipment or building structure.
5. Strut Systems, General: Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers.

D. Piping General Brace Location Requirements: Each straight run of piping shall include a minimum of (2) transverse and (1) longitudinal brace.
1. If the overall length of the run exceeds maximum brace spacing identified below, than additional bracing must be installed.
2. Transverse brace locations shall include the ends of each straight run.
3. A transverse brace within 2-feet of a 90° bend may meet the spacing requirements of a longitudinal brace in the adjacent 90° section to the order of half the maximum allowable longitudinal spacing minus 2 feet.
4. Install a transverse brace within 2-feet of each pipe drop or rise to an equipment connection.
5. Exceptions: Bracing of pipe systems is not required under the following circumstances. These exceptions do not apply to natural gas, propane, fuel oil, toxic or corrosive gasses.
   a. Piping suspended by individual hangers where the distance from top-of-pipe to the underside of supporting structure is 12-inches or less.
   b. Piping in mechanical equipment rooms which is smaller than 1-1/4-inch diameter.
   c. Piping in all other areas which is smaller than 2-1/2-inch diameter.
   d. Ducts suspended by individual hangers where the distance from top-of-duct to the underside of supporting structure is 12-inches or less.
   e. Ducts which have a cross-sectional area less than 6 square feet.

E. Steel Piping Systems (Welded, Soldered, Brazed, Grooved, or Threaded): Install bracing in accordance with the following maximum spacing:
1. Transverse Brace Spacing: 50 feet.
2. Longitudinal Braces: Install at 80 foot intervals, maximum.

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:
   1. Isolator seismic-restraint clearance.
   2. Isolator deflection.

3.6 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 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.

3.7 CLEANING

A. 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. Valve tags.
8. Valve schedules.
9. Warning tags.

1.3 SUBMITTALS

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

B. Valve numbering scheme.

C. 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 for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Access Panel and Door Markers: 1/16-inch thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch 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: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches 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 thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.4 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch thick brass.
2. 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.

1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Finished hardwood.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

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. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
3. Heat exchangers, coils, evaporators, and similar equipment.
4. Fans, blowers, primary balancing dampers, and mixing boxes.
5. Packaged HVAC central-station and zone-type units.

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

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.
    b. Fire department hose valves and hose stations.
    c. Meters, gages, thermometers, and similar units.
    d. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
    e. Pumps, compressors, chillers, condensers, and similar motor-driven units.
    f. Heat exchangers, coils, evaporators, and similar equipment.
    g. Fans, blowers, primary balancing dampers, and mixing boxes.
    h. Packaged HVAC central-station and zone-type units.
    i. Tanks and pressure vessels.
    j. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Identify mechanical equipment with equipment markers in the following color codes:

    a. Green: For cooling equipment and components.
    b. Yellow: For heating equipment and components.
    c. Orange: For combination cooling and heating equipment and components.

2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
4. Include signs for the following general categories of equipment:

    a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
    b. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
    c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
    d. Heat exchangers, coils, evaporators, and similar equipment.
    e. Fans, blowers, primary balancing dampers, and mixing boxes.
    f. Packaged HVAC central-station and zone-type units.
    g. Tanks and pressure vessels.
    h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

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: Pretensioned pipe markers. Use size to ensure a tight fit.
2. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.

B. Locate pipe markers and color bands where piping is exposed or above accessible ceilings 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 along each run. Reduce intervals to 25 feet 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 for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except 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.

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

1. Valve-Tag Size and Shape:

   a. Cold Water: 1-1/2 inches round.
   b. Hot Water: 1-1/2 inches, round.
   c. Fire Protection: 1-1/2 inches round.
   d. Gas: 1-1/2 inches, round.

3.6 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.7 ADJUSTING

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

3.8 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

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

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.

2.3 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..

1. Tape Width: 4 inches.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
2. Galvanized Steel: 0.005 inch thick.
3. Aluminum: 0.007 inch thick.

C. 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 for direct pull perpendicular to the attached surface.

D. 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 for direct pull perpendicular to the adhered surface.

2.4 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.

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. Space 16 inches o.c. each way, and 3 inches 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 from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches 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 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 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 and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches 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 from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch 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 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 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 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 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.

3.6 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.

END OF SECTION 15081

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 2, Section 02551 "Hydronic Distribution" for loose-fill pipe insulation in underground piping outside the building.
2. Division 7, Section 07270 "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
3. Section 15081 "Duct Insulation" for insulation for ducts and plenums.
4. Section 15082 "Equipment Insulation" for insulation materials and application for pumps, tanks, hydronic specialties, and other equipment.
5. 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. Attachment and covering of heat trace inside insulation.
   c. Insulation application at pipe expansion joints for each type of insulation.

d. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
e. Removable insulation at piping specialties and equipment connections.
f. Application of field-applied jackets.

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 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

C. Flexible Elastomeric Thermal Insulation:
   1. Armstrong World Industries, Inc.
   2. Rubatex Corp.

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. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
   4. 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.

   5. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.

B. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Thermal conductivity: 0.27 Btu*in/(hr*sq ft*degree F) at 75 degrees F.
   2. Adhesive: As recommended by insulation material manufacturer.
   3. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.
   4. Based on Armstrong AP Armaflex.

C. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

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

B. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils 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.

C. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil 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.

D. Aluminum Jacket: Aluminum roll stock, ready for shop or field cutting and forming to indicated sizes. Comply with ASTM B 209, 3003 alloy, H-14 temper.

1. Finish and Thickness: Stucco-embossed finish, 0.016 inch thick.
2. Moisture Barrier: 1-mil thick, heat-bonded polyethylene and kraft paper.
3. Elbows: Preformed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.

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.

1. Tape Width: 4 inches.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
2. Galvanized Steel: 0.005 inch thick.
3. Aluminum: 0.007 inch thick.

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 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 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 o.c.
3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches 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. 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. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal metal jacket to roof flashing with vapor-retarder mastic.

Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

S. 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."

T. 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 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 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, 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 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Follow manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:

1. Apply 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 cut sections of sheet insulation of the same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:

1. Apply mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

D. Apply insulation to valves and specialties as follows:

1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to strainer basket.
3. Apply insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
5. surface.

3.6 FIELD-APPLIED JACKET APPLICATION

A. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Provide PVC jacket on insulation below 10 feet in mechanical rooms.

B. Apply metal jacket where indicated, with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.

3.8 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.

3.9 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.

3.10 INSULATION APPLICATION SCHEDULE

A. Service: Domestic hot and recirculated hot water.

1. Operating Temperature: 60 to 140 deg F.
2. Insulation Material: Fiber glass 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. Insulation Material: Fiber glass 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: Storm drain piping.

1. Operating Temperature: 32 to 100 deg F.
2. Insulation Material: Fiberglass with jacket.
   a. Insulation Thickness: ½" thickness.
3. Vapor Retarder Required: yes.
4. Finish: none.

D. Service: Roof drain bodies.

1. Operating Temperature: 32 to 100 deg F.
2. Insulation Material: Flexible elastomeric.
3. Insulation Thickness: 1" thick.
4. Vapor Retarder Required: No.
5. Finish: none.

E. Service: Condensate drain piping from cooling coils.

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

F. Service: Chilled-water supply and return.

1. Operating Temperature: 40 to 65 deg F.
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.

G. Service: Chilled-water supply and return piping within roof-top air handler pipe chase.

1. Operating Temperature: 40 to 65 deg F.
2. Insulation Material: Fiberglass with jacket.
3. Insulation Thickness: Apply the following insulation thicknesses:
   a. All Piping 1": 1.5" thickness.

4. Vapor Retarder Required: Yes.
5. Finish: None.

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

1. Operating Temperature: 100 to 200 deg F.
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.
4. Vapor Retarder Required: No.
5. Finish: none.

I. Service: Heating hot-water supply and return piping within roof-top air handler pipe chase.

1. Operating Temperature: 100 to 200 deg F.
2. Insulation Material: Fiberglass with jacket.
3. Insulation Thickness: Apply the following insulation thicknesses:

   a. All Piping: 1.5" thickness.
4. Vapor Retarder Required: No.
5. Finish: none.

END OF SECTION 15083

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.

B. Related Sections include the following:
1. Division 15, Section 15140 "Plumbing Piping and Specialties" for domestic and fire-protection water service meters inside the building.
2. Division 15, Section 15194 "Fuel Gas Piping" for gas meters inside the building.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

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

1.4 SUBMITTALS

A. General: See Division 1 for general submittal and product substitution requirements.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Metal-case, liquid-in-glass thermometers:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

C. Thermowells

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Marsh Bellofram.
5. Miljoco Corp.
6. NANMAC Corporation.
7. Noshok, Inc.
8. Palmer - Wahl Instruments Inc.
9. REO TEMP Instrument Corporation.
10. Tel-Tru Manufacturing Company.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

D. Pressure gages

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
6. Marsh Bellofram.
7. Miljoco Corp.
8. Noshok, Inc.
9. Palmer - Wahl Instruments Inc.
10. REO TEMP Instrument Corporation.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

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. Trerice, H. O. Co.
7. Watts Industries, Inc.; Water Products Div.

2.2 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Case: Die-cast aluminum, 9 inches long.

B. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.

C. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

D. Window: Glass or plastic.

E. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

F. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

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

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 PRESSURE GAGES

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

1. Case: Dry type, cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.

5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Window: Glass or plastic.
7. Ring: Stainless steel.
8. Accuracy: Grade 1A, plus or minus 1 percent of whole scale.

B. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.5 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.

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 shall be CR.

PART 3 - EXECUTION

3.4 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each hydronic heat exchanger.
5. Inlet and outlet of each hydronic heat-recovery unit.
6. Inlet and outlet of each thermal storage tank.
7. Outside-air, return-air, and mixed-air ducts.

B. Install liquid-filled in glass case-type, thermometers in the inlet and outlet of each boiler.

C. Provide the following temperature ranges for thermometers:

1. Domestic Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
3. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
4. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.

3.5 GAGE APPLICATIONS

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

B. Install pressure gages at chilled water inlets and outlets of chillers.

C. Install pressure gages at suction and discharge of each pump.

3.6 INSTALLATIONS

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

B. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.

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

D. Install remote-mounting pressure gages on panel.

E. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).

F. Install test plugs in tees in piping.

3.7 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

3.8 ADJUSTING

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

END OF SECTION 15122

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.
      b. Non-potable Water.
      c. Tempered Water.
   2. Drainage, Waste and Vent, (DWV).
      a. Sanitary Waste and Vent.
      b. Storm Drainage.
      c. Indirect Waste.
   3. Acid Waste (AW).

B. Related Sections include the following:

   1. Division 2 Sections for site utility service piping to a point 10-feet outside the building.

   2. Division 7, Section 07270 "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.

   3. Division 7, Section 07900 "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.

   4. Section 15083, "Pipe Insulation" for system insulation requirements.
   5. Section 15122, "Meters and Gauges" for thermometers, pressure gages, and fittings.
   6. Section 15430, "Plumbing Specialties" for water distribution piping specialties.
   7. Section 15444, "Packaged Booster Pumps" for supply connections to pressure booster pumping systems.
   8. Section 15445, "Sewage and Sump Pumps" for drainage connections to effluent pumps.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

B. EPDM: Ethylene-propylene-diene terpolymer.

C. CLDI: Cement Lined Ductile Iron.

D. 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. Water Supply Systems, Below Ground: 150 psig.
3. DWV, (Gravity) Systems: 10 foot of head of water.
4. DWV, (Forced Main) Systems: 100 psig.

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.
2. Product Data: For pipe, tube, fittings, couplings, valves and water meters.

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 14, "Plastics Piping System Components and Related Materials," for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.

C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

D. 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.

D. Gate Valves:
1. Crane Co.; Crane Valve Group; Stockham Div.
2. Grinnell Corporation.
3. Hammond Valve.
4. Milwaukee Valve Company.
5. NIBCO INC.
6. Watts Industries, Inc.; Water Products Div.

E. Butterfly Valves:
1. Crane Co.; Crane Valve Group; Stockham Div.
2. Grinnell Corporation.
3. Hammond Valve.
4. Milwaukee Valve Company.
5. NIBCO INC.
6. Watts Industries, Inc.; Water Products Div.

F. Globe Valves:
1. Crane Co.; Crane Valve Group; Stockham Div.
2. Grinnell Corporation.
3. Hammond Valve.
4. Milwaukee Valve Company.
5. NIBCO INC.

G. Swing Check Valves:

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

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 DUCTILE IRON PIPE AND FITTINGS

A. Cement-Lined, Mechanical-Joint, Ductile-Iron Pipe, (CLDI): AWWA C151, with mechanical-joint, bell- and plain-spigot ends, AWWA C205 cement-mortar lining.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern, AWWA C205 cement-mortar lining.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Cement-Lined, Push-on-Joint, Ductile-Iron Pipe, (CLDI): AWWA C151, with push-on-joint, bell- and plain-spigot ends, AWWA C205 cement-mortar lining.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern, AWWA C205 cement-mortar lining.

a. Gaskets: AWWA C111, rubber.

b. Restraints: push-on joints to include pipe clamp and tie-rod reinforcement.

