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SECTION 23 20 00

HVAC PIPING AND DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.0 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.
- B. All criteria establish within Specification 23 00 00 shall apply to this section unless specifically noted otherwise.
- C. Examine all Drawings and all Sections of the Specifications for requirements and provisions affecting the Work of this Section.

1.1 SUMMARY

- A. All requirements of Section 23 00 00 apply to this section.
- B. Section includes the following:
 - 1. Hydronic heating and cooling systems piping.
 - 2. HVAC pipe hangers and supports.
 - 3. HVAC valves and strainers.
 - 4. Pumps – all system types.

1.2 ACTION SUBMITTALS

- A. Provide original file copies only, scanned file copies are not acceptable. All submittals shall be submitted in hardcopy and editable and searchable electronic format.
- B. Product Data: Include manufacturer's technical literature for each item. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
- C. Specifications, Schedule, and Control Sequence Compliance Statement
 - 1. The manufacturer shall submit a point by point statement of compliance with each specification criteria listed in each paragraph for those submittals listed in Paragraph D: Product Data that are noted with an asterisk (*).
 - 2. The statement of compliance shall consist of a list of all paragraphs (line by line) identified in Part 2 and applicable Part 3 of the specification and

that the unit controls will provide all manufacturer's portions of the control sequences shown on the drawings for which the submitted product in the opinion of the manufacturer complies, deviates, or does not meet.

3. Where the proposed submittal complies fully, the word "comply" shall be placed opposite the paragraph number.
 4. Where the proposed submittal does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.
 5. Verify each field of the associated schedule where associated technical data is presented and sequences are shown on the drawings. Where the submitted material does not "comply" provide the value the submitted equipment will achieve based upon the specified conditions.
 6. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question and the product will be rejected.
 7. Submissions which do not include a point by point statement of compliance as specified shall be disapproved.
- D. Shop Drawings: Provide the following:
1. Valves and strainers: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves. (*)
 2. Listing of pipe types and pressure ratings to be used for each system including: material, schedule number, fittings, etc., with pressure ratings for each system. (*)
 3. Pumps, all types.
 4. Piping hangers, all types.
 5. Pipe stands and supports.
 6. Equipment supports.
 7. Piping connection details for each type of equipment.
 8. Differential Pressure Meter: For each type of balancing valve, automatic flow limiting valve, and pressure and temperature test plugs, including pressure and temperature probes, hoses, flow charts, and carrying cases.
 9. Operating and maintenance manuals.
 10. All start-up and balancing forms.
 11. All pressure testing reports.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Manual Data: For all equipment, hydronic and steam specialties, valves, special-duty valves, along with a valve chart. This chart shall include normal and emergency positions/operation, as well as operation and maintenance manuals.

- B. All product warranties which shall cover materials and labor for a minimum of 1 year (or longer as specified herein for some products) from the date of acceptance.
- C. All documentation required for project completion, including contractor's project completion certificate in accordance with MA code 780CMR 107.6.3 indicating that the installation is in accordance with the approved construction documents and all applicable local, state and federal statutes and regulations. All pertinent deviations shall be specifically noted in the certificate.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be protected during delivery, storage on site, and use from water or other damaging conditions. Any damaged materials shall be replaced with new.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, anchors, and insulation shields specified in Section 23 00 00.
- B. Coordinate clearance requirements with equipment Installer for equipment piping space requirements, including the sizes of all piping vestibules.
- C. Coordinate installation and testing of heat tracing where applicable.

1.6 SCHEDULING

- A. Schedule the placement of any pipe sleeves through concrete and pipe anchor and guide locations with the General Contractor or Construction Manager.
- B. Schedule insulation application after pressure testing systems and, where applicable, after installing and testing heat tracing.

PART 2 - PRODUCTS

2.1 HYDRONIC PIPING AND FITTINGS

- A. Fittings are to be manufactured from CPVC material which meets or exceeds the requirements of ASTM D-1784, Type IV, Grade 1, cell classification 23447B. Pressure pipe used in fabrication must conform to ASTM D-441 and listed by the National Sanitation Foundation (NSF) for potable water applications. Sheet stock material (where used) must conform to ASTM D-1784, cell classification 23447B, Type IV, Grade 1, manufactured without the use of plasticizers or fillers.
- B. All solvent cements used, to conform to ASTM D-2564, listed by NSF for potable use applications. Welding rod used in the manufacture of the above fittings, shall conform to ASTM D-1784, cell class 23447B for CPVC and shall be of a material compatible with the corresponding pipe/sheet stock

- C. Fittings shall be Butt Fusion (machine) welded where feasible or hand welded (fillet welded) by qualified and experienced craftsman trained in the art of thermoplastic welding and fabrication.

