SECTION 23 21 00 - HYDRONIC PIPING AND PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this section apply to the HVAC heating and cooling water systems. Provide pipe, pipe fittings, pumps, and related items required for complete piping system.

B. Related Work: The requirements of Section 23 05 00, Common HVAC Materials and Methods, also apply to this section.

1.2 QUALITY ASSURANCE

A. General: ASTM and ANSI Standards are indicated. In addition, special standards are referenced where neither ASTM nor ANSI Standards are applicable.

B. Labeling: All piping shall be continuously and legibly labeled on each length as required by codes and standards and including as a minimum, country of origin, manufacturers identification marking, wall thickness designation, and applicable standards and approvals. Fittings shall be labeled as required by the referenced standard.

C. Concealed Plastic Piping: No concealed plastic piping inside the building unless approved by Code or Governing Authorities.

D. Definitions: Where piping fluid is not indicated in the following paragraphs, provide similar piping materials for similar fluids.

E. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.
   1. All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.

1.3 STORAGE AND HANDLING

A. Provide factory-applied end caps on each length of pipe and tube. Maintain end caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

1.4 SUBMITTALS

A. Submit catalog data, construction details, performance characteristics for all equipment.

B. Submit operating and maintenance data.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Black Steel Pipe:
   1. Applications:
      a. Chilled water
      b. Condensing water inside
   2. Pipe: Schedule 40, standard black steel pipe ASTM A-106 or A-53.
   3. Threaded Fittings: For above ground installations only.
      a. Banded class 120 cast iron fittings, ANSI B16.4 to 125 psi.
   4. Welding Fittings: Beveled ends, seamless fittings of the same type and class of piping above.
   5. Pipe/Grooved (Standard/Lightwall): Carbon Steel, A-53B/A-106B - Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends to be grooved in accordance with current listed standards conforming to ANSI/AWWA C-606. For use on water systems to +250- degrees F.

B. Black Steel Pipe:
   1. Applications:
      a. Chilled water
      b. Condensing water inside
   2. Pipe: Schedule 40, standard black steel pipe ASTM A-106 or A-53.
   3. Mechanical Couplings for Joining Carbon Steel Pipe
      a. Standard Mechanical Couplings, 2 inch (DN50) through 12 inch (DN300): Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa).
         1) Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13. Basis of Design: Victaulic Style 07.
            a) 2” (DN50) through 8” (DN200): Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designned for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C). Basis of Design: Victaulic Style 107H.
         2) Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source. Basis of Design: V ictaulic Style 77.

a) 2" (DN50) through 8" (DN0200): Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C). Basis of Design: Victaulic Style 177.

b. Flange Adapters: For use with grooved end pipe and fittings, flat faced, for mating to ANSI Class 125 / 150 flanges. Basis of Design: Victaulic Style 741.

c. Grooved couplings shall meet the requirements of ASTM F-1476.

d. Gasket: Synthetic rubber conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.

4. Grooved End Fittings:

a. Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall (9,53 mm wall), or factory-fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.

b. Fittings shall be manufactured of ductile iron conforming to ASTM A-536, forged carbon steel conforming to ASTM A-234, or factory fabricated from carbon steel pipe conforming to ASTM A-53. Fittings shall be manufactured to the dimensional standards ASME B16.9. Orange enamel coated or galvanized.

5. Tooling: Tools shall be manufactured and supplied by pipe fitting manufacturer. Use roll sets or cut groovers compatible with the pipe material and wall thickness per installation instructions.

6. Approved Manufacturers: Victaulic. For alternate manufacturers, see other end treatments listed above.

C. Copper Pipe and Tube:

1. Application:
   a. Non-potable make-up water
2. Pipe: Type L hard temper copper with soldered joints, ASTM B88.
3. Fittings: Wrought copper solder-joint fittings, ANSI B16.22.

D. Copper Pipe and Tube:

1. Application:
   a. Non-potable make-up water
2. UPC approved copper fitting with EPDM o-ring.
3. Press fit connection.
4. Viega Pro Press approved.