2.4 COPPER TUBE AND FITTINGS

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

B. 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.
4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

    a. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

C. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

2.5 CAST-IRON SOIL PIPE AND FITTINGS

A. Hub-and-Spigot Pipe and Fittings: ASTM A 74, Service class.

1. Gaskets: ASTM C 564, rubber.

B. 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.

2.6 PVC PIPE AND FITTINGS

A. PVC Schedule 40 Pipe: ASTM D 1785.
1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

2.7 ACID WASTE AND VENT PLASTIC PIPING SYSTEMS

A. Polypropylene (PP) Piping: ASTM F1412 / D4101, schedule 40 and 80, standard and flame retardant.
1. Fittings: ASTM F1412 / D4101, standard and flame retardant, made to ASTM D 3311 drain, waste, and vent patterns.
2. Joints: ASTM F1290 Electrofusion.
3. Basis of Design: Zurn PP Corrosive Waste Drainage System

2.8 STEEL PIPING

A. Steel Pipe: ASTM A 53, Type E or S, Grade A or B, Schedule 40, galvanized. Include ends matching joining method.

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Cast-Iron, Threaded, Drainage Fittings: ASME B16.12, galvanized.
4. Cast-Iron Flanges: ASME B16.1, Class 125.
5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.
6. Steel-Piping, Grooved-End Fittings: ASTM A 47, galvanized, malleable-iron casting; ASTM A 106, galvanized steel pipe; or ASTM A 536, galvanized, ductile-iron casting; with dimensions matching steel pipe.
   a. Steel-Piping, Keyed Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2.9 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. Handwheel: For valves other than quarter-turn types.
4. Lever Handle: For quarter-turn valves NPS 6 and smaller.
5. Extended Valve Stems: On insulated valves.
6. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
7. Valve Grooved Ends: AWWA C606, NPS 2-1/2 (DN 65) and larger.
8. Solder Joint: With sockets according to ASME B16.18.
   a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.
9. Threaded: With threads according to ASME B1.20.1.
10. 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. Threaded for NPS 4 and smaller.
   b. Soldered for NPS 3 and smaller.
   c. Flanged or grooved for NPS 4 and larger.
3. Basis of Design: Apollo 70 Series.

E. Gate Valves:
1. MSS SP-80, Class 125, bronze body, bronze trim, rising stem, hand wheel, inside screw, solid wedge disc.
2. Acceptable end connections;
a. Soldered for NPS 3 and smaller.

F. Butterfly Valves:
1. MSS SP-67, CWP Rating, Cast or Ductile Iron Body, disc, (nickel-plated ductile iron, elastomer coated ductile iron, or aluminum bronze) resilient replaceable EPDM seat, 10 position handle, one or two piece stem.
2. Acceptable end connections;
a. Flanged or grooved for NPS 2-1/2 and larger.

G. Globe Valves:
1. MSS SP-80, Class 125, bronze body, bronze trim, bronze disc.
2. Acceptable end connections;
a. Soldered for NPS 3 and smaller.

H. Swing Check Valves:
1. Up to NPS 3: MSS SP-80, Class 125, bronze body and cap, bronze swing disc with rubber seat.
2. NPS 4 and larger: MSS SP-71, Class 125, iron body, bronze swing disc, renewable disc seal and seat.
3. Acceptable end connections;
a. Soldered for NPS 3 and smaller.
b. Flanged or grooved for NPS 4 and larger.

PART 3 - EXECUTION

3.1 EXCAVATION AND PREPARATION

A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

B. Prepare pipe bedding to receive buried piping.
1. Grade the bottom of the trench smooth. Provide a stable, rock free base.
2. Remove any unstable materials from the base of the trench. Provide sand or pea stone as required to grade the trench bottom.
3. Remove base materials at each piping joint to relieve undo stresses at the fittings and couplings.

3.2 PIPE AND FITTING APPLICATIONS

A. Underground and Building Slab, Water-Service Piping to 10-feet outside the building wall:
1. NPS ½ to NPS 2-1/2: Soft copper tube, Type K; no fittings or joints allowed.
2. NPS 4 to NPS 8: Cement-lined ductile iron pipe; mechanical or bell and spigot fittings; mechanical or restrained push-on joints.

B. Water Supply Piping, Below Building Slab, (downstream of the meter):

1. Soft copper tube, Type K; no fittings or joints allowed. Piping to be run within schedule 40 PVC piping. PVC piping to be sized and arranged to allow for the removal and replacement of the copper supply line(s).

C. Water Supply Piping, Aboveground:
1. Hard copper tube, Type L; copper pressure fittings; lead-free soldered joints.
a. Option for NPS 2-1/2 and larger: Hard copper tube, Type L with grooved ends; copper grooved-end fittings and couplings; and grooved joints.

D. DWV Gravity Piping, Below Building Slab and to 10-feet outside the building wall:
1. Service weight cast iron soil pipe; hub and spigot fittings; gasket or lead and oakum joints.
a. Option: Schedule 40 PVC pipe; drainage pattern PVC socket fittings; solvent cement joints.

E. 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.

F. DWV Forced Main Piping, Aboveground:
1. Clear water wastes NPS 2-inch and smaller: Copper tube, Type L; copper pressure fittings; soldered joints.
2. Wastes 2-1/2-inch and larger, and wastes containing solids: Steel pipe, schedule 40, galvanized; threaded drainage pattern fittings; threaded joints.
a. Option: Steel pipe, schedule 40, galvanized, with grooved ends; steel grooved-end fittings and couplings; and grooved joints.

G. Acid Waste:
1. Above Ground (Gravity Flow): Schedule 40 flame retardant polypropylene, DWV fittings, electrofusion joints.

3.3 VALVE APPLICATIONS

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

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly valves for piping NPS 2-1/2 and larger.
3. Directional Duty: Use swing check valves.
4. Hot-Water-Piping, Balancing Duty: Memory-stop balancing valves.
5. Drain Duty: Hose-end drain valves.

B. Cast-iron, grooved-end valves may be used with grooved-end piping.

C. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures

that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

D. 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.

E. Install balancing valve in each hot-water circulation return branch. Set balancing valves partly open to restrict but not stop flow. Balancing valves are specified in Division 15 Section "Plumbing Specialties."

3.4 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

B. Install under-building-slab copper tubing according to CDA's "Copper Tube Handbook."

C. Install wall penetration system at each service pipe penetration through foundation wall where piping enters/exits a below grade basement space, (not required for slab-on-grad frost wall penetrations). Make installation watertight. Wall penetration systems are specified in Division 15 Section "Basic Mechanical Materials and Methods."

D. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

E. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

F. 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."

G. 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.

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

I. Install DWV piping at the following minimum slopes, unless otherwise indicated:

1. Horizontal drainage piping, NPS 3-inch and smaller: ¼-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.

J. Install PVC DWV piping according to ASTM D 2665.

K. Install underground PVC DWV piping according to ASTM D 2321.

L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.5 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. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

D. 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.

E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.6 HANGER AND SUPPORT INSTALLATION

A. 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 and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 15 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

F. Install supports for vertical steel piping every 15 feet.

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

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

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

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: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
6. NPS 15: 60 inches with 1-inch rod.
7. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

J. Install supports for vertical cast-iron soil piping every 15 feet.

K. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.

2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8: 48 inches with 7/8-inch rod.

L. Install supports for vertical PVC piping every 48 inches.

M. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

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

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

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to 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 and larger.

E. Connect DWV piping to exterior sanitary and storm piping. Use transition fitting to join dissimilar piping materials.

F. 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 and larger.

G. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

H. Connect storm drainage piping to roof drains and storm drainage specialties.

3.8 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 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. 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. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 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 of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

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.

3.11 PROTECTION

A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 15140

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 condenser water systems; makeup water for these systems; blowdown drain lines; 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 15122 "Meters and Gages" for thermometers, flow meters, and pressure gages.
5. Division 15, Section 15075 "Mechanical Identification" for labeling and identifying hydronic piping.
6. Division 15, Section 15185 "Hydronic Pumps" for pumps, motors, and accessories for 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. 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

B. Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings and calibrated balancing valves.

C. Welding Certificates: Copies of certificates for welding procedures and personnel.

D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

E. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 1.

F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

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 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 sleeve installations for foundation wall penetrations.

C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

D. Coordinate pipe fitting pressure classes with products specified in related Sections.

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

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7, Section 07841 "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

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

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

1.8 EXTRA MATERIALS

A. Water Treatment Chemicals: Furnish sufficient chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

1. 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. Grooved Mechanical-Joint Fittings and Couplings:

   a. Central Sprinkler Company; Central Grooved Piping Products.
   b. Grinnell Corporation.
   c. Victaulic Company of America.
   d. Shurjoint Piping Products

3. Calibrated Balancing Valves:

   a. Flow Design, Inc.
   b. Griswold Controls.
   c. Nexus
   d. Taco, Inc.

4. Pressure-Reducing Valves:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Conbraco Industries, Inc.
   d. ITT Bell & Gossett; ITT Fluid Technology Corp.
   e. Spence Engineering Company, Inc.
   f. Watts Industries, Inc.; Watts Regulators.

5. Safety Valves:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Conbraco Industries, Inc.
   d. ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
   e. Kunkle Valve Division.
   f. Spence Engineering Company, Inc.

6. Automatic Flow-Control Valves:

   a. Flow Design, Inc.
   b. Griswold Controls.
   c. Nexus

7. Expansion Tanks:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. ITT Bell & Gossett; ITT Fluid Technology Corp.
   d. Taco, Inc.

8. Air Separators and Air Purgers:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. ITT Bell & Gossett; ITT Fluid Technology Corp.
   d. 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.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Wrought-Copper Fittings: ASME B16.22.

E. Wrought-Copper Unions: ASME B16.22.

F. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.

G. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 STEEL PIPE AND FITTINGS

A. Steel Pipe, NPS 2 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: ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel, plain ends.

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2 and smaller and electric-resistance welded for NPS 2-1/2 and larger.

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. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47, Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.

I. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

J. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

K. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

L. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 SPECIAL-DUTY VALVES

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

B. Calibrated Balancing Valves, NPS 2 and Smaller: Bronze body, ball type, 125-psig working pressure, 250 deg F 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. Use in piping mains and branches.

C. Calibrated Balancing Valves, NPS 2-1/2 and Larger: Cast-iron or steel body, ball type, 125-psig working pressure, 250 deg F 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. Use in piping mains and branches.

D. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.

E. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.

F. Automatic Flow-Control Valves: Gray-iron body, factory set to maintain constant flow with plus or minus 5 percent over system pressure fluctuations, and equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case. Each valve shall have an identification tag attached by chain, and be factory marked with the zone identification, valve number, and flow rate. Use only at terminal units, not to be used in pump discharge, piping mains, or for branch balance valves. Valve shall be line size and one of the following designs:

1. Gray-iron or brass body, designed for 175 psig at 200 deg F with stainless-steel piston and spring.
2. Brass or ferrous-metal body, designed for 300 psig at 250 deg F with corrosion-resistant, tamperproof, self-cleaning, piston-spring assembly easily removable for inspection or replacement.
3. Combination assemblies, including bronze ball valve and brass alloy control valve, with stainless-steel piston and spring, fitted with pressure and temperature test valves, and designed for 300 psig at 250 deg F.

2.6 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.

B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection.

C. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity by a flexible bladder securely sealed into tank. Include drain fitting and taps for pressure gage and air-charging fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Factory fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

D. Tangential-Type Air Separators: Welded black steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature; perforated stainless-steel air collector tube designed to direct released air into expansion tank; tangential inlet and outlet connections; threaded connections for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger; threaded blowdown connection. Provide units in sizes for full-system flow capacity.

E. In-Line Air Separators: One-piece cast iron with an integral weir designed to decelerate system flow to maximize air separation at a working pressure up to 175 psig and liquid temperature up to 300 deg F. Basis of Design: Taco 4900 Series Air and Dirt Separator.

F. Air Purgers: Cast-iron body with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal. Maximum working pressure of 150 psig and temperature of 250 deg F.

G. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

H. Y-Pattern Strainers: 125-psig working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 and larger, threaded connections for NPS 2 and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection.

I. Basket Strainers: 125-psig working pressure; high-tensile cast-iron body (ASTM A 126, Class B), flanged-end connections, bolted cover, perforated stainless-steel basket, and bottom drain connection.

J. T-Pattern Strainers: 750-psig working pressure; ductile-iron or malleable-iron body, grooved-end connections, stainless-steel basket with 57 percent free area; removable access coupling and end cap for strainer maintenance.

K. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

2.7 VALVES, GENERAL

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

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

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

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

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

F. Valve Actuators:

1. Handwheel: For valves other than quarter-turn types.
2. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.

G. Extended Valve Stems: On insulated valves.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

I. Valve Grooved Ends: AWWA C606.

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

a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.

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

J. 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 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 FERROUS-ALLOY BUTTERFLY VALVES

A. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, for tight shutoff, with bronze disc and lining suitable for potable water, EPDM seats, unless otherwise indicated.

B. Wafer-Type Flangeless, 200-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer type with two-piece stainless steel stem, dead end rated at no less than 150 psig.
1. Basis of Design: Hammond 6100.

C. Lug-Type Single-Flange, 200-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer-lug type with two-piece stainless steel stem, dead end rated at no less than 150 psig.
1. Basis of Design: Hammond 6200.

D. Grooved-End, 175-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Ductile-iron or steel body with grooved or shouldered ends.
1. Basis of Design: Hammond 5100.

2.10 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.

2.11 GRAY-IRON SWING CHECK VALVES

A. MSS SP-71 Type I, Class 125, 175-psig CWP Rating, Grooved-End, Swing Check Valves: Gray-iron, metal seats, ductile-iron body with grooved or shouldered ends.

2.12 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. FCI 74-1, Type II, Class 125, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle; spring-loaded bronze or alloy disc and bronze or alloy seat

2.13 BRONZE GATE VALVES

A. MSS SP-80 Type 2, Class 125, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge union-ring bonnet, and ferrous-alloy handwheel.
1. Basis of Design: Hammond IB 617/635.

2.14 CAST-IRON GATE VALVES

A. Cast-Iron Gate Valves, General: MSS SP-70, Type I.

B. MSS SP-70, Type 1, Class 125, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid-wedge disc.

2.15 BRONZE GLOBE VALVES

A. MSS SP-80, Type 2, Class 125, Bronze Globe Valves: Bronze body with PTFE or TFE disc union-ring bonnet and ferrous-alloy handwheel.
1. Basis of Design: Hammond IB 416T/423.

2.16 CAST-IRON GLOBE VALVES

A. MSS SP-85 Type I, Class 125, Cast-Iron Globe Valves: Gray-iron body with bronze seats.
1. Basis of Design: Hammond IR 116.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot and Chilled Water, NPS 2 and Smaller: Aboveground, use Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints. Belowground or

within slabs, use Type K annealed-temper copper tubing with soldered joints. Use the fewest possible joints belowground and within floor slabs.

B. Hot and Chilled Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded and flanged joints or grooved mechanical-joint couplings.