2.2 PIPE HANGERS AND SUPPORTS

- A. Hangers shall be as manufactured by Carpenter & Patterson, Inc., Grinnell Corporation, B-Line Systems, ERICO, or equal. Hangers shall transmit the load exclusively to the structure of the building. All hangers and supports to conform to MSS standards SP-58 and SP-69 and ANSI B 31.1.
- B. Hangers for all piping four (4) inches and above shall be adjustable roll type. Hangers for piping below four (4) inches shall be clevis type. Hangers for piping in tunnels on strut support frames shall be roller type, similar to Fig. B379 by B-Line Systems. Additionally, the first five (5) pipe hangers on both sides of all pump piping (suction and discharge) to be pre-compressed spring and double-deflection neoprene style, with 30o hanging rod swing capability, similar and equal in all respects to Mason Industries Model PC 30N, selected by manufacturer for anticipated loading and deflection.
- C. Provide all additional structural steel required for proper installation of hangers, anchors, guides and supports; hangers shall be arranged to maintain the required grading and pitch of piping, to prevent vibration and to provide for expansion and contraction.
- D. Maximum spacing of hangers and supports for steel pipe:

<u>Pipe Size (inches)</u>	<u>Horizontal</u>	<u>Vertical</u>
Up to 1	6 feet	10 feet
1¼-2½	9 feet	15 feet
- E. Reduce Steel pipe spacing to a maximum of ten (10) feet, regardless of pipe, as necessary for fittings, valves, and other concentrated loads.
- F. Horizontal copper tubing shall have maximum hanger spacing of five (5) feet for tubing up to 1-¼ inch and eight (8) feet for 1½ inch and larger. Vertical copper tubing shall have maximum hanger and support spacing of ten (10) feet. Maximum spacing for PVC pipe hangers and supports shall be four (4) feet (horizontal), and ten (10) feet (vertical) with mid-story guides.
- G. Steel or stainless steel tubing shall have maximum hanger and support spacing of eight (8) feet (horizontal) or ten (10) feet (vertical).
- H. If any other piping material is used, the maximum hanger and support spacing shall be the lesser of manufacturer's recommendation or the listed spacing in the mechanical code (adopted edition of IMC Table 305.4).
- I. Branch piping and runouts of over 5 feet shall have at least one (1) hanger or support.
- J. At all copper piping, provide pipe supports with copper finish to eliminate the possibility of galvanic action.

- K. Furnish additional hangers or supports at vertical or horizontal changes of direction and at locations of concentrated loads due to valves, fittings, strainers, and accessories.
- L. Hangers and supports shall provide for two (2) inches of vertical adjustments.
- M. Hanger rods shall be steel, threaded and furnished with two (2) removable nuts at each end of positioning rod and hanger and locking each in place.
- N. Except as otherwise noted, hanger rods shall be of the following sizes:

SCHEDULE OF PIPE HANGER ROD SIZES		
Pipe Sizes (inches)	Single Rod Diameter (inches)	Double Rod Diameter (inches)
1/2-2	3/8	3/8
2 1/2-3	1/2	3/8

- O. Pipe covering protection saddles shall not be loaded to more than 80% of maximum loading as rated by the manufacturer.
- P. Insulated piping insulation shields:
 - 1. Up to three (3) inch pipe size: 18 gauge galvanized steel, located outside the vapor barrier, minimum 180° arc, twelve (12) inches long, or pipe covering protection saddles.
 - 2. 4" pipe size and larger: pipe covering protection saddles.

2.3 VALVES AND STRAINERS VALVES

- A. Ball and butterfly valves are specified in Division 15 Section "Valves."