E. Polypropylene Pipe

1. Applications:
   a. Condensing water pipe outside

2. Pipe: Pipe shall be manufactured from a PP-R resin (Fusiolen) meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in an extrusion process. Hydronic hot water and heating piping shall contain a fiber layer (faser) to restrict thermal expansion. All pipe shall be manufactured with a 1 mm (0.039") layer of HDPE to protect the pipe from UV exposure. All pipe shall comply with the rated pressure requirements of ASTM F 2389 or CSA B137.11. All pipe shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11. Aquatherm®, Blue Pipe® MF®UV or approved.
3. Fittings: Fittings shall be manufactured from a PP-R resin (Fusiolen) meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11. Fitting manufacture shall match pipe manufacture.

2.2 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Welding Materials: Provide welding materials as determined by the installer to comply with installation requirements.

B. Sleeve Seal: Rubber-link pipe wall and casing closure. Thunderline Link-Seal. For fire rated wall, floor or ceiling penetrations, 3-M "CP-25" caulk, "No. 303" putty and/or "PSS 7904" sealing system.

C. Strainers: "Y-pattern," ductile iron or bronze body (depending on pipe system) rated for pressures indicated with blow-off connection and 20 mesh stainless steel screen or perforated metal basket with 1/16" or 1/8" openings. Basis of Design: Victaulic Style 732.

D. Valves up to 12": Model #'s listed are Nibco unless noted otherwise. Aproved equal are Watts, Hammond, Appollo, Pro Hydronics, and Victualic.
1. Ball (to 2"):
   a. Two-piece, cast bronze body, full port, 600 psi WOG, T/S 585-70.
   b. Two-piece, forged brass body, standard port, 300 psi, Victaulic Series P589.
2. Butterfly 2 1/2" and Larger: Ductile iron body, electroless-nickel coated ductile iron aluminum bronze disc, 300 psi WOG, pressure responsive elastomer seat, and stainless steel stem that is offset from the disc centerline to provide complete 360-degree circumferential seating, suitable for water temperatures to +250 degrees F. Lugged body – LD-2000, Wafer body – WD-2000, Grooved body – Victaulic Vic300 MasterSeal.
3. Check: Bronze or ductile iron body, spring-assisted swing check, 300 psi WOG, T/S-413B and F-918B, Grooved body – Victaulic Series 716.

E. Grooved Joint Lubricants: Lubricate gasket in accordance with manufacturer's recommendations with a lubricant supplied by the coupling manufacturer that is compatible with the gasket elastomer and fluid media. Basis of Design: Victaulic Vic-Lube.

2.3 HEATING AND CHILLED WATER SPECIALTIES

A. Air Vents: Install at all system high points whether shown or not; fabricate of 2" diameter or larger pipe at least 12" long. At the high point of each main install an Armstrong No. 1AV autovent, or equivalent Taco, Bell & Gossett, Armstrong, Dunham-Bush approved substitute.

B. Pumps (350 to 1500 GPM): End Suction, base mounted, flexible coupling, mechanical seals, suitable for hot or cold water service at head and capacity stated on Drawings. Cast iron casing, bronze fitted, roller bearing, 1750 rpm standard frame motor. Impeller size not to exceed 90% of largest diameter impeller which will fit pump casing. Minimum horsepower and efficiency as indicated on Drawings and not less than will be required at any point of the impeller curve. Provide pressure gauge tappings on suction and discharge flanges. Bell & Gossett, Taco, Armstrong, Patterson, or approved substitute. Provide coupling and shaft guard to meet requirements of State Safety Code. Provide shaft grounding at all motors. Aegis Inc. SGR Series or equal.

C. Pumps (Larger than 1500 GPM): Double suction, base mounted, flexible coupling, mechanical seals, suitable for hot or cold water service at head and capacity stated on Drawings. Cast iron casing, bronze fitted, roller bearing, 1750 rpm standard frame motor. Impeller size not to exceed 90% of largest diameter impeller which will fit pump casing. Minimum horsepower and efficiency as indicated on Drawings and not less than will be required at any point of the impeller curve. Provide pressure gauge tappings on suction and discharge flanges. Bell & Gossett, Taco, Armstrong, Patterson, or approved substitute. Provide coupling and shaft guard to meet requirements of State Safety Code. Provide shaft grounding at all motors. Aegis Inc. SGR Series or equal.