3.2 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

1. Shutoff Duty: Gate, ball, and butterfly valves.
2. Throttling Duty: Globe, ball, and butterfly valves.
3. Pump Discharge: Spring-loaded, lift-disc check 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 at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

G. 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.

H. 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. Butterfly Valves, NPS 2-1/2 and Larger: Wafer or Lug-Type, 200-psig CWP rating, ferrous alloy, with EPDM liner.
3. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2-1/2 and Larger: 300-psig CWP rating.
4. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
5. Swing Check Valves, NPS 2-1/2 and Larger: Type I, Class 125, gray iron.
6. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125 minimum.
7. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, cast iron.
8. Gate Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
9. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, OS&Y, bronze-mounted cast iron.

10. Globe Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
11. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

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

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water services.
2. For Steel Piping, NPS 2 and Smaller: Threaded ends.
3. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
4. For Grooved-End, Steel Piping: Valve ends may be grooved.

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 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

D. Install 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, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

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.
2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

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 long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

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; and solvent-welded joints for PVC and CPVC piping.

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

C. Valve Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.7 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.

B. Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.

C. Install dip-tube fittings in boiler outlet. Install piping to expansion tank with a 2 percent upward slope toward tank. Connect boiler-outlet piping.

D. Install in-line air separators in pump suction lines. Install drain valve on units NPS 2 and larger.

E. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.

F. Install expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.

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 CHEMICAL TREATMENT

A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
1. pH: 6.5 to 7.5

B. Fill system and perform initial chemical treatment.

3.10 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. Flush system with clean water. Clean strainers.
3. 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.
4. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
3. Check expansion tanks to determine that they are not air bound and that system is full of water.
4. 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."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

3.11 ADJUSTING

A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

B. Perform these adjustments before operating the system:

1. Open valves to fully open position.
2. Check pump for proper direction of rotation.
3. Set automatic fill valves for required system pressure.
4. 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).
5. Set temperature controls so all coils are calling for full flow.
6. Check operation of automatic bypass valves.
7. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.

8. Lubricate motors and bearings.

3.12 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.

END OF SECTION 15181

SECTION 15185

HYDRONIC PUMPS

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 the following:

1. Close-coupled, in-line centrifugal pumps.
2. Separately coupled, base-mounted, end-suction centrifugal pumps.
3. System lubricated circulators.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Close-coupled, in-line centrifugal pumps
   a. Armstrong Pumps Inc.
   b. Bell & Gossett; Div. of ITT Industries.
   c. Grundfos Pumps Corporation.
   d. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
   e. Patterson Pump Co.; a Subsidiary of The Gorman-Rupp Co.
   f. Taco, Inc.

2. Separately coupled, vertical, in-line centrifugal pumps
   a. Armstrong Pumps Inc.
   b. Bell & Gossett; Div. of ITT Industries.
   c. Patterson Pump Co.; a Subsidiary of The Gorman-Rupp Co.
   d. Taco, Inc.

3. Separately coupled, base-mounted, end-suction centrifugal pumps
   a. Armstrong Pumps Inc.
   b. Bell & Gossett; Div. of ITT Industries.
   c. Patterson Pump Co.; a Subsidiary of The Gorman-Rupp Co.
   d. Taco, Inc.

4. System lubricated circulators
   a. Armstrong Pumps Inc.
   b. Bell & Gossett; Div. of ITT Industries.
   c. Flowserve Corporation; Div. of Ingersoll-Dresser Pumps.
   d. Grundfos Pumps Corporation.
   e. Patterson Pump Co.; a Subsidiary of The Gorman-Rupp Co.
   f. Taco, Inc.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 150-psig maximum working pressure and a continuous water temperature of 225 deg F.

B. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, and companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
3. Pump Shaft: Alloy steel, with protective coating.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket.
5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Permanently lubricated ball bearings.

C. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 15 Section "Motors."

D. Capacities and Characteristics: As scheduled on drawings.

2.3 SEPARATELY COUPLED, VERTICAL, IN-LINE CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Rate pump for 175-psig maximum working pressure and a continuous water temperature of 250 deg F.

B. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket.
5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Permanently lubricated ball bearings.

C. Shaft Coupling: Flexible coupling.

D. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with lifting eye and supporting lugs in motor enclosure. Comply with requirements in Division 15 Section "Motors."

E. Capacities and Characteristics: As scheduled on drawings.

2.4 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig maximum working pressure and a continuous water temperature of 250 deg F.

B. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Carbon steel, with stainless steel shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket.

5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

C. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.

D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

E. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

F. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 15 Section "Motors."

G. Capacities and Characteristics: As scheduled on drawings

2.5 SYSTEM LUBRICATED CIRCULATORS

A. Description: Horizontal shaft, single stage, direct connected with single speed wet rotor motor for in-line mounting. Rate pump for 125-psig maximum working pressure and a continuous water temperature of 230 deg F.

B. Pump Construction:

1. Casing: Cast iron, with flanged pump connections.
2. Impeller, Shaft, Rotor: Non-metallic, Ceramic.
3. Pump Bearings: Metal Impregnated carbon (graphite) and ceramic..

C. Capacities and Characteristics: As scheduled on drawings.

2.6 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and stainless-steel permanent strainers; cast iron straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 125-psig pressure rating, ductile-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement. Basis of Design: Taco Plus Two Multi-Purpose Valve.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

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

E. 3.2 CONCRETE BASES

A. Coordinate sizes and locations of concrete bases. Verify structural requirements with structural engineer.

B. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 15 Section "Basic Mechanical Materials and Methods."

1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.3 PUMP INSTALLATION

A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods of sufficient size to support pump weight. Hanger and support materials are specified in Division 15, Section 15060 "Hangers and Supports."

D. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.

2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

E. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Install triple-duty valve on discharge side of pumps.

D. Install suction diffuser and shutoff valve on suction side of base mounted pumps.

E. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

F. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

G. Connect wiring and ground equipment according to Division 16.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 15185

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 condenser water systems; makeup water for these systems; blowdown drain lines; 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 15122 "Meters and Gages" for thermometers, flow meters, and pressure gages.
5. Division 15, Section 15075 "Mechanical Identification" for labeling and identifying hydronic piping.
6. Division 15, Section 15185 "Hydronic Pumps" for pumps, motors, and accessories for 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. 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

B. Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings and calibrated balancing valves.

C. Welding Certificates: Copies of certificates for welding procedures and personnel.

D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

E. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 1.

F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

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 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 sleeve installations for foundation wall penetrations.

C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

D. Coordinate pipe fitting pressure classes with products specified in related Sections.

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

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7, Section 07841 "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

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

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

1.8 EXTRA MATERIALS

A. Water Treatment Chemicals: Furnish sufficient chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

1. 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. Grooved Mechanical-Joint Fittings and Couplings:

   a. Central Sprinkler Company; Central Grooved Piping Products.
   b. Grinnell Corporation.
   c. Victaulic Company of America.
   d. Shurjoint Piping Products

3. Calibrated Balancing Valves:

   a. Flow Design, Inc.
   b. Griswold Controls.
   c. Nexus
   d. Taco, Inc.

4. Pressure-Reducing Valves:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Conbraco Industries, Inc.
   d. ITT Bell & Gossett; ITT Fluid Technology Corp.
   e. Spence Engineering Company, Inc.
   f. Watts Industries, Inc.; Watts Regulators.

5. Safety Valves:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Conbraco Industries, Inc.
   d. ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
   e. Kunkle Valve Division.
   f. Spence Engineering Company, Inc.

6. Automatic Flow-Control Valves:

   a. Flow Design, Inc.
   b. Griswold Controls.
   c. Nexus

7. Expansion Tanks:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. ITT Bell & Gossett; ITT Fluid Technology Corp.
   d. Taco, Inc.

8. Air Separators and Air Purgers:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. ITT Bell & Gossett; ITT Fluid Technology Corp.
   d. 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.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Wrought-Copper Fittings: ASME B16.22.

E. Wrought-Copper Unions: ASME B16.22.

F. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.

G. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 STEEL PIPE AND FITTINGS

A. Steel Pipe, NPS 2 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: ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel, plain ends.

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2 and smaller and electric-resistance welded for NPS 2-1/2 and larger.

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. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47, Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.

I. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

J. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

K. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

L. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 SPECIAL-DUTY VALVES

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

B. Calibrated Balancing Valves, NPS 2 and Smaller: Bronze body, ball type, 125-psig working pressure, 250 deg F 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. Use in piping mains and branches.

C. Calibrated Balancing Valves, NPS 2-1/2 and Larger: Cast-iron or steel body, ball type, 125-psig working pressure, 250 deg F 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. Use in piping mains and branches.

D. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.

E. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.

F. Automatic Flow-Control Valves: Gray-iron body, factory set to maintain constant flow with plus or minus 5 percent over system pressure fluctuations, and equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case. Each valve shall have an identification tag attached by chain, and be factory marked with the zone identification, valve number, and flow rate. Use only at terminal units, not to be used in pump discharge, piping mains, or for branch balance valves. Valve shall be line size and one of the following designs:

1. Gray-iron or brass body, designed for 175 psig at 200 deg F with stainless-steel piston and spring.
2. Brass or ferrous-metal body, designed for 300 psig at 250 deg F with corrosion-resistant, tamperproof, self-cleaning, piston-spring assembly easily removable for inspection or replacement.
3. Combination assemblies, including bronze ball valve and brass alloy control valve, with stainless-steel piston and spring, fitted with pressure and temperature test valves, and designed for 300 psig at 250 deg F.

2.6 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.

B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection.

C. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity by a flexible bladder securely sealed into tank. Include drain fitting and taps for pressure gage and air-charging fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Factory fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

D. Tangential-Type Air Separators: Welded black steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature; perforated stainless-steel air collector tube designed to direct released air into expansion tank; tangential inlet and outlet connections; threaded connections for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger; threaded blowdown connection. Provide units in sizes for full-system flow capacity.

E. In-Line Air Separators: One-piece cast iron with an integral weir designed to decelerate system flow to maximize air separation at a working pressure up to 175 psig and liquid temperature up to 300 deg F. Basis of Design: Taco 4900 Series Air and Dirt Separator.

F. Air Purgers: Cast-iron body with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal. Maximum working pressure of 150 psig and temperature of 250 deg F.

G. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

H. Y-Pattern Strainers: 125-psig working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 and larger, threaded connections for NPS 2 and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection.

I. Basket Strainers: 125-psig working pressure; high-tensile cast-iron body (ASTM A 126, Class B), flanged-end connections, bolted cover, perforated stainless-steel basket, and bottom drain connection.

J. T-Pattern Strainers: 750-psig working pressure; ductile-iron or malleable-iron body, grooved-end connections, stainless-steel basket with 57 percent free area; removable access coupling and end cap for strainer maintenance.

K. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

2.7 VALVES, GENERAL

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

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

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

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

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

F. Valve Actuators:

1. Handwheel: For valves other than quarter-turn types.
2. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.

G. Extended Valve Stems: On insulated valves.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

I. Valve Grooved Ends: AWWA C606.

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

a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.

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

J. 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 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 FERROUS-ALLOY BUTTERFLY VALVES

A. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, for tight shutoff, with bronze disc and lining suitable for potable water, EPDM seats, unless otherwise indicated.

B. Wafer-Type Flangeless, 200-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer type with two-piece stainless steel stem, dead end rated at no less than 150 psig.
1. Basis of Design: Hammond 6100.

C. Lug-Type Single-Flange, 200-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer-lug type with two-piece stainless steel stem, dead end rated at no less than 150 psig.
1. Basis of Design: Hammond 6200.

D. Grooved-End, 175-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Ductile-iron or steel body with grooved or shouldered ends.
1. Basis of Design: Hammond 5100.

2.10 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.

2.11 GRAY-IRON SWING CHECK VALVES

A. MSS SP-71 Type I, Class 125, 175-psig CWP Rating, Grooved-End, Swing Check Valves: Gray-iron, metal seats, ductile-iron body with grooved or shouldered ends.

2.12 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. FCI 74-1, Type II, Class 125, Compact-Wafer, Lift-Disc Check Valves: Compact-wafer style with cast-iron shell with diameter made to fit within bolt circle; spring-loaded bronze or alloy disc and bronze or alloy seat

2.13 BRONZE GATE VALVES

A. MSS SP-80 Type 2, Class 125, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge union-ring bonnet, and ferrous-alloy handwheel.
1. Basis of Design: Hammond IB 617/635.

2.14 CAST-IRON GATE VALVES

A. Cast-Iron Gate Valves, General: MSS SP-70, Type I.

B. MSS SP-70, Type 1, Class 125, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid-wedge disc.

2.15 BRONZE GLOBE VALVES

A. MSS SP-80, Type 2, Class 125, Bronze Globe Valves: Bronze body with PTFE or TFE disc union-ring bonnet and ferrous-alloy handwheel.
1. Basis of Design: Hammond IB 416T/423.

2.16 CAST-IRON GLOBE VALVES

A. MSS SP-85 Type I, Class 125, Cast-Iron Globe Valves: Gray-iron body with bronze seats.
1. Basis of Design: Hammond IR 116.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot and Chilled Water, NPS 2 and Smaller: Aboveground, use Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints. Belowground or

within slabs, use Type K annealed-temper copper tubing with soldered joints. Use the fewest possible joints belowground and within floor slabs.

B. Hot and Chilled Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded and flanged joints or grooved mechanical-joint couplings.

3.2 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

1. Shutoff Duty: Gate, ball, and butterfly valves.
2. Throttling Duty: Globe, ball, and butterfly valves.
3. Pump Discharge: Spring-loaded, lift-disc check 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 at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

G. 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.

H. 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. Butterfly Valves, NPS 2-1/2 and Larger: Wafer or Lug-Type, 200-psig CWP rating, ferrous alloy, with EPDM liner.
3. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2-1/2 and Larger: 300-psig CWP rating.
4. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
5. Swing Check Valves, NPS 2-1/2 and Larger: Type I, Class 125, gray iron.
6. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125 minimum.
7. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, cast iron.
8. Gate Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
9. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, OS&Y, bronze-mounted cast iron.