2.4 CENTRIFUGAL PUMPS

- A. Description of Work
 - 1. Provide pumps and required system trim for water systems including all related appurtenances for a complete and operating systems.
- B. Contractor shall furnish and install new close-coupled inline pump for chilled water and hot water systems as indicated on the drawings.
- C. Pool circulating pumps shall be by the following manufacturers.
 - 1. TACO
 - 2. Bell and Gossett
 - 3. Grundfos
 - 4. Approved Alternates

- D. Pumps shall meet types, sizes, capacities, and characteristics as scheduled on the Equipment Schedule drawings. Pump substitutions shall be provided with connection sizes equal to those scheduled. Pump connections shall not be downsized. Pump substitutions shall not be provided at efficiencies less than those scheduled.
- E. Components
1. The pumps shall be close-coupled, inline for vertical or horizontal installation, in cast iron bronze fitted (or all bronze) construction specifically designed for quiet operation. Suitable standard operations at 250°F and 175 PSIG working pressure. The pump internals shall be capable of being serviced without disturbing piping connections.
 2. The pumps shall have a solid stainless steel shaft that is integral to the motor.
 3. The motor bearings shall support the shaft via heavy-duty permanently lubricated ball bearings.
 4. Pump shall be equipped with an internally-flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall be the unitized type with stainless steel drive tabs, EPR bellows and seat gasket, stainless steel spring, and be of a carbon silicon-carbide design with the carbon face rotating against a stationary silicon-carbide face.
 5. Pump shaft shall connect to a brass impeller. Impeller shall be hydraulically and dynamically balanced, threaded onto the motor shaft.
 6. Pump should be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.
 7. Pump volute shall be of a cast iron design for heating systems or cast brass. The connection style on the cast iron and bronze pumps shall be flanged. Volute shall include gauge ports at nozzles.
 8. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors shall have permanently lubricated ball bearings sized to offset the additional bearing loads associated with the closed-coupled pump design. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
 9. Pumps shall conform to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.
 10. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.
 11. Pump manufacturer shall be ISO-9001 certified.
 12. Each pump shall be factory tested and name-plated before shipment.
- F. Accessories
1. Where noted on the schedule provide one spare mechanical seal for each model type for primary pump.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

- A. Install equipment in accordance with manufacturer's instructions.
- B. Reduction from line size to pump connection size shall be made with eccentric reducers attached to the pump with tops flat to allow continuity of flow.
- C. Furnish and install triple duty valves on the discharge side of all pumps and furnish and install a line size shut-off valve on the suction side of all pumps.
- D. Provide temperature and pressure gauges where and as detailed or directed.
- E. Provide an adequate number of isolation valves for service and maintenance of the system and its components.
- F. Circulating pump shall have sufficient capacity to circulate the scheduled GPM against the scheduled external head (feet) with the horsepower and speed as scheduled and/or as denoted on the drawings. Motors shall be of electrical characteristics as scheduled, denoted and/or as indicated on the electrical plans and specifications. Pump characteristics shall be such that the head of the pump under varying conditions shall not exceed the rated horsepower of the drive motor.
- G. On systems where the final balancing procedure requires the triple duty valve to be throttled more than 25% to attain design flow (on a constant speed pumping system) and no future capacity has been built in to the pump, the pump impeller must be trimmed to represent actual system head resistance. The pump provider and engineer of record, based on the balancing contractor's reports, shall determine the final impeller trim diameter.
- H. All piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections or piping. All piping shall be fitted to the pumps even though piping adjustments may be required after the pipe is installed.
- I. Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturer's instruction and applicable state, federal, and local codes.
- J. Control wiring for remote mounted switches and sensor / transmitters shall be the responsibility of the control's contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal, and local codes.

3.2 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply and return mains over 1-1/2 inches and at all supply (and return, if shown on the details) connection to each piece of equipment.

3.3 PIPING

A. General

1. Piping shall be cut accurately to measurements established at the jobsite, shall be installed without cold springing, and shall properly clear windows, doors and other openings and electrical gear. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Piping shall be free of burrs, oil, grease, and other foreign matter. Piping shall be installed to permit free expansion and contraction without damaging building structure, pipe, joints, or hangers. Changes in direction shall be made with fittings. Vent pipes shall be carried through the roof and shall be properly flashed.
2. Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. A waterproofing clamping flange shall be installed as indicated. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its specified wall, floor, or roof, and shall be cut flush with each surface, except that sleeves through floors and roofs shall extend above the top surface at least 6 inches for proper flashing or finishing. Membrane clamping rings shall be provided where membranes are penetrated. Unless otherwise indicated or required by the sealing system, sleeves shall be sized to provide a minimum clearance of 1/4 inch between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be galvanized steel pipe. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in non-fire rated walls, partitions, and floors shall be sealed as indicated and specified. Metal jackets shall be provided over insulation passing through exterior walls, fire walls, fire partitions, floors, or roofs, shall not be thinner than 0.006 inch thick aluminum, if corrugated, and 0.16 inch thick aluminum, if smooth, and shall be secured with aluminum or stainless steel bands not less than 3/8 inch wide and not more than 8 inches apart. When penetrating roofs, before fitting the metal jacket into place, a 1/2-inch wide strip of sealant shall be run vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of 36 inches above the roof.
3. If the pipe turns from vertical to horizontal, the sealant strip shall be run to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, the metal jacket shall extend from a point below the backup material to a minimum distance of 2 inches above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 12 inches above floor; or when passing through walls above grade, jacket shall extend at least 4 inches beyond each side of the wall.
4. Pipes Passing through Waterproofing Membranes: In addition to the pipe sleeves referred to above, pipes passing through roof or floor waterproofing membranes shall be provided with a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably

formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches above the roof or floor. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Pipes passing through roof or floor waterproofing membrane shall be installed through a galvanized steel sleeve. The annular space between pipe and sleeve or conduit and sleeve shall be sealed by a modular mechanical-type sealing assembly (equal to Link-Seal). The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide a water-tight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor shall provide sleeves of the proper diameters and gauge.

- B. All necessary precautions shall be taken to prevent fire or damage occurring as the result of welding, soldering, brazing or any other hot work, including fire watches.

3.4 WATER PIPING

- A. Unless otherwise indicated, horizontal water piping shall pitch down in the direction of flow with a grade of not less than 1 inch in 100 feet and condensate drain piping shall pitch down in direction of flow with a grade of not less than 1 inch in 30 feet. Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated.
- B. Unless otherwise allowed in Part 2 Piping and Fittings, or shown on the drawings, connections to equipment shall be made with malleable-iron unions or flanges for steel pipe 2 inches or less in diameter and with flanges or grooved joint couplings for pipe 2-1/2 inches or more in diameter. Unions for copper pipe or tubing shall be brass or bronze. Connections between ferrous piping and copper piping shall be electrically isolated from each other with dielectric waterway as specified in the Part 2 Piping and Fittings section of this specification. Where the temperature or pressure of the system is beyond the waterway limits, dielectric couplings or other approved methods shall be used. Reducing fittings shall be used for changes in pipe sizes.
- C. Pipe joints between sections of pipe shall be as listed in the Part 2 Piping and Fittings section in the Schedules for Piping and Fittings tables. Exceptions are pipe and fittings installed in inaccessible conduits or trenches beneath concrete floor slabs or in difficult to access locations such as shafts which shall be welded, soldered or brazed. Some joint types or materials listed may have lower pressure and/or temperature limits and Contractor shall ensure they are only used where those limits will NOT be exceeded.

- D. Welded joints shall be fusion welded in accordance with ASME B31.1 for all water piping over 160 psig and any other piping where B31.1 is required. All other piping shall be welded in accordance with ASME B31.9 unless otherwise stated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be acceptable. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improvement flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength.
1. Beveling: Field and shop bevels shall be in accordance with the recognized standards and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of scale and oxidation before welding.
 2. Alignment: Before welding, the component parts to be welded shall be aligned so that no strain is placed on the weld when finally positioned. Height shall be so aligned that no part of the pipe wall is offset by more than 20 percent of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operation. If tack welds are used, welds shall be of the same quality and made by the same procedure as the completed weld; otherwise, tack welds shall be removed during the final welding operation.
 3. Erection: Where the temperature of the component parts being welded reaches 32 degrees F or lower, the material shall be heated to within 100 degrees F of the system's maximum design temperature for a distance of 3 feet on each side of the weld before welding, and the weld shall be finished before the materials cool to within 200 degrees F of the maximum design temperature.
 4. Defective Welding: Defective welds shall be removed and replaced. Repairing of defective welds shall be in accordance with the applicable standard: ASME B31.9 or B31.1.
 5. Electrodes: After filler metal has been removed from its original package it shall be protected or stored so that its characteristics or welding properties are not affected. Electrode material shall be as required for the pipe material. Electrodes that have been wetted or that have lost any of their coating shall not be used.
- E. Flanges and unions shall be faced true, and made square and tight. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full-face or self-centering flat ring type. The Gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service. Union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.
- F. Threaded joints shall be made with tapered threads properly cut and shall be made perfectly tight with Teflon (polytetrafluoroethylene) tape or equal. Teflon tape shall be non-toxic and rated for piping systems with temperatures to at least 450 degree F and pressures to at least 1,000 psig. Tape shall be applied the male threads only, and in no case to the fittings.