D. In-Line Circulators: For application smaller than 50 GPM, pipe mounted, in-line arrangement, suitable for continuous operation at 225 deg. F at head and capacity stated on Drawings. Cast iron casing, stainless steel shaft, graphite bearings, non-metallic rotor, EC motor. Provide with built-in controller capable of operating the pump at constant flow regardless of system hydraulic condition. Minimum horsepower and efficiency as indicated on Drawings. B&G, Armstrong, Patterson, Taco, or approved.

E. Triple Duty Valve: Not allowed. Use check valve, balance valve and shut-off valve.

F. Suction Diffusers: Where indicated on Drawings provide a suction diffuser with stainless steel inlet vanes, combination diffuser-strainer orifice cylinder 20-mesh stainless steel and temporary start-up strainer on the inlet of base mounted pumps. Bell & Gossett, Taco, Armstrong, Thrush, Victaulic, Wheatley**,** Patterson, or approved substitute.

G. Circuit Setter and Balancing Valves:
1. Smaller than 4" for calibrated ball valve style balancing fitting with differential pressure taps, brass or bronze body and trim.
2. 4" & Larger: Cast iron body and bonnet. Brass or stainless steel globe disk with EPDM insert and seal ring. Stainless steel stern, Teflon-graphit packing. Bell & Gossett, Taco or approved.

3. Bell & Gossett, Taco, Wheatley, Pro Hydronics, Nutech, Griswold or approved substitute.

H. Freeze Protection Heat Cable: See Section 23 05 00.

I Flex Connector**:** Straight type design for 2" deflection in any direction, carbon steel end fittings and elbows with 300 series hose and braided cover. Provide with ends to match piping system or flanged. Rated to 250 psi at 70ºF operating and approved for glycol application. Global-Flex, Unisource, Metraflex or Flexonics.

J. Condensing Water Filter / Separation System

1. A completely assembled package shall be supplied for the isolated re-circulation and particle separation /filtration of the fluid in the cooling tower basin in order to prevent accumulation of solids in the tower basin. Flow through the separator package shall be continuous, without interruption for the periodic evacuation of separated solids.
2. The separator package shall provide for initial pre-straining prior to pump suction, followed by directly pumping through a centrifugal action solids from liquid separator and immediate return of flow to the nozzles. Separated solids shall be continuously bled from the separator's collection chamber into the package's integral solids recovery vessel and solids collection bag.
3. Strainer: Cast Iron housing, manual cleaning, 9/32-inch minimum mesh rating.
4. Pump: End-suction, single stage; TEFC motor or open drip proof motor, cast iron or bronze housing, iron or stainless shaft, bronze or cast iron impeller with shaft sleeve and with mechanical seal for shaft sealing. No packing allowed for pump shaft sealing.
5. Separator: Centrifugal-action design, incorporating a tangential inlet to promote the proper velocity necessary for the removal of the separable solids. When operating in the separator flow midrange, single pass separation for solids with a specific gravity of 1.8 and greater shall yield 98% removal of particulate 71 micron and larger. Operating pressure differential shall be between 3 and 10 psig. The centrifugal separator housing shall be constructed of carbon steel and shall have an epoxy coated exterior. The separator housing shall be equipped with a manual air vent and inlet & outlet pressure gauges. Separator inlet and outlet shall be ANSI 150 lb. raised face flanged connections. The separator and system matched pump shall be designed to accommodate flows ranging from scheduled minimum and maximum flows.
6. Separated solids shall collect in the separator lower chamber and shall be continuously purged to a bag filter.
7. Separated particle matter shall spiral downward along the perimeter of the inner separation barrel and into the solids collection chamber, located below the vortex deflector plate.
8. System fluid shall exit the separator by following the center vortex finder in the separation barrel and spiral upward to the separator outlet.
9. Separator design shall include a 150 lb. flanged removable lid for removal and easy access for internal inspection. The separator shall also incorporate a hand-hole clean-out in the solids collection chamber.
10. Solids collection vessel: housing shall be carbon steel 7 x 36" 150 lb rated bag filter with stainless steel basket and coated carbon steel lid with air relief valve. 25 micron fiberfelt solids collection bag.