10. Globe Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
11. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

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

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water services.
2. For Steel Piping, NPS 2 and Smaller: Threaded ends.
3. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
4. For Grooved-End, Steel Piping: Valve ends may be grooved.

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 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

D. Install 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, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

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.
2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

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 long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

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; and solvent-welded joints for PVC and CPVC piping.

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

C. Valve Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.7 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.

B. Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.

C. Install dip-tube fittings in boiler outlet. Install piping to expansion tank with a 2 percent upward slope toward tank. Connect boiler-outlet piping.

D. Install in-line air separators in pump suction lines. Install drain valve on units NPS 2 and larger.

E. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.

F. Install expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.

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 CHEMICAL TREATMENT

A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
1. pH: 6.5 to 7.5

B. Fill system and perform initial chemical treatment.

3.10 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. Flush system with clean water. Clean strainers.
3. 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.
4. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
3. Check expansion tanks to determine that they are not air bound and that system is full of water.
4. 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."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

3.11 ADJUSTING

A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

B. Perform these adjustments before operating the system:

1. Open valves to fully open position.
2. Check pump for proper direction of rotation.
3. Set automatic fill valves for required system pressure.
4. 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).
5. Set temperature controls so all coils are calling for full flow.
6. Check operation of automatic bypass valves.
7. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.

8. Lubricate motors and bearings.

3.12 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.

END OF SECTION 15181

SECTION 15194

FUEL GAS 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 the Section.

1.2 SUMMARY

A. This Section includes fuel gas piping, specialties, and accessories within the building.

B. Related Sections include the following:

1. Division 2 Section "Natural Gas Distribution" for natural gas service piping, specialties, and accessories outside the building.
2. Division 7, Section 07270 "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
3. Division 7, Section 07900 "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
4. Division 15 Section "Meters and Gages" for pressure gages.

1.3 PROJECT CONDITIONS

A. Gas System Pressures: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2.0 psig, and is reduced to secondary pressure of 0.5 psig or less.

B. Design values of fuel gas supplied for these systems are as follows:

1. Nominal Heating Value: 1000 Btu/cu. ft..
2. Nominal Specific Gravity: 0.6.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
2. Service-meter bars. Include service-meter size of selected models.
3. Service meters. Include pressure rating and capacity of selected models.
4. Service-meter bypass fittings.
5. Pressure regulators. Include pressure rating, capacity, and settings of selected models.

B. Shop Drawings: For fuel gas piping. Include plans and attachments to other Work. Show different pressure zones and indicate pressure for each zone.

1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

D. Maintenance Data: For natural gas specialties and accessories to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

A. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ANSI Standard: Comply with ANSI Z223.1, "National Fuel Gas Code."

C. FM Standard: Provide components listed in FM's "Fire Protection Approval Guide" if specified to be FM approved.

D. IAS Standard: Provide components listed in IAS's "Directory of A. G. A. and C. G. A Certified Appliances and Accessories" if specified to be IAS listed.

E. UL Standard: Provide components listed in UL's "Gas and Oil Equipment Directory" if specified to be UL listed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

1.7 COORDINATION

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Appliance Connector Valves:

   a. American Valve.
   b. B&K Industries, Inc.
   c. Brass Craft Manufacturing Co.
   d. Cimberio Valves, S. p. A.
   e. Conbraco Industries, Inc.; Apollo Div.
   f. E. M. Plastic and Electric Products, Ltd.; Neo Valve Div.
   g. Frey: John M. Frey Co.
   h. Jomar International, Ltd.
   i. Key Gas Components, Inc.
   j. Legend Valve and Fitting, Inc.
   k. McDonald: A. Y. McDonald Mfg. Co.
   l. Mueller Co.; Mueller Gas Products Div.
   m. Newman Hattersley, Ltd.; Specialty Valve Div.
   n. Robert Manufacturing Co.
   o. State Metals, Inc.
   p. Watts Industries, Inc.; Water Products Div.

2. Gas Valves, NPS 2 and Smaller:

   a. BMI Canada, Inc.
   b. Crane Valves.
   c. Dungs: Karl Dungs, Inc.
   d. Flow Control Equipment, Inc.
   e. Grinnell Corp.
   f. Honeywell, Inc.
   g. Jomar International, Ltd.
   h. Kitz Corp. of America.
   i. Legend Valve and Fitting, Inc.
   j. Lyall: R. W. Lyall & Co., Inc.
   k. McDonald: A. Y. McDonald Mfg. Co.
   l. Milwaukee Valve Co., Inc.
   m. Mueller Co.; Mueller Gas Products Div.
   n. Nibco, Inc.
   o. Red-White Valve Corp.
   p. Velan Valve Corp.
   q. Watts Industries, Inc.; Water Products Div.

3. Plug Valves, NPS 2-1/2 and Larger:

   a. Flow Control Equipment, Inc.
   b. Milliken Valve Co., Inc.
   c. Nordstrom Valves, Inc.
   d. Olson Technologies, Inc.; Homestead Valve Div.
   e. Walworth Co.

4. Automatic Gas Valves:

   a. ASCO General Controls.
   b. ASCOLECTRIC, Ltd.
   c. Automatic Switch Co.
   d. Dungs: Karl Dungs, Inc.
   e. Eaton Corp.; Controls Div.
   f. Eclipse Combustion, Inc.
   g. GPS Gas Protection Systems, Inc.
   h. Honeywell, Inc.
   i. Johnson Controls, Inc.

5. Line Pressure Regulators:

   a. American Meter Co.
   b. Donkin: Bryan Donkin RMG Canada, Ltd.
   c. Eclipse Combustion, Inc.
   d. Equimeter, Inc.
   e. Fisher Controls International, Inc.
   f. Maxitrol Co.
   g. National Meter.
   h. Richards Industries, Inc.; Jordan Valve Div.
   i. Schlumberger Industries; Gas Div.

6. Appliance Pressure Regulators:

   a. Canadian Meter Co., Inc.
   b. Eaton Corp.; Controls Div.
   c. Harper Wyman Co.
   d. Maxitrol Co.
   e. SCP, Inc.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

A. Steel Pipe: ASTM A 53; Type E or S; Grade B; Schedule 40; black.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
3. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
4. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

B. Transition Fittings: Type, material, and end connections to match piping being joined.

C. Common Joining Materials: Refer to Division 15 Section "Basic Mechanical Materials and Methods" for joining materials not in this Section.

2.4 PROTECTIVE COATING

A. Furnish pipe and fittings with factory-applied, corrosion-resistant polyethylene coating for use in corrosive atmosphere.

2.5 PIPING SPECIALTIES

A. Flexible Connectors: ANSI Z21.24, copper alloy.

B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

2.6 SPECIALTY VALVES

A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Valves, NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

C. Appliance Connector Valves: ANSI Z21.15 and IAS listed.

D. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.

E. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating.

1. Tamperproof Feature: Include design for locking.

F. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating.

1. Tamperproof Feature: Include design for locking.

G. Automatic Gas Valves: ANSI Z21.21, with [**electrical**] [**mechanical**] operator for actuation by appliance automatic shutoff device.

2.7 PRESSURE REGULATORS

A. Description: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.

1. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
2. Line Pressure Regulators: ANSI Z21.80 with 2-psig minimum inlet pressure rating.
3. Appliance Pressure Regulators: ANSI Z21.18. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

PART 3 - EXECUTION

3.1 PREPARATION

A. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.

B. Comply with ANSI Z223.1, "Prevention of Accidental Ignition" Paragraph.

3.2 SERVICE ENTRANCE PIPING

A. Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.

1. Exterior fuel gas distribution system piping, service pressure regulator, and service meter will be provided by gas utility.
2. Natural gas distribution system piping, service pressure regulator, and service meter are specified in Division 2 Section "Natural Gas Distribution."

B. Install dielectric fitting downstream from and adjacent to each service meter unless meter is supported from service-meter bar with integral dielectric fitting. Install shutoff valve downstream from and adjacent to dielectric fitting. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for dielectric fittings.

3.3 CONCRETE BASE INSTALLATION

A. Locate bases at service meters and service regulators.

B. Excavate earth and make level beds to support bases. Set bases level with top surface projecting approximately 3 inches above grade.

3.4 VALVE APPLICATIONS

A. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.

B. Piping Line Valves, NPS 2 and Smaller: Gas valve.

3.5 PIPING INSTALLATION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.

B. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.

1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
2. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.

    a. Exception: Tubing passing through partitions or walls.

3. In Walls: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in masonry walls, subject to approval of authorities having jurisdiction.
4. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

    a. Exception: Accessible above-ceiling space specified above.

C. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

D. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, unless indicated to be exposed to view.

E. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

F. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

G. Connect branch piping from top or side of horizontal piping.

H. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

I. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.

J. Install pressure gage upstream and downstream from each line pressure regulator.

K. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.

L. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

M. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches outside building, and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar, epoxy-polyamide paint according to SSPC-Paint 16.

3.6 JOINT CONSTRUCTION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Use materials suitable for fuel gas.

1. Brazed Joints: Make with brazing alloy with melting point greater than 1000 deg F. Brazing alloys containing phosphorus are prohibited.

3.7 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 15 Section "Hangers and Supports" for pipe hanger and support devices.

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

3.8 CONNECTIONS

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

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

C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

E. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
2. Do not use gas pipe as grounding electrode.

3.9 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.

1. Text: In addition to name of identified unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
2. Refer to Division 15 Section "Mechanical Identification" for nameplates and signs.

3.10 FIELD QUALITY CONTROL

A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging," and requirements of authorities having jurisdiction.

B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

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

D. Verify capacities and pressure ratings of service meters, pressure regulators, valves, and specialties.

E. Verify correct pressure settings for pressure regulators.

F. Verify that specified piping tests are complete.

3.11 ADJUSTING

A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION 15194

SECTION 15410

PLUMBING FIXTURES

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 plumbing fixtures and related components.

B. Related Sections include the following:
   1. Section 15430, "Plumbing Specialties" for water distribution piping specialties.

1.3 DEFINITIONS

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

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

C. ADA: Americans with Disabilities Act.

1.4 SUBMITTALS

A. Pre-Construction Submittals: Submit the following items prior to commencing with the installations.
   1. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
   2. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

B. Post Construction Submittals: Submit the following items upon completion of system installations.
   1. Maintenance Data: For plumbing fixtures to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

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

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

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

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Hand Sinks: NSF 2 construction.
   2. Plastic Mop-Service Basins: ANSI Z124.6.
   3. Plastic Shower Enclosures: ANSI Z124.2.
   4. Stainless-Steel Fixtures Other Than Service Sinks: ASME A112.19.3M.
   5. Vitreous-China Fixtures: ASME A112.19.2M.
   6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

   1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
   2. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
   3. Faucet Hose: ASTM D 3901.
   4. Faucets: ASME A112.18.1M.
   5. Hose-Connection Vacuum Breakers: ASSE 1011.
   6. Hose-Coupling Threads: ASME B1.20.7.
   7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.

8. NSF Materials: NSF 61.
9. Pipe Threads: ASME B1.20.1.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Supply and Drain Fittings: ASME A112.18.1M.

I. Comply with the following applicable standards and other requirements specified for shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Faucets: ASME A112.18.1M.
4. Hand-Held Showers: ASSE 1014.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Manual-Control Antiscald Faucets: ASTM F 444.
8. Pipe Threads: ASME B1.20.1.
9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
10. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1M.
3. Manual-Operation Flushometers: ASSE 1037.
4. Plastic Tubular Fittings and Piping: ASTM F 409.
5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
6. Tubular Brass Drainage Fittings and Piping: ASME A112.18.2M.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Floor Drains: ASME A112.21.1M.
2. Grab Bars: ASTM F 446.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Off-Floor Fixture Supports: ASME A112.6.1M.
5. Pipe Threads: ASME B1.20.1.
6. Plastic Shower Receptors: ANSI Z124.2.
7. Plastic Toilet Seats: ANSI Z124.5.
8. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 COORDINATION

A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

1.7 EXTRA MATERIALS

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

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Faucet, Flow-Control Fittings: Equal to 10 percent of amount of each type and size installed.
4. Supply, Flow-Control Fittings: Equal to 5 percent of amount of each type and size installed.
5. Shower, Flow-Control Fittings: Equal to 5 percent of amount of each type and size installed.
6. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but not less than 12 of each type.
7. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
8. Toilet Seats: Equal to 5 percent of amount of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Commercial Cast Brass Faucets:
1. Chicago Faucet Co.
2. Symmons Industries, Inc.
3. T&S Brass and Bronze Works.
4. Speakman Co.

C. Shower Heads and Trim:
1. Symmons Industries, Inc.
2. Powers Process Controls.
3. Leonard Valve Co.

D. Flush Valves:
1. Sloan Valve Co.
2. Zurn Industries, Inc.
3. Toto, USA.

E. Toilet Seats:
1. Church Seat Co.
2. Bemis Mfg. Co.
3. Beneke.
4. Kohler Co.

F. Protective Shielding Guards, (Under counter Insulation Kits):
1. Truebro, Inc.
2. McGuire/Pro Wrap.
3. Plumberex Specialty Products, Inc.

G. Fixture Carriers and Supports:
1. Zurn Industries, Inc.
2. J.R. Smith Mfg. Co.
3. Josam Co.
4. Watts Drainage.
5. Mifab.

H. Supply Stops:
1. Chicago Faucet Co.
2. McGuire Mfg. Co.

I. Vitreous China Fixtures:
1. American Standard, Inc.
2. Crane Plumbing/Fiat Products.
3. Kohler Co.
4. Eljer Mfg. Co.

J. Pre-fabricated Plastic Shower Cabinets:
1. Acryline USA, Inc.
2. Aqua Bath.
3. Aquarius by Praxis Industries.
4. Lasco Bathware.

K. Stainless Steel Sinks:
1. Just Mfg. Co.
2. Elkay Mfg. Co.
3. Kindred.

L. Stainless Steel Security Fixtures:
1. Acorn Engineering Co.
2. Willoughby Industries, Inc.
3. Metcraft, Inc.
4. Bradley Corp.