- G. Soldered and Brazed Joints: Pipe and tubing shall be cut square and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned with an abrasive before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connection. Changes in direction of piping shall be made with soldered or brazed fittings only. Solder and flux shall be lead free. Joints for soldered fittings shall be made with silver solder or 95:5 tin-antimony solder, or as specified in the Part 2 Piping specification for the system. Cored solder shall not be used. Joints for brazed fittings shall use brazing alloys with strength equal to B-Ag alloy and have a melting point above 1000 degrees F. Swing joints or offsets shall be provided on all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Care shall be taken to ensure solder is uniformly (360 degrees) drawn into the joint.

3.5 HYDROSTATIC TESTS

- A. Prior to flushing and cleaning and before the application of any insulation, hydrostatic tests shall be made in accordance with applicable ASME requirements. Coordinate with Owner's Representative for witnessing of tests. Testing of buried piping shall be completed both prior to backfilling and again between 2 to 3 months after backfilling. Test reports shall be submitted to the Engineer and Owner's Representative. The systems shall be proved 100% leak tight for four (4) hour tests (no loss in pressure) under gauge pressures of 1-1/2 times the working pressure specified, but not less than the following:
1. PVC Water piping (including pumped steam condensate). Refer to piping manufacturer for test pressure.
- B. Retesting: If any deficiencies are revealed during test, such deficiencies shall be corrected and the tests repeated until the system is leak free at no additional costs to the Owner.

3.6 CONNECTIONS TO EQUIPMENT

- A. Supply and return connections shall be provided by the Contractor unless otherwise indicated. Valves and traps shall be installed in accordance with the manufacturer's recommendations. Unless otherwise indicated, the size of the supply and return pipes to each piece of equipment shall be not smaller than the connections on the equipment. No bushed connections shall be permitted. Change in sizes shall be made with reducers or increasers only.

3.7 BRANCH CONNECTIONS

- A. Branches shall pitch up or down as indicated, unless otherwise specified. Connection shall be made to insure unrestricted circulation, eliminate air pockets, and permit drainage of the system.

3.8 RISERS

- A. The location of risers is approximate. Exact locations of the risers shall be as approved. Steam supply risers shall terminate in a dirt pocket and shall be dripped through a trap to the return line.

3.9 SUPPORTS

- A. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. All piping subjected to vertical movement when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.
- B. Pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as specified as follows:
 - 1. Types 5, 12, and 26 shall not be used.
 - 2. Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.
 - 3. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.
 - 4. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
 - 5. Type 20 attachments used on angles and channels shall be furnished with an added malleable iron heel plate or adapter.
 - 6. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
 - 7. Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle shall be used on all pipe 4 inches and larger.
 - 8. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves.
 - 9. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, except that pipe shall be supported not more than 8 feet from end of risers, and at vent terminations.
 - 10. Type 35 guides using steel, reinforced PTFE or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions and

bearing loads encountered. Where steel slides do not require provision for restraint or lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate. Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.

11. Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.
- C. Piping in trenches shall be supported as indicated on drawings and as required by the manufacturer.
- D. Escutcheons shall be provided at all finished surfaces where exposed piping, bare or covered, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves being visible. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheons shall be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrew.

3.10 GAUGES AND THERMOMETERS

- A. Pressure Gauges
 1. Provide at the following locations:
 - a. At the discharge connection of each pump as well as the inlet and outlet of each pump suction diffuser or strainer.
 - b. At inlet and outlet of each chilled and hot water heating coil (except fan coils, reheat coils, and unit type heaters).
 - c. At inlet and outlet of each heat exchanger.
 - d. In addition to the above, as indicated on diagrams.
 2. All gages shall be provided with isolation valves. Snubbers shall be provided on all pressure gauge connections.
 3. Gauges on piping in the Mechanical Room shall be so placed as to be easily read from the floor without parallax.

3.11 ELECTRIC HEAT PIPE TRACE COORDINATION

- A. Heat trace cable shall be not be installed until the piping has been leak tested and approved. Confirm the following:
 1. The total lengths and diameter of all pipes that need heat tracing.
 2. The required control type for each piping system; pipe temperature, temperature maintenance, etc. Heat trace cable shall be not be installed until the piping has been leak tested and approved.

3.12 DEMONSTRATION

- A. Engage factory-authorized service representatives to train Owner's maintenance personnel to adjust, operate, and maintain all equipment provided in this section.

END OF SECTION 23 20 00