11. In indictor package: sensing pressure differential through the solids recovery vessel, shall identify when the internal bag requires cleaning and or replacement. A visual indicator shall be installed with a dry contact for remote indication that the bag filter needs servicing.
12. Piping: Schedule 80 PVC
13. Electrical control panel: NEMA-Class UL listed control panel with all electrical components necessary for a complete and operational system.
14. Valves: Ball valves on purge line for isolation of solids handling equipment.
15. Skid plate: carbon steel epoxy coated for separator packages over 4". Packaged systems smaller than 4" use stainless steel structural steel framework.
16. Maximum working pressure and temperature: 150 PSI , 100 F
17. Acceptable Manufacture: PEP Filters, or equal Orival, Lakos.

M. Evaporator Water Strainer
1. A strainer shall be installed on the evaporator inlet of the chiller bank. Strainer shall be first pass type with minimum 60-mesh rating.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. General: Install pipe, tube and fittings in accordance with recognized industry practices. Install each run accurately aligned with a minimum of joints and couplings, but with adequate and accessible unions and flanges for disassembly, maintenance and/or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings.
1. Unions and flanges for disassembly, maintenance and/or replacement of valves and equipment are not required in installations using grooved joint couplings. (The couplings shall serve as disconnect points.)

B. Piping Runs: Route piping close to and parallel with walls, overhead construction, columns and other structural and permanent-enclosure elements of the building (pitched for drainage). If not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building or equipment and avoid diagonal runs. Wherever possible in finished and occupied spaces, conceal piping from view. Do not encase horizontal runs in solid partitions.

3.2 PIPING JOINTS

A. General: Provide joints of the type indicated in each piping system, and where piping and joint as manufactured form a system, utilize only that manufacturer's material.

B. Ferrous Threaded Piping: Thread pipe in accordance with ANSI 82.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave no more than 3 threads exposed.

C. Weld Pipe Joints: In accordance with recognized industry practice and as follows:
   1. Weld pipe joints only when ambient temperature is above 0 degrees F.
   2. Bevel pipe ends at a 37.5 degree angle, smooth rough cuts, and clean to remove slag, metal particles and dirt.
   4. Use pipe clamps or tack-weld joints with 1" long welds; 4 welds for pipe sizes to 10"; 8 welds for pipe sizes up to 20".
   5. Build up welds with a stringer-bead pass, followed by a hot pass, followed by a cover of filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusion.
   6. Do not weld out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.
   7. Install forged branch-connection fittings wherever branch pipe is indicated, or install regular "T" fitting at Contractor's option.

D. Grooved Pipe Joints: Prior to any pipe assembly manufacturer's representative shall conduct a training session with all installers of these systems present. During construction manufacturer's representative shall visit the site once to ensure best practices in grooved product installation are being followed per installation guidelines. Comply with fitting manufacturer's instructions for making grooves in pipe ends. Remove burrs and ream pipe ends. Assemble joints in accordance with manufacturer's instructions.
   1. Installation:
      a. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.
      b. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
      c. Install the piping system in accordance with the latest Victaulic installation instructions.
      d. Install piping of the same type only.
      e. Couplings installation shall be complete when visual metal-to-metal contact is reached. Tongue-and-recess type couplings, or any coupling that requires exact gapping of bolt pads at required torque ratings, are not permitted.
   2. Training: A factory trained representative (direct employee) shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation.
   3. Application:
      a. A representative of the pipe and fitting manufacturer shall periodically visit the job site and review installation. Contractor shall remove and replace any improperly installed products.
      b. Grooved mechanical pipe couplings, fittings, valves and other grooved components may be used as an option to welding, threading or flanged methods.
      c. All grooved components shall conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-31.9, ASME, UL/ULC, FM, IAPMO or BOCA.
      d. Grooved end product manufacturer to be ISO-9001 certified.
      e. Poly Propylene Pipe Installation
         1) Installers shall be trained and certified to install the pipe according to the manufacturer's guidelines. Contact your local Aquatherm representative for training.