M. Molded Stone and Plastic Basins:
1. Fiat Products.
2. Swan.

2.2 FIXTURES, GENERAL

A. General fixture, faucet and related item requirements are listed below. Refer to the "Plumbing Fixture Schedule" on the Drawings for the basis o f design for each item.

B. Accessibility: Fixtures and items that are required to be accessible are tagged as such in the Plumbing Fixture Schedule on the Drawings.

2.3 FAUCETS

A. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Maximum Flow Rate, (unless otherwise indicated):
   a. Sinks, Bathtubs, Showers: 1.8 gpm.
   b. Lavatories: 0.5 gpm
2. Body Material: Cast brass
3. Finish: Polished chrome plate
4. Vacuum Breaker: Required for service sinks, and basins.
   a. Required at any sink faucet, which has exposed hose thread end(s).
5. Operation Mechanism: Lever handles, or electric-sensor. See schedule.

2.4 FLUSHOMETERS

A. General: Cast-brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, and copper or brass tubing, and polished chrome-plated finish on exposed parts.

1. Internal Design: Diaphragm operation.
2. Style: Exposed, unless noted otherwise.
3. Inlet Size: NPS 1.
   a. NPS ¾ acceptable for urinals if scheduled as such.
4. Trip Mechanism: Electric-sensor.
5. Consumption:
   a. Sensor Actuated Water Closets: 1.6 gal./flush.
   b. Sensor Actuated Urinals: 0.5 gal./flush.
6. Tailpiece Size: Diameter scheduled, length to top of bowl.

2.5 TOILET SEATS

A. General: Solid plastic, open front, without cover, self sustaining check hinges.
1. Color: White.
2. Size: Elongated, unless otherwise noted.

2.6 PROTECTIVE SHIELDING GUARDS

A. General: Manufactured insulation and plastic covering for water supply, trap and drain piping and complying with ADA requirements.

2.7 FIXTURE SUPPORTS

A. Water-Closet Support: Water-closet combination carrier designed for accessible and standard mounting heights, (see schedule). Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with

gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

B. Urinal Support: Urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include steel uprights with feet.

C. Lavatory and Sink Supports: Lavatory carrier with concealed arms and tie rod. Include steel uprights with feet.

2.8 SUPPLY STOPS

A. General: Cast brass or copper, chrome plated angle style with chrome plated escutchon and loose key operator.
   1. Lavatory Supplies: NPS 3/8.
   2. Sink and Tank Style Water Closet Supplies: NPS ½.

2.9 WATER CLOSETS

A. General: Commercial, vitreous-china fixture, siphon jet design, 1.6 gal./flush.
   1. Mounting: Wall hung or floor mounted. See schedule.
   2. Outlet: Back.
   3. Flush style: Electric sensor operated flushometer valve.
   4. Color: White.

2.10 URINALS

A. General: Wall hung, back-outlet, vitreous-china fixture designed for sensor operated flushometer valve, wash out design, 0.5 gal./flush.
   1. Color: White.

2.11 LAVATORIES

A. General: Wall hung or self rimming counter mount vitreous-china fixture.
   1. Color: White.

2.12 PRE-FABRICATED SHOWER CABINETS

A. General: Acrylic plastic enclosure with slip-resistant bathing surface complying with ASTM F 462 and shower rod with curtain.
   1. Cabinet Configuration: One-piece surround.
   2. Color: White.
   3. Drain: Grid, NPS 2.
   4. Accessibility Options: Include grab bars and bench meeting applicable accessibility requirements for units designated as accessible in the Plumbing Fixture Schedule on the Drawings.
      a. Threshold: ½-inch maximum lip allowed at front entrance to the cabinet.

2.13 PRE-FABRICATED SHOWER CABINETS – SECURE AREA

A. General: Stainless steel enclosure with slip-resistant bathing surface complying with ASTM F 462.
   1. Cabinet Configuration: One-piece surround.
   2. Drain: Vandal resistant grid, NPS 2.
   3. Accessibility Options: Include grab bars and bench meeting applicable accessibility requirements for units designated as accessible in the Plumbing Fixture Schedule on the Drawings.
      a. Threshold: ½-inch maximum lip allowed at front entrance to the cabinet.

2.14 SECURITY WATER CLOSETS

A. Stainless Steel Security Water Closets: Back-mounting-type, IAPMO PS 61, front accessible fixture; made for on-floor installation; fabricated from 14 gauge, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
   1. Configuration: Compact design, with bowl on wall flange.
   2. Bowl: Elongated, with back inlet, integral trap, blowout design with back outlet and contoured seat.
      a. Seat Surface: SSINA No. 8 highly polished finish.
      b. Punching: Provide two holes for installation of separate toilet seat, where scheduled.
      c. Drain: NPS 4, horizontal with cleanout and slip joint.
   3. Toilet Seat: ANSI Z124.5, white commercial, heavy-duty, elongated, open front with cover, with self-sustaining check hinges, where scheduled.
   4. Flushing Device: Concealed flushometer valve with push-button mechanism and 1.6-gal./flush consumption.
   5. Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture. Include steel bars or other design that will prevent escape if fixture is removed.
   6. Basis of Design: As scheduled on the Drawings.

2.15 SECURITY LAVATORIES

A. Stainless Steel Security Lavatories: Accessible fixture; fabricated from 14 gauge, ASTM A 666, Type 304, stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
   1. Receptor: Oval or rectangular bowl with integral soap depression and backsplash.
   2. Hot- and Cold-Water and Bubbler Supply Valves: Pneumatic type with push-button actuation and individual check stops.
   3. Filler Spout/Bubbler: Backsplash mounted.
   4. Drain: Integral punched grid with NPS 1-1/4 minimum tailpiece, trap, and waste complying with ASME A112.18.2M.
   5. Access to Internal Components: Vandal-resistant access panels, (for front access type).
   6. Mounting Device: Wall bracket.
   7. Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture. Include steel bars or other design that will prevent escape if fixture is removed.

2.16 Basis of Design: As scheduled on the Drawings.

2.17 GENERAL USE SINKS

A. General: Commercial, counter mount, self rimming, sound deadening fixture.
1. Material: 18 gauge, type 304 stainless steel.

2.18 SERVICE FIXTURES

A. Mop Service Basins: Flush-to-wall, floor-mounting precast terrazzo or plastic basin with rim guards.
1. Drain: NPS 3, grid.
2. Accessories: Mop hanger, splash guards, faucet hose attachment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

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

3.2 FIXTURE INSTALLATION

A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.

D. Install wall-hanging fixtures with tubular waste piping attached to supports.

E. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture.

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

K. Install protective shielding guards on exposed under counter supply and waste piping at fixtures identified as accessible and at other locations scheduled.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install toilet seats on water closets.

N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

O. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.

P. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install shower, flow-control fittings with specified maximum flow rates in shower arms.

R. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

S. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for escutcheons.

T. Set shower receptors and service basins in leveling bed of cement grout. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for grout.

U. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 7 Section "Joint Sealants" for sealant and installation requirements.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water supplies from water distribution piping to fixtures.

C. Connect drain piping from fixtures to drainage piping.

D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

F. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 15410

SECTION 15430

PLUMBING 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 this Section.

1.2 SUMMARY

A. This Section includes the following plumbing specialties:

1. Backflow preventers.
2. Water meters.
3. Water regulators.
4. Balancing valves.
5. Thermostatic water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Exterior wall hydrants.
9. Trap seal primer valves.
10. Drain valves.
11. Backwater valves.
12. Miscellaneous piping specialties.
13. Cleanouts.
14. Floor, trench and roof drains.
15. Interceptors.
16. Emergency Equipment.

B. Related Sections include the following:

1. Section 15122, "Meters and Gages" for water meters, (other than at municipal entrances), thermometers, and pressure gages.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. PE: Polyethylene plastic.

C. PUR: Polyurethane plastic.

D. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
1. Water Supply Systems, Above Ground: 125 psig.
2. Water Supply Systems, Below Ground: 150 psig.
3. DWV, (Gravity) Systems: 10 foot of head of water.
4. DWV, (Forced Main) Systems: 100 psig.

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, including wiring diagrams for electrically and battery powered items.
   a. Backflow preventers and water regulators.
   b. Balancing valves, water filters, and strainers.
   c. Thermostatic water mixing valves.
   d. Water hammer arresters, air vents, and trap seal primer valves and systems.
   e. Drain valves, hose bibbs, and wall hydrants.
   f. Outlet boxes.
   g. Backwater valves, cleanouts, floor drains, open receptors, trench drains, and roof drains.
   h. Interceptors.
   i. Emergency equipment.

C. Post Construction Submittals: Submit the following items upon completion of system installations.
1. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:
   a. Backflow preventers and water regulators.
   b. Thermostatic water mixing valves.
   c. Trap seal primer valves and systems.
   d. Wall hydrants.
   e. Interceptors.
   f. Emergency equipment.

1.6 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.

E. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components. Include marking "NSF-dwv" on plastic drain, waste, and vent piping.
2. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Operating Key Handles: Equal to 100 percent of amount installed for each key-operated hose bibb and hydrant installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Backflow Preventers:
1. Ames Co., Inc.
2. CMB Industries, Inc.; Febco Backflow Preventers.
3. Conbraco Industries, Inc.
4. Watts Industries, Inc.; Water Products Div.
5. Zurn Industries, Inc.; Wilkins Div.

C. Water Meters: Provide units by manufacturers dictated by the local water authority. In the absence of such direction, provide units by:
1. Badger Meter, Inc.
2. Invensys North American Water.
3. Mueller Company.
4. ABB.

D. Water Pressure Regulators:
   1. Cla-Val Co.
   2. Conbraco Industries, Inc.
   3. Watts Industries, Inc.; Water Products Div.
   4. Zurn Industries, Inc.; Wilkins Div.

E. Memory Stop Circulated Hot Water Balancing Valves:
   1. Conbraco Industries, Inc.
   2. Crane Co.; Crane Valve Group; Stockham Div.
   3. Hammond Valve.
   4. Milwaukee Valve Company.
   5. NIBCO INC.
   6. Red-White Valve Corp.

F. Thermostatic Water Mixing Valves:

   1. Lawler Manufacturing Company, Inc.
   2. Leonard Valve Company.
   3. Mark Controls Corp.; Powers Process Controls.
   4. Symmons Industries, Inc.
   5. Armstrong-Lynnwood, Inc.; Rada.

G. Outlet Boxes:

   1. Acorn Engineering Company.
   2. Gray, Guy Manufacturing Co., Inc.
   3. IPS Corporation.
   4. Symmons Industries, Inc.

H. Exterior Wall Hydrants:
   1. Smith, Jay R. Mfg. Co.
   2. Tyler Pipe; Wade Div.
   3. Watts Industries, Inc.; Drainage Products Div.
   4. Zurn Industries, Inc.

I. Trap Seal Primer Valves:
   1. Precision Plumbing Products, Inc.
   2. Smith, Jay R. Mfg. Co.
   3. Tyler Pipe; Wade Div.
   4. Watts Industries, Inc.
   5. Zurn Industries, Inc.

J. Backwater Valves:

   1. Josam Co.
   2. Smith, Jay R. Mfg. Co.
   3. Watts Industries, Inc.; Drainage Products Div.
   4. Zurn Industries, Inc.; Specification Drainage Operation.

K. Water Hammer Arresters:
   1. Josam Co.

2. Precision Plumbing Products, Inc.
3. Sioux Chief Manufacturing Co., Inc.
4. Watts Industries, Inc.
5. Smith, Jay R. Mfg. Co.
6. Zurn Industries, Inc.; Wilkins Div.

L. Hose Bibbs:
1. Chicago Faucet Co.
2. T & S Brass and Bronze Works, Inc.
3. Royal Brass Mfg. Co.

M. Cleanouts; Floor, Trench, and Roof Drains:
1. Watts Industries, Inc.
2. Smith, Jay R. Mfg. Co.
3. Zurn Industries, Inc.; Wilkins Div.
4. Josam Co.
5. Tyler Pipe; Wade Div.

N. Emergency Equipment:
1. Encon Safety Products.
2. Guardian Equipment Co. / Leonard Water Temperature Controls.
3. Haws Corporation.

2.2 BACKFLOW PREVENTERS

A. General: ASSE standard, backflow preventers.

1. NPS 2 and Smaller: Bronze body with threaded ends.
2. NPS 2-1/2 and Larger: Bronze, cast-iron, steel, or stainless-steel body with flanged ends.

a. Interior Lining: AWWA C550 or FDA-approved, epoxy coating for backflow preventers having cast-iron or steel body.

3. Interior Components: Corrosion-resistant materials.
4. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.
5. Strainer: Provide strainer on inlet. Include draw off valve with cap and chain.
a. Exception: Where backflow preventers are located immediately downstream of a water meter and strainer, a strainer is not required at the backflow preventer, unless specifically required by the applicable water authority.

B. Reduced-Pressure-Principle Backflow Preventers: ASSE 1013, suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet; test cocks; and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves.

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

2.3 WATER METERS

A. General: Provide meters as required by the local water supplier.

B. Displacement-Type Water Meters NPS 2 and Smaller: AWWA C700, nutating-disc totalization meter with bronze case and 150-psig minimum working-pressure rating; with registration in gallons or cubic feet as required by utility; and with threaded end connections.

C. Turbine-Type Water Meters: AWWA C701, totalization meter with 150-psig minimum working-pressure rating; with registration in gallons or cubic feet as required by utility; and with the following end connections:

1. NPS 2 and Smaller: Threaded.
2. NPS 2-1/2 and Larger: Flanged.

D. Compound-Type Water Meters NPS 3 and Larger: AWWA C702, totalization meter with integral main-line and bypass meters, bronze case, and 150-psig minimum working-pressure rating; with registration in gallons or cubic feet as required by utility; and with flanged end connections.

E. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility.

F. Remote Registration System: Encoder-type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility.

2.4 WATER PRESSURE REGULATORS

A. General: ASSE 1003, water regulators, rated for initial working pressure of 150 psig minimum. Include integral factory-installed or separate field-installed, Y-pattern strainer.

1. NPS 2 and Smaller: Bronze body with threaded ends.

a. General-Duty Service: Single-seated, direct operated, unless otherwise indicated.
b. Booster Heater Water Supply: Single-seated, direct operated with integral bypass.

2. NPS 2-1/2 and Larger: Bronze or cast-iron body with flanged ends. Include AWWA C550 or FDA-approved, interior epoxy coating for regulators with cast-iron body.

a. Type: Single-seated, direct operated.
b. Type: Pilot-operated, single- or double-seated, cast-iron-body main valve, with bronze-body pilot valve.

3. Interior Components: Corrosion-resistant materials.
4. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.

B. Basis of Design: As scheduled on the Drawings.

2.5 BALANCING VALVES

A. Memory-Stop Balancing Valves, NPS 2 and Smaller: MSS SP-110, ball valve, rated for 400-psig minimum CWP. Include two-piece, copper-alloy body with standard or full-port, chrome-plated brass ball, replaceable seats and seals, threaded or solder-joint ends, and vinyl-covered steel handle with memory-stop device.

2.6 THERMOSTATIC WATER MIXING VALVES

A. General: ASSE 1017, manually adjustable, thermostatic water mixing valve with bronze body. Include check stop and union on hot- and cold-water-supply inlets, adjustable temperature setting, and thermometer.

1. Type: Bimetal thermostat, operation and pressure rating 125 psig minimum.

B. Manifolded (High-Low), Thermostatic Water Mixing-Valve Assemblies: Factory-fabricated unit consisting of parallel arrangement of thermostatic water mixing valves.

1. Arrangement: One large-flow, thermostatic water mixing valve with flow-control valve, pressure regulator, inlet and outlet pressure gages, and one small-flow, thermostatic water mixing valve with flow-control valve. Include outlet thermometer, factory- or field-installed inlet and outlet valves, and other indicated options.
   a. Acceptable Alternate: Assemblies which meet scheduled flow range and pressure drop requirements need not be high-low style. The intent of the units is to meet the entire flow range and pressure constraints.
2. Basis of Design: As scheduled on the drawings.

2.7 STRAINERS

A. Strainers: Y-pattern, unless otherwise indicated, and full size of connecting piping. Include ASTM A 666, Type 304, stainless-steel screens with 3/64-inch round perforations, unless otherwise indicated.

1. Pressure Rating: 125-psig minimum steam working pressure, unless otherwise indicated.
2. NPS 2 and Smaller: Bronze body, with female threaded ends.
3. NPS 2-1/2 and Larger: Cast-iron body, with interior AWWA C550 or FDA-approved, epoxy coating and flanged ends.
4. Y-Pattern Strainers: Screwed screen retainer with centered blowdown.
   a. Drain: Pipe plug.
5. T-Pattern Strainers: Malleable-iron or ductile-iron body with grooved ends; access end cap with drain plug and access coupling with rubber gasket.

2.8 OUTLET BOXES

A. General: Recessed-mounting outlet boxes with supply fittings complying with ASME A112.18.1M. Include box with faceplate, services indicated for equipment connections, and wood-blocking reinforcement.

B. Icemaker Outlet Boxes: With hose connection and the following:

1. Box and Faceplate: Enameled or epoxy-painted steel.
2. Shutoff Fitting: Hose bibb.
3. Supply Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.
4. Basis of Design: As scheduled on the Drawings.

C. Reinforcement: 2-by-4-inch fire-retardant-treated-wood blocking between studs. Fire-retardant-treated-wood blocking is specified in Division 6 Section "Rough Carpentry."

2.9 EXTERIOR WALL HYDRANTS

A. General: ASME A112.21.3M, key-operation hydrant with pressure rating of 125 psig.

1. Inlet: NPS 3/4 or NPS 1 threaded or solder joint.
2. Outlet: ASME B1.20.7, garden-hose threads.
3. Operating Keys: One with each key-operation hydrant.

B. Nonfreeze Concealed-Outlet Wall Hydrants: ASSE 1019, self-drainable with flush-mounting box with cover, integral non-removable hose-connection vacuum breaker, casing and operating rod to match wall thickness, concealed outlet, and wall clamp.
1. Box and Cover Finish: Polished nickel bronze.
2. Basis of Design: As scheduled on the Drawings.

2.10 TRAP SEAL PRIMER VALVES

A. Supply-Type Trap Seal Primer Valves: ASSE 1018, water-supply-fed type, with the following characteristics:

1. 125-psig minimum working pressure.
2. Bronze body with atmospheric-vented drain chamber.
3. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
4. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
5. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.11 DRAIN VALVES

A. Hose-End Drain Valves: MSS SP-110, NPS 3/4 ball valve, rated for 400-psig minimum CWP. Include two-piece, copper-alloy body with standard port, chrome-plated brass ball, replaceable seats and seals, blowout-proof stem, and vinyl-covered steel handle.

1. Inlet: Threaded or solder joint.
2. Outlet: Short-threaded nipple with ASME B1.20.7, garden-hose threads and cap.

B. Stop-and-Waste Drain Valves: MSS SP-110, ball valve, rated for 200-psig minimum CWP or MSS SP-80, Class 125, gate valve; ASTM B 62 bronze body, with NPS 1/8 side drain outlet and cap.

2.12 BACKWATER VALVES

A. Horizontal Backwater Valves: ASME A112.14.1, cast-iron body, with removable bronze swing-check valve and threaded or bolted cover.
   1. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor, instead of cover.

2.13 WATER HAMMER ARRESTERS

A. General: ASSE 1010 or PDI-WH 201, piston type with pressurized metal-tube cushioning chamber. Sizes indicated are based on ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.14 HOSE BIBBS

A. General: Bronze body with replaceable seat disc complying with ASME A112.18.1M for compression-type faucets. Include NPS 3/4 threaded or solder-joint inlet, of design suitable for pressure of at least 125 psig; integral non-removable, drainable hose-connection vacuum breaker; and garden-hose threads complying with ASME B1.20.7 on outlet.

   1. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
   2. Finish for Finished Rooms: Chrome or nickel plated.
   3. Operation: Operating key.
   4. Include operating key with each operating-key hose bibb.
   5. Include wall flange with each chrome- or nickel-plated hose bibb.

B. Basis of Design: As scheduled on the Drawings.

2.15 MISCELLANEOUS PIPING SPECIALTIES

A. Open End Drains, (or "Stand Drains"): Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, backwater valve, hub-and-spigot riser section; and increaser fitting, joined with ASTM C 564, rubber gaskets.

B. Deep-Seal Traps: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap seal primer valve connection.

   1. NPS 2: 4-inch minimum water seal.
   2. NPS 2-1/2 and Larger: 5-inch minimum water seal.

C. Fixed Air-Gap Fittings: Manufactured cast-iron or bronze drainage fitting with semiopen top with threads or device to secure drainage inlet piping in top and bottom spigot or threaded outlet

larger than top inlet. Include design complying with ASME A112.1.2 that will provide fixed air gap between installed inlet and outlet piping.

D. Wall Accessible Cleanouts: Line type with lacquered cast iron body, gas and water tight tapered thread plug, and round stainless steel access cover secured with machine screw.
   1. Basis of Design: Zurn #Z-1441.

   Note: Note: For applications within secure areas including Intox (148), Salleyport (145), Toliet (149), and Interview (147) rooms, provide vandal resistant fasteners.

E. Finished Floor Cleanouts: Lacquered cast iron body with anchor flange, reversible clamping collar, adjustable threaded top assembly, and round, gasketed cover.
   1. Cover to be scored in unfinished and service areas.
   2. Cover to be depressed to receive floor finish material in finished spaces.
   3. Basis of Design: Zurn #Z-1400.

   Note: For applications within secure areas including Intox (148), Salleyport (145), Toliet (149), and Interview (147) rooms, provide vandal resistant fasteners.

2.16 FLOOR, AREA, AND TRENCH DRAINS

A. General: ASME A112.21.2M; Provide trap primer inlet connections on drain bodies unless otherwise scheduled.
   1. Where drains do not require trap primers, install a threaded plug in the primer inlet port. Plug to be of a dielectrically compatible material.
   2. Basis of Design: As scheduled on the Drawings.

B. Floor Drains:
   1. Body Material: Cast Iron.
   2. Seepage Flange and Clamping Device: Required for interior application.
   3. Anchor Flange: Required for exterior application.
   4. Exposed Surfaces and Interior Lining: As scheduled.
   5. Outlet Style: Hub and Spigot for slab-on-grade applications. No-hub for above grade applications.
   6. Sediment Bucket and Grate Variations: As scheduled.

2.17 ROOF DRAINS

A. General: ASME A112.21.2M
   1. Body Material: Cast Iron.
   2. Dome Material: Cast Aluminum or Cast Iron.
   3. Under deck Clamp: Required.
   4. Sump Receiver: Required.
   5. Waterproofing Flange: Required.
   6. Extension Collar: Required to compensate for roof insulation.
   7. Gravel Stop and Flashing Ring: Required only for ballasted roof construction.
   8. Basis of Design: As scheduled on the Drawings.

B. Expansion Joints: ASME A112.21.2M, assembly with cast-iron body with bronze sleeve, packing gland, and packing; of size and end types corresponding to connected piping.

C. Downspout Boots: ASTM A 48, gray-iron casting, with NPS 4 outlet; shop-applied bituminous coating; and inlet size to match downspout.

2.18 EMERGENCY EQUIPMENT

A. General: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment." In as much as possible, provide water tempering equipment and fixtures as supplied by the same manufacture or pair of manufacturers as listed in paragraph 2.01.

B. Water Tempering Equipment: Thermostatic mixing valve assembly with fail-cold bypass. Valves shall be specifically manufactured for use with emergency fixtures.
1. Water supplied to plumbed emergency Fixtures to be 85°F, +/- 5°F.
2. Minimum flow range for valves serving showers: 20-30 gpm.
3. Minimum flow range for valves serving eye/face washes: 3-5 gpm.
4. Basis of Design: As scheduled on the Drawings.

C. Emergency Fixtures: Fixtures may include; Showers, combination shower & eye/fash wash units, and eye/face wash units. Units shall be barrier free and shall include stay open style activation.
1. Basis of Design: As scheduled on the Drawings.

D. Drain Piping: Provide drain piping for eye/face wash units as well as the eye/face wash portion of combination units, where drain ports are supplied as part of the fixture.
1. Exposed Piping Application: Steel pipe and fittings, schedule 40, galvanized. Include galvanized steel escutcheons where piping penetrates finished walls.
2. Concealed Piping Applications: Copper tube and fittings, type DWV.

E. Signage: Provide signage for each unit, as supplied by the same manufacturer as the fixtures. Signage to be as per ANSI Z358.1.

F. Test Equipment: Provide the following test equipment for the project where shower or combination units are included. Test equipment to be furnished by the same manufacturer as the fixtures.
1. Test curtain chute.
2. 5 gallon collection bucket.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Water Meter Installation: Rough-in domestic water piping according to utility company's requirements. Install water meters according to AWWA M6 and utility's requirements.

1. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
2. Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
3. Install compound-type water meters with shutoff valves on water-meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.
4. Install remote registration system according to standards of utility and of authorities having jurisdiction.

D. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.

E. Install high-low thermostatic mixing valves which serve as "master" hot water system mixers, with circulated hot water connections, as per manufacturer's written instructions.
1. Where alternate "master" mixing valves are provided, and do not include circulated hot water connections, piping configurations at these valves shall be as per manufacturer's written instructions to insure proper function.

F. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve.

G. Install interior hose bibs 18-inches above finished floors.

H. Install exterior wall hydrants 18-inches above finished grade.

I. Install trap seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

J. Drain Valve Application: Install hose end drain valves at the base of system risers.
1. Acceptable Alternate: For ¾-inch supply risers which serve only one story above, stop-and-waste shut-off valves may be used in lieu of shut-off valves and separate drain valves.

K. Storm Drain Expansion Fittings: Provide where piping connected to a roof drain does not immediately offset to the horizontal and run for more than 5 feet.

L. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

M. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.

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

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

P. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    b. Radius, 30 to 60 Inches Equivalent to 1 percent slope.
    c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

Q. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install roof-drain flashing collar or flange so no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Position roof drains for easy access and maintenance.

R. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.

S. Fasten recessed-type plumbing specialties to reinforcement built into walls.

T. Install wood-blocking reinforcement for wall-mounting and recessed-type plumbing specialties.

U. Install individual shutoff valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated. Install shutoff valves in accessible locations.

Refer to Division 15 Section "Valves" for general-duty ball, butterfly, check, gate, and globe valves.

V. Install air vents at piping high points. Include ball, gate, or globe valve in inlet and drain piping from outlet to floor drain.

W. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

X. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Emergency Fixture Drains: Unless otherwise indicated on the plans, connect to fixture drain ports and spill drain piping to nearest drain. Where local drains do not exist, terminate drain piping at 18-inches above the finished floor with a down turned elbow.

3.3 PROTECTION

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

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

END OF SECTION 15430

SECTION 15445

SUMP PUMPS

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 the following sewage and sump pumps and accessories for sanitary waste and storm drainage piping systems in buildings:
   1. Oil retaining sump pump systems.

B. Related Sections include the following:
   1. Division 15 Section "Meters and Gauges" for pressure gauges."
   2. Section 15140, "Plumbing Piping and Specialties" for system pipe, fittings and valves.

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 and size of pump system specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.
   2. Shop Drawings: Diagram power, signal, and control wiring.
   3. Warranty data.

C. Post Construction Submittals: Submit the following items upon completion of system installations.
   1. Operation and Maintenance Data: For each pump system to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of pump systems and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.6 COORDINATION

A. Coordinate size and location of pits and basins with concrete work. 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 specified.

B. Oil retaining sump pump systems:
1. Stancor, Inc.

2.2 OIL RETAINING SUMP PUMP SYSTEMS

A. Description: Pump and control system which includes an oil sensing probe to identify the presence of oil, hydraulic fluid or other similar substances.

B. Pump: Factory-assembled and -tested, single-stage, centrifugal, end-suction, automatic-operation, submersible effluent pump unit.
1. Pump Body and Impeller: Corrosion-resistant materials.
2. Pump Seals: Mechanical type.
3. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection. Comply with requirements of Section 15050, Basic Mechanical Materials and Methods."