2) Installation must be accomplished with the proper tools for installing Aquatherm piping following manufacturer's instructions.
3) 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.
4) Install Hydronic piping level and plumb.
5) Fusion Welding of Joints
   a) Install fittings and joints using socket-fusion, elecrofusion, or butt-fusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
   b) Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
   c) Prior to joining, the pipe and fittings shall be prepared in accordance with ASTM F 2389 and the manufacturer's specifications. The black plastic coating on the UV pipe shall be removed before fusing the pipe.
   d) Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.

E. Changes in Direction: Use fittings for all changes in direction. Run lines parallel with building surfaces.

F. Line Grades: Pitch hydronic piping 1" to 40' minimum to low point drips or drains.

G. Unions and Flanges: At all equipment to permit dismantling and elsewhere as consistent with good installation practice.

H. Expansion: Provide loops, swing joints, anchors, runouts and spring pieces to prevent damage to piping or equipment.

3.3 VALVES

A. General: Provide factory fabricated valves of the type, body material, temperature and pressure class, and service indicated. Bronze gate, globe and check valves shall comply with MSS-SP-80. Ball valves shall comply with MSS-SP-110. Iron gate and globe valves shall comply with MSS-SP-70. Iron check valves shall comply with MSS-SP-71. Butterfly valves shall comply with MSS-SP-67. Valve size same as connecting pipe size.

B. Acceptable Manufacturers: Milwaukee, Crane, Grinnell, Nibco, Hammond, Stockham, Legend, Watts, and Walworth. Grooved end valves Victaulic, Gruvlock, or accepted substitute. NIBCO numbers are given except as noted. Where possible, provide valves from a single manufacturer.

C. Valve Styles: See individual Division 23 sections for valve styles.

D. Butterfly Valve Operators: Locking lever for shut-off service; “Memory Stop” for lever handle with 10-position throttling plate for throttling service; gear operator with babbitt sprocket rim for chain-operated valves and gear operators on all 8” or larger valves.

E. Butterfly Valve Style: Lug-type with cap screws for all valves utilized for equipment isolation for servicing. Lug and grooved style valves shall be capable for use as isolation valves and recommended by manufacturer for dead-end service at full system pressure.

F. Insulated Valves: Install extended-stem valves in all piping specified as insulated, and arrange in the proper manner to receive insulation.

G. Mechanical Actuators: Provide mechanical actuators with chain operators where indicated, where valves 4" and larger are mounted more than 7' above the floor, and where manual operation is difficult because of valve size, pressure differential or other operating conditions. Drop chains to 6'-6" above the floor.

H. Selection of Valve Ends (Pipe Connections): Select and install valves with ends matching the types of pipe/tube connections.

3.4 VALVE INSTALLATION

A. General: Comply with the following requirements:
   1. Install valves where required for proper operation of piping and isolation of equipment, including valves in branch lines where necessary to isolate sections of piping, and where shown on the drawings. Install valves at low points in piping systems that must be drained for service or freeze protection.
   2. Locate valves in accessible spaces (or behind access panels) and so that separate support can be provided when necessary.
   3. Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward from a horizontal plane.

B. Insulated Valves: Install extended-stem valves in all piping specified as insulated, and arrange in the proper manner to receive insulation.

C. Valve Access: Provide access panels to all valves installed behind walls, in furring or otherwise inaccessible.

3.5 MISCELLANEOUS PIPING EQUIPMENT

A. Floor, Wall and Ceiling Plates: Chrome plated pressed steel or brass screw locked split plates on all pipe penetrations in finished spaces.