C. Control: UL 508, NEMA 4X gasketed enclosure, local audible alarm as well as contacts for building automation system interface. Panel shall include 16 foot long cables for connection to

the pump, and an 8-foot power cord. Pump control to include a self cleaning, corrosion resistant sensor probe. Alarm conditions shall be as follows;

1. Presence of oil in the sump.
2. High liquid in the sump.
3. High amps or locked rotor.

D. Basis of Design: As scheduled on the Drawings.

2.3 BUILDING AUTOMATION SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:

1. On-off status of each pump.
2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of piping connections before pump system installation.

3.2 INSTALLATION

A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

B. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

C. Install elevator sump pumps in elevator pit sumps. Connect to drainage piping as per the Drawings. Install control panels in adjacent elevator machine rooms unless otherwise indicated on the Drawings.

D. Support piping so weight of piping is not supported by pumps.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 15 Section "Plumbing Piping and Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect drainage and vent piping to pumps. Install discharge piping equal to or greater than size of pump discharge piping. Install vent piping equal to or greater than size of pump basin vent connection. Refer to Division 15 Section "Plumbing Piping and Specialties."

1. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves same size as connected piping.

C. Ground equipment according to Division 16 Section "Grounding and Bonding."

D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify bearing lubrication.
3. Disconnect couplings and check motors for proper direction of rotation.
4. Verify that each pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
5. Verify that pump controls are correct for required application.

B. Start pumps without exceeding safe motor power:
1. Start motors.
2. Open discharge valves slowly.
3. Check general mechanical operation of pumps and motors.

C. Test and adjust controls and safeties.

D. Remove and replace damaged and malfunctioning components.

1. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.
2. Set field-adjustable switches and circuit-breaker trip ranges as indicated, or if not indicated, for normal operation.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 15445

SECTION 15487

DOMESTIC WATER HEAT EXCHANGERS

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 for domestic water systems:
1. Semi-Instantaneous heat exchangers.
2. Circulating pumps.
3. Expansion tanks.
4. Accessories.

B. Related Sections include the following:
1. Division 15 Section "Meters and Gages" for thermometers, flow meters, and pressure and vacuum gages.

1.3 DEFINITIONS

A. Semi-Instantaneous: Heat exchangers with 10 – 120 gallons of nominal storage.

B. Type III Lining/Tank: Internal tank constructed of type 316L stainless steel.
1. Anode rod(s) not required or provided.

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 and size of; heat exchanger, expansion tank, and circulator. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

2. Shop Drawings: Detail heat-exchanger assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
4. Product Certificates: Signed by manufacturers of heat exchangers certifying that products furnished comply with requirements.
5. Warranty data.

C. Post Construction Submittals: Submit the following items upon completion of system installations.
1. Maintenance Data: For heat exchangers, expansion tanks, and circulators; to include in maintenance manuals specified in Division 1.
2. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of heat exchangers through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of heat exchangers and are based on specific units indicated. Other manufacturers' products complying with requirements may be considered. Refer to Division 1 Section "Substitutions."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Fabricate and label heat-exchanger, hot-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

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

1.6 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of heat exchangers that fail in materials or workmanship within specified warranty period.

C. Circulators: Include a 5 year warranty from date of Substantial Completion.

D. Heat Exchanger Tube Bundles: Include a 10 year warranty from date of Substantial Completion.

E. Tank and Lining: Include a 10 year warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Semi-Instantaneous Hot Water Fired Heat Exchangers, Type III Lining/Tank:
1. Adamson Global Technology Corp. [Dura-Mite w/ copper sheet]
2. Amtrol, Inc. [Boilermate w/ Stainless steel]
3. Cemline Corp. [SSH w/ stainless steel]
4. RECO Industries, Inc. [Thermodyne w/ copper alloy]
5. Viessmann Manufacturing Co. (US), Inc. [Vitocell w/ stainless steel]

C. Circulating Pumps:
1. Armstrong Pumps Inc.
2. Bell & Gossett Domestic Pump; ITT Industries.
3. Grundfos Pumps Corp.
4. Taco, Inc

D. Expansion Tanks:
1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Smith: A. O. Smith; Aqua-Air Div.
4. Taco, Inc.
5. Wessels Co.

2.2 SEMI-INSTANTANEOUS HOT WATER FIRED HEAT EXCHANGERS

A. Description: Packaged, commercial, indirect-fired water heater with 10-120 gallons of storage capacity; and heat exchanger for heating water with boiler water.

B. Storage Tank Shell Construction: ASME-code steel or stainless steel with 150-psig working-pressure rating.
1. Tappings: Factory fabricated of materials compatible with tank for piping connections, relief valve, pressure gage, thermometer, blowdown, vent, anode rods, and controls as required. Attach tappings to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
2. Interior Finish: Type III tank or lining, complying with NSF 61. Extend finish into and through tank fittings and outlets.
3. Insulation: Manufacturer's standard, unless otherwise indicated, and suitable for operating temperature. Surround entire tank except connections and controls. Comply with ASHRAE 90.1.
4. Jacket: Steel, with enameled finish, unless otherwise indicated.

C. Heating Coil: Double wall copper or stainless-steel.

D. Temperature Control: Adjustable thermostat that operates boiler water pump and that is capable of maintaining outlet-water temperature within 5 deg F of setting.

E. Safety Control: Automatic, high-temperature-limit cutoff device or system.

F. Miscellaneous Components: Strainer, valves, and piping.

G. Stand: Factory fabricated for floor mounting.

H. Basis of Design: As scheduled on the Drawings.

2.3 EXPANSION TANKS

A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

B. Construction: 150-psig working-pressure rating.

C. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.

D. Tank Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

E. Basis of Design: As scheduled on the Drawings.

2.4 CIRCULATING PUMPS

A. Distribution Piping Circulator, Type I: Factory assembled and tested, centrifugal, overhung-impeller, separately coupled, in-line pump, designed for installation with pump and motor shafts mounted horizontally.

1. Pump Construction: All bronze.
   a. Casing: Radially split, bronze with threaded companion-flange connections.
   b. Impeller: Cast bronze, keyed to shaft.
   c. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
   d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
   e. Bearings: Oil-lubricated; bronze-journal or thrust type.
2. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
3. Motor: Single speed, with oil-lubricated bearings, unless otherwise indicated; and resiliently mounted to pump casing.
4. Basis of Design: As scheduled on the Drawings.

B. Distribution Circulator Control: Provide immersion-type thermostats, (aquastats) for control of circulators.

C. Distribution Circulator Control Provisions: Provide auxiliary contacts in pump controllers for interface to building automation system.

2.5 HEAT-EXCHANGER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input and include pressure setting less than heat-exchanger working-pressure rating. Select relief valve with sensing element that extends into tank.

1. Option: Separate temperature and pressure relief valves are acceptable instead of combination relief valve.

B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than heat-exchanger working-pressure rating.

C. Vacuum Relief Valves: Comply with ASME PTC 25.3. Furnish for installation in piping.

1. Exception: Omit if heat exchanger has integral vacuum-relieving device.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases of dimensions indicated. Refer to Division 3 Section "Cast-in-Place Concrete" and Division 15 Section "Basic Mechanical Materials and Methods."

3.2 HEAT-EXCHANGER INSTALLATION

A. Install heat exchangers on concrete bases, level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Exception: Where specifically called for, install exchangers on wall.

B. Anchor heat exchangers to substrate.

C. Install temperature and pressure relief valves in top portion of storage tank shells of heat exchangers with storage. Use relief valves with sensing elements that extend into shells. Extend relief valve outlet with water piping in continuous downward pitch to discharge onto closest floor drain. Terminate relief valve piping 6-inches above floor drain. Support the drain piping independent of the relief valve.

D. Install pressure relief valves in water piping for heat exchangers without storage. Extend relief valve outlet with water piping in continuous downward pitch and discharge to closest floor drain. Terminate relief valve piping 6-inches above floor drain. Support the drain piping independent of the relief valve.

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

F. Install heat-exchanger drain piping as indirect waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 15 Section "Plumbing Specialties" for drain valves.

G. Install thermometers on heat-exchanger inlet and outlet piping. Refer to Division 15 Section "Meters and Gages" for thermometers.

H. Install pressure gages on heat-exchanger piping. Refer to Division 15 Section "Meters and Gages" for pressure gages.

I. Fill heat exchanger with water.

3.3 DISTRIBUTION PIPING CIRCULATOR INSTALLATION

A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Install pumps with motor and pump shafts horizontal, unless otherwise directed by the pump manufacturer's written instructions.

D. Control: Install immersion-type thermostats in hot-water return piping.
1. Coordinate timer and/or service switch installation with the Electrical Contractor.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to heat exchangers to allow service and maintenance.

C. Connect hot- and cold-water piping with shutoff valves and unions.

D. Connect boiler water supply and return piping with shutoff valves and unions.

E. Make connections with dielectric fittings where piping is made of dissimilar metal.

F. Install piping adjacent to pumps to allow service and maintenance. Connect recirculated domestic hot water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

G. Install shutoff valve on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Provide unions at each connection where flanges are not integral.

H. Electrical Connections: Power wiring and disconnect switches are specified in Division 16 Sections. Arrange wiring to allow unit servicing.

I. Ground Equipment: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to perform startup service.

B. In addition to manufacturer's written installation and startup checks, perform the following:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment and retest until satisfactory results are achieved.
2. Verify that piping system tests are complete.
3. Check for piping connection leaks.
4. Check for clear relief valve inlets, outlets, and drain piping.
5. Check operation of circulators.
6. Test operation of safety controls, relief valves, and devices.
7. Energize electric circuits.
8. Adjust operating controls.
9. Adjust hot-water-outlet temperature settings. Do not set above 140 deg F (60 deg C) unless piping system application requires higher temperature.

3.6 DEMONSTRATION

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

1. Train Owner's maintenance personnel on procedures for starting and stopping, troubleshooting, servicing, and maintaining equipment.
2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION

SECTION 15513

CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

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.

D. The requirements of Section 15122, "Meters and Gages" apply to work defined by the Section.

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

1.3 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other Work.

1. Wiring Diagrams: Detail power, signal, and control wiring.

C. Source quality-control test reports.

D. ASME "A" Stamp Certification and Report: Submit "A" stamp certificate of authorization, and document hydrostatic testing of piping external to boiler.

E. Startup service reports.

F. Operation and Maintenance Data: For condensing boilers to include in emergency, operation, and maintenance manuals.

G. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of condensing boilers and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASME Compliance: Fabricate and label condensing boilers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. ASHRAE/IESNA 90.1 Compliance: Condensing boilers shall have minimum efficiency according to Table 10-8.

E. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

F. UL Compliance: Test condensing boilers to comply with UL 726, "Oil-Fired Boiler Assemblies."

G. UL Compliance: Test condensing boilers to comply with UL 795, "Commercial-Industrial Gas Heating Equipment."

1.5 COORDINATION

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

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing boilers that fail in materials or workmanship within specified warranty period.

B. Warranty Period for Fire-Tube Condensing Boilers:

1. Leakage, Corrosion and Materials: 10 years from date of Substantial Completion.
2. Heat Exchanger Damaged by Thermal Stress: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

1. Fire-Tube Condensing Boilers:
   a. Cleaver Brooks
   b. Viessmann Manufacturing Company
   c. Buderus

2. Plant Wide Controller
   a. Preferred Untilities
   b. Viessmann Manufacturing Company

2.2 FIRE-TUBE CONDENSING BOILERS

A. Description: Factory-fabricated, -assembled, and -tested fire-tube condensing boiler with heat exchanger sealed pressure-tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

B. Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist boiler movement during a seismic event when boiler base is anchored to building structure.

C. Boiler Characteristics and Capacities: As scheduled on drawings.

D. Fire-Tube Boiler Components:

1. Heat Exchanger: Stainless steel tubes and tube sheets, corrosion-resistant combustion chamber.
2. Pressure Vessel: Carbon steel with welded heads and tube connections.
3. Burner: Natural gas, forced draft. The burner shall be of the unitized venture, gas valve, blower and burner head design. This design shall use a variable speed fan connected to a venturi to simultaneously modulate the air and fuel for a minimum 5:1 turndown. The venturi shall compensate for air pressure, temperature, and humidity to provide the required combustion air.
4. Gas Train: Combination gas valve with manual shutoff and pressure regulator. Low and high gas pressure interlock and test cocks.
5. Casing:
   a. Jacket: 18 gauge sheet metal
   b. Control Compartment Enclosures: NEMA 250, Type 1.
   c. Finish: Powder-coated protective finish.
   d. Insulation: Minimum 2-inch thick fiberglass insulation surrounding the heat exchanger.
   e. Combustion-Air Connections: Inlet and vent duct collars.
6. Mounting base to secure boiler to concrete base.

2.3 HOT-WATER BOILER TRIM

A. Aquastat Controllers: Operating, firing rate, and high limit.

B. Safety Relief Valve: ASME rated. 40 psig.

1. Pressure Setting: 30 psig.

C. Pressure and Temperature Gauges: Pressure and temperature gauges shall be mounted on the water outlet. Gages shall have operating-pressure and -temperature ranges so normal operating range is at approximately 50 percent of full range. Pressure gauge shall be minimum 3-1/2" diameter and temperature gauge shall be minimum 9" long.

D. Boiler Air Vent: Automatic.

E. Drain Valve: Minimum NPS 1-1/2 hose-end gate valve.

2.4 BURNER OPERATING CONTROLS

A. Description: To maintain safe operating conditions, burner safety controls limit the operation of burner.

1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.

2.5 INSTRUMENTATION & CONTROL, PLANT WIDE CONTROLLER (PWC)

A. Manufacturer: Preferred Instruments PWC.
1. Other acceptable manufacturers: None.

B. GENERAL

1. Supply a fully integrated boiler hot water control system to coordinate the operation of two fully modulating hot water boilers, boiler water circulating pumps and boiler water flow control valves in order to maintain Hot Water Supply (HWS) temperature at setpoint and provide boiler thermal shock protection. Additionally the control system shall integrate the control of boiler room the combustion air damper, combustion air variable speed drive. The equipment must be a "state-of-the-art" system, delivering high boiler availability, while maintaining low operating costs.

C. OPERATOR CONTROLS, TRENDS, INDICATIONS AND ALARMS

1. The control system shall include an 16 line x 40 character (or greater) LCD display for boiler sequence control and status, alarm and event summaries, and setup menus for easy operation, tuning and troubleshooting. Alarms, events and operator actions shall be

logged with Time/Date stamp and English language description. The control system shall include a minimum of 200 point memory. The control system shall include a minimum 100x150 pixel historical trending display or a paperless chart recorder or other videographic hardware to permit the logging of at least 32 data points for at least 45 days.

D. RELIABILITY

1. Include hard wired backup stations to permit manual operation of the plant should the control system require service. Manual operation must be possible when the microprocessor is not functioning. Hard wired "Hand-Off-Auto" control switches must be wired directly into every boiler and pump Start/Stop circuit. Each 4-20 mAdc or 0-135 ohm modulating control output must include a hard wired manual backup station with Auto/Manual switch, output control knob and output level indicator (bargraph, analog meter or digital display).

E. COMMUNICATION

1. The Control System shall include simultaneous communication to the Building's Direct Digital Control System (DDC) via RS485 Modbus protocol and to a Personal Computer and an alphanumeric pager via standard telephone lines. The individual boiler limits, lockout, start/stop, warm standby, and firing rate status shall be readable. HWS setpoint, plant firing rate, boiler quantity called to start, boiler selected as lead and all setup parameters shall be readable and writable.
2. Coordinate interface with Controls Contractor and DDC System. Refer to Sections 15900.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code: Section I, for high-pressure boilers and Section IV, for low-pressure boilers.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. Condensing Boilers:
1. The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit.

B. Plant Wide Controller:
1. Prior to shipment, the manufacturer shall perform the following tests:

3.2 After fabrication, the Control Cabinet(s) shall be fully tested, and a copy of the test procedures shall be sent to the consulting engineer and owner. The Owner and or the Engineer at their discretion shall observe this and all other tests. Electrical components shall be functionally tested with all instruments and controls. Settings of all instruments and controls shall be

verified for conformance to these specifications. A certificate of factory testing, together with a copy of the wiring diagram shall be placed in the control cabinet prior to shipment. The UL-508 label shall be affixed to the inside of the cabinet.

3.3 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 BOILER INSTALLATION

A. Install boilers level on concrete base. Concrete base is specified in Division 15 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.

B. Concrete Bases: Anchor boilers to concrete base.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Cast-in-place concrete materials and placement requirements are specified in Division 3.

C. Install gas-fired boilers according to NFPA 54.

D. Assemble and install boiler trim.

E. Install electrical devices furnished with boiler but not specified to be factory mounted.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 15 Section "Basic Mechanical Materials and Methods."

C. Connect gas piping full size to boiler gas-train inlet with union.

D. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

E. Install piping from safety relief valves to nearest floor drain.

F. Connect breeching full size to boiler outlet. Refer to Division 15 Section "Breechings, Chimneys, and Stacks" for venting materials.

G. Install piping adjacent to boiler to allow service and maintenance.

H. Ground equipment according to Division 16 Section "Grounding and Bonding."

I. Connect wiring according to Division 16 Section "Conductors and Cables."

J. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to test, inspect, and adjust boiler components and equipment installation and to perform startup service.

B. Perform installation and startup checks according to manufacturer's written instructions.

C. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.

D. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.

E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Adjust initial temperature set points.

G. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

H. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

I. Prepare written report that documents testing procedures and results.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain condensing boilers. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 15513

SECTION 15550

BREECHINGS, CHIMNEYS, AND STACKS

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 the following:

1. Listed double wall chimneys.
2. Condensing Gas Appliance Vents

1.3 SUBMITTALS

A. Product Data: For the following:

1. Special gas vents.
2. Guy wires and connectors.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welding certificates.

D. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.

C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.5 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.

B. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Listed special gas vents
   a. Heat-Fab Inc.
   b. Metal-Fab, Inc.
   c. Z-FLEX.
   d. Selkirk Inc.; Selkirk Metalbestos and Air Mate.

2.2 LISTED SPECIAL GAS VENT

A. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211 and suitable for condensing-gas appliances.

B. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.

C. Inner Shell: ASTM A 959, Type 29-4C stainless steel.

D. Outer Jacket: Aluminized steel inside the building and stainless steel.

E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Exit cone with drain section incorporated into riser.

2.3 GUYING AND BRACING MATERIALS

A. Cable: Three galvanized, stranded wires of the following thickness:

1. Minimum Size: 1/4 inch in diameter.
2. For ID Sizes 4 to 15 Inches: 5/16 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.2 INSTALLATION OF LISTED VENTS

A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

B. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

D. Slope breechings down ¼" per foot in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

E. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.

F. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.

G. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom.

3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 15550

SECTION 15627

OIL LESS CENTRIFUGAL WATER CHILLERS

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 packaged, air-cooled, electric-motor-driven, centrifugal water chillers with the following features:

1. Variable frequency controller.
2. Microprocessor-based controls complying with ASHRAE 135.

1.3 DEFINITIONS

A. EER: Energy-efficiency ratio.

B. IPLV: Integrated part-load value.

1.4 SUBMITTALS

A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Complete set of manufacturer's certified prints of water chiller assemblies, control panels, sections, and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Operating weight and load distribution.
3. Required clearances for maintenance and operation.
4. Size and location of piping and wiring connections.
5. Wiring Diagrams: Power, signal, and control wiring.

C. Certificates: For certification required in "Quality Assurance" Article.

D. Source quality-control test reports.

E. Startup service reports.

F. Operation and Maintenance Data: For each water chiller to include in emergency, operation and maintenance manual.

G. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. ARI Certification: Signed by manufacturer certifying compliance with requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."

B. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15 for safety code for mechanical refrigeration. Comply with ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.

C. ASME Compliance: Fabricate and label water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Comply with NFPA 70.

E. Comply with UL 1995.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory fully charged with refrigerant or nitrogen.

1.7 COORDINATION

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

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Smardt, Inc.
2. Multistack.

2.2 PACKAGED WATER CHILLERS

A. Description: Factory-assembled and -tested water chiller complete with compressor, evaporator, condenser, controls, interconnecting unit piping and wiring, indicated accessories, and mounting frame.

1. Casing: Weatherproof, constructed of hot-dip galvanized steel with factory-painted finish.
2. Fans: Propeller type, statically and dynamically balanced, with vertical air discharge for high efficiency and low sound; located in its own compartment to eliminate cross flow of condenser air during fan cycling; and equipped with heavy-gage, weather-protected fan guard.
3. Fan Motor: Direct drive, weatherproof, with bearings permanently lubricated, and having built-in current- and thermal-overload protection. Fans shall be variable speed controlled for low noise and capacity control.

B. Fabricate water chiller mounting frame and attachment to the pressure vessel with reinforcement strong enough to resist water chiller movement during a seismic event when the water chiller mounting frame is anchored to the building structure.

C. Water Chiller Characteristics and Capacities: As scheduled on drawings.

2.3 COMPRESSORS

A. Description: Direct drive, high efficiency permanent-magnetic synchronous motor, powered by pulse width modulating power supply.

1. Casing: Cast aluminum, precision machined for minimum clearance about periphery of impellers.
2. Impeller: Two stage, cast-aluminum alloy on carbon- or forged-steel shaft; dynamically balanced.

B. Capacity Control: Modulates infinitely as motor speed is varied across the range. Inlet guide vanes shall be built in to further trim the compressor capacity in conjunction with the variable speed control, to optimize compressor performance at low loads. Throttling range shall be from 100 to 10 percent of full load.

C. Bearings: Radial and axial magnetic bearings to levitate the shaft thereby eliminating metal to metal contact, and thus eliminating friction and the need for oil. In the event of power failure, the compressor shall be capable of allowing for a normal de-levitation and shutdown.

D. Refrigerant and Oil: HCFC-134a.

E. Refrigerant Compatibility: Seals, O-rings, motor windings, and internal water chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

F. Refrigerant Circuit: Two independent circuits. Each circuit shall include an electronic expansion valve, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter drier, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

2.4 HEAT EXCHANGERS

A. Evaporator:

1. Description: Shell-and-tube design, ASME labeled, with internal separator for liquid refrigerant.
2. Shell Material: Carbon steel.
3. Tube Construction: Individually replaceable, expanded into tube sheets.

   a. Material: Copper.
   b. Internal Finish: Enhanced.

4. Water Box: Standard, with design working pressure of 300 psig, and having flanged or grooved mechanical-joint coupling water-nozzle connections with a thermistor-type temperature sensor factory installed in each nozzle.

B. Air-Cooled Condenser: Copper tubes with mechanically bonded aluminum fins, integral subcooling circuit, leak tested at 500 psig.

2.5 INSULATION

A. Cold Surfaces: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type II, for sheet materials.

1. Thickness: 3/4 inch.
2. Adhesive: As recommended by insulation manufacturer.
3. Factory apply insulation over entire surfaces of water chiller components.

   a. Apply adhesive to 100 percent of insulation contact surface.
   b. Seal seams and joints.
   c. After adhesive has fully cured, apply two coats of protective coating to insulation.

2.6 ACCESSORIES

A. Pressure Relief Valve: Single- or multiple-reseating-type, spring-loaded relief valve.

2.7 CHILLER PLANT CONTROLS

A. Control Panel: Stand-alone, microprocessor based control system furnished by chiller manufacturer.

B. Enclosure: Unit-mounted, NEMA 250, Type 1 enclosure, hinged or lockable; factory wired with a single-point power connection and a separate control circuit.

C. Status Display: Multiple-character liquid-crystal display or light-emitting diodes and keypad. Display the following conditions:

1. Date and time.
2. Operating or alarm status.
3. Operating hours.
4. Outside-air temperature if required for chilled-water reset.
5. Temperature and pressure of operating set points.
6. Entering and leaving temperatures of chilled water.
7. Refrigerant pressures in evaporator and condenser.
8. Saturation temperature in evaporator and condenser.
9. Percent of maximum motor amperage.
10. Current-limit set point.
11. Number of compressor starts.

D. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Entering and leaving chilled-water temperature, control set points, and motor load limit. Chilled-water temperature shall be reset based on return water temperature.
3. Current limit and demand limit.
4. External water chiller emergency stop.
5. Chilled water pump VFDs and bypass valve control.
6. Chiller lead/lag as well as sequencing chiller start/stop based on chiller load.
7. Remote air-cooled condenser control.

E. Manually Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

1. Low evaporator pressure and temperature.
2. Low chilled-water temperature.
3. High compressor-discharge temperature.
4. Loss of chilled- or condenser-water flow.
5. Electrical overload.
6. Sensor- or detection-circuit fault.
7. Processor communication loss.
8. Starter fault.

F. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor and control chilled-water set point and chiller-control displays and alarms.

1. The following point shall be monitored by the BMS:
   a. System water supply and return temperature
   b. Ambient refrigerant temperature
   c. System chilled water flow
   d. System chiller enable/disable
   e. System pump on/off
   f. Chilled water setpoint
   g. System demand setpoint

2.8 MOTORS

A. Comply with requirements in Division 15, Section 15050 Basic Mechanical Materials and Methods, "Motors for Mechanical Equipment."

1. Open-drive motors shall have flanged or flexible coupling suitable for direct connection to compressor.

2.9 MAGNETIC ENCLOSED CONTROLLERS

A. Enclosure: Unit mounted, NEMA 250, Type 3R, with hinged access door with lock and key or padlock and key.

B. Control Circuit: 120 V; obtained from integral control power transformer with a control power source of enough capacity to operate connected pilot and indicating and control devices.

C. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of water chiller control microprocessor.

D. Star-Delta Controller: NEMA ICS 2, closed transition.

E. Solid-State, Reduced-Voltage Controller: NEMA ICS 2.

1. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Light-emitting-diode indicators showing motor and control status, including the following conditions:

a. Controller on.
b. Overload trip.
c. Loss of phase.
d. Starter fault.

F. Accessories: Devices shall be factory installed in controller enclosure, unless otherwise indicated.

1. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hard-wired connections.

2.10 SOURCE QUALITY CONTROL

A. Factory test and rate water chillers, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle." Stamp with ARI label.

B. Factory test heat exchangers hydrostatically at 1.50 times the design pressure.

C. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

D. Factory test and inspect water boxes at 150 percent of working pressure.

E. Rate sound power level according to ARI 575 procedure.

F. Rate sound power level according to ARI 370 procedure.

G. Allow Owner access to places where water chillers are being source quality-control tested. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before water chiller installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping, and electrical to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.

1. Final water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

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

3.2 WATER CHILLER INSTALLATION

A. Install water chillers on concrete base. Concrete base is specified in Division 15 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.

B. Concrete Bases: Anchor chiller mounting frame to concrete base.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Cast-in-place concrete materials and placement requirements are specified in Division 3.

C. Vibration Isolation: Rubber pads with a minimum deflection of 0.25 inch. Vibration isolation devices and installation requirements are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Charge water chiller with refrigerant if not factory charged.

F. Install separate devices furnished by manufacturer.

3.3 CONNECTIONS

A. Chilled-water piping installation requirements are specified in Division 15 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Evaporator Connections: Connect inlet to evaporator with controller-bulb well, shutoff valve, thermometer, strainer, pressure gage, and union or flange. Connect outlet to evaporator with shutoff valve, flow switch, balancing valve, thermometer, pressure gage, and union or flange.

D. Refrigerant Pressure Relief Valve Connections: Extend vent piping to the outside without valves or restrictions.

E. Ground water chillers according to Division 16 Section "Grounding and Bonding."

F. Connect wiring according to Division 16 Section "Conductors and Cables."

G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gages are installed.
4. Operate water chiller for run-in period according to manufacturer's written instructions.
5. Check bearing lubrication and oil levels.
6. Verify proper motor rotation.
7. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
8. Verify and record performance of chilled-water flow and low-temperature interlocks.
9. Verify and record performance of water chiller protection devices.
10. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Prepare a written startup report that records results of tests and inspections.

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 15626