B. Strainers: Install in a manner to permit access for cleaning and screen removal and with blow-off valve.

C. Sleeves: At all penetrations of concrete or masonry construction. PVC, 24 gauge galvanized steel or Schedule 40 galvanized steel pipe. Use steel pipe sleeves through beams, footings, girders or columns and for all penetrations of walls or floors below grade. Where floor finish is ceramic tile, terrazzo, or similar material extend standard steel pipe sleeves 1-1/2" above finished floor. Fabricate sleeves 1" diameter larger than pipe or insulation. PVC and sheet metal sleeves at non-structural penetrations only.

D. Sleeve Caulking: Grout uninsulated pipe with cement mortar or approved waterproof mastic. All caulking or grouting shall extend full depth of sleeve. Install UL sealing caulk, putty and/or system at all penetrations of fire rated walls, floors and ceiling.

E. Valves: Install valves in accordance with Section 23 05 00. Install control valves specified in other division 23 sections.

3.6 EQUIPMENT INSTALLATION

A. Installation and Arrangement: Install and arrange as shown on the Drawings. Comply with manufacturer's recommendations for installation connections and start-up.

B. Lubrication: Lubricate all moving and rotating parts in accordance with the manufacturer's recommendations prior to start-up.

C. Expansion Joint and Compensator Installation: Carefully align joint or compensator and make proper allowance for temperature of pipe at time of installation.

D. Air Vents: Conduct 1/4" copper tubing from high end of air chambers to accessible locations and terminate with screwdriver cock. Conduct 1/4" copper tubing from outlets of automatic air vents to floor drains indicated or to the outside when approved by Governing Authorities.

E. Press Fittings: MegaPress Cold Press Mechanical Joint Fittings shall be installed in accordance with the manufacturer’s installation instructions. The protective corrosion coating shall be removed from the outside of the pipe end. The pipe shall be fully inserted into the fitting and the pipe marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the pipe to assure the pipe is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer.

3.7 CLEANING

A. General: Clean all dirt and construction dust and debris from all mechanical piping systems and equipment and leave in a new condition. Touch up paint where necessary.

B. Chilled Water Piping Systems:
1. Isolate chiller at connection point. Provide temporary circulation pump at tie in and circulate cleaning agent.
2. Add cleaning chemical in proper concentration to clean system of manufacturing and installation contamination and residue.

3. At all chilled water coils in mechanical rooms. Remove strainer basket and clean. Provide new seal and re-install.
4. Fill, vent and circulate the system with this solution at design operating temperature. After circulating for four hours, bleed out cleaning solution by the addition of fresh water to the system.
5. Test for pH and add sufficient amount of the cleaning chemical to obtain a pH between 7 and 8.
6. Clean all strainers after the system has operated for one week.
7. The entire system shall be tested and treated per above.

3.8 TEST

A. General:
1. Minimum duration of two hours or longer, as directed for all tests. Furnish report of test observation signed by qualified inspector. Make all tests before applying insulation, backfilling, or otherwise concealing piping or connecting fixtures or equipment. Where part of the system must be tested to avoid concealment before the entire system is complete, test that portion separately, same as for entire system.
2. Provide all necessary temporary equipment for testing, including pump and gauges. Remove control devices before testing and do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for the indicated pressure and time.
3. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.

B. Repair:
1. Repair piping system sections which fail the required piping test by disassembly and re-installation, using new materials to the extent required to overcome leakage. Do not use chemical stop-leak compounds, solder, mastics, or other temporary repair methods.
2. Drain test water from piping systems after testing and repair work has been completed.

C. New Chilled and Condensing Water Piping: 75 psig hydrostatic for 30 psig systems without loss for four hours.

D. Tanks and Equipment: Hydrostatic pressure to 1.5 times operating pressure.

3.9 START-UP

A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect equipment installation, to include electrical and piping connections. Report results to A/E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.

B. Engage a factory authorized service representative to perform startup service. Verify water source for compliance with manufacturer's requirements for flow and temperature. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.

C. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the entire unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

END OF SECTION