

**PART 1 GENERAL****1.01 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 0500, Common HVAC Materials and Methods, also apply to this section.

**1.02 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.

**1.03 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.

**1.04 SUBMITTALS**

- A. Submit catalog data, construction details, performance characteristics for all equipment.
- B. Submit operating and maintenance data.

**PART 2 PRODUCTS****2.01 PIPING MATERIALS**

- A. Black Steel Pipe:
  - 1. Applications:
    - a. Heating water
  - 2. Pipe: Systems 10" or smaller, operating below 400 psi, 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.
    - b. Banded class 150 malleable iron fittings, ANSI B16.3 to 150 psi.

4. Welding Fittings: Beveled ends, seamless fittings of the same type and class of piping above.
  5. Flanged Fittings: For above ground installations only.
    - a. Class 125 cast iron fittings, ANSI B16.2 including bolting to 125 psi.
    - b. Class 150 steel welding neck flanges, ANSI B16.9 to 150 psi.
    - c. Class 250 cast iron fittings, ANSI B16.1 including bolting to 250 psi.
    - d. Class 300 steel welding neck flanges, ANSI B16.9 to 300 psi.
    - e. Facing and Gasketing: Selected for service pressures and temperatures. Full-faced for cast iron and raised face for steel flanges.
- B. Copper Pipe and Tube:
1. Application:
    - a. Heating water
  2. Pipe: Type L hard temper copper with soldered joints, ASTM B88.
  3. Fittings: Wrought copper solder-joint fittings, ANSI B16.22.
  4. Preinsulated Piping: Type K solder joint copper piping with 1" thick urethane insulation protected by 20 gauge PVC outer jacket. Rovanco "Insul/80," equivalent Rikwil or approved substitute.
- C. Plastic Pipe:
1. Application:
    - a. Snowmelt system below slab or where concealed.
  2. Pipe:
    - a. Cross-linked polyethylene (PEX) tubing manufactured by PEX-a or Engel Method for closed loop heating service (with oxygen barrier): Tested/listed to ASTM E84, ASTM F876 and F877, and CSA B137.5 listed certified to NSF standards 14 and 61. Rated for 100 PSI at 180° F. Wirsbo AQUAPEX or approved.
  3. Pre-insulated PEX: Insulation equivalent to 2" of fiberglass with carrier CPE pipe. Install with no joints below grade. PEX pipe to match #2 above. Rovanco, Ecoflex or approved.
  4. Fittings: ASTM F1960 cold expansion fittings. Provide fittings of the type matching piping manufacture and recommended by the piping manufacturer for the service indicated.

## 2.02 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

- A. Insulating (Dielectric) Fittings: Provide standard products recommended by the manufacturer for use in the service indicated, and which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and reduce corrosion. Victaulic "Clear Flow."
- B. Welding Materials: Provide welding materials as determined by the installer to comply with installation requirements.
- C. Soldering and Brazing Materials: Provide soldering materials as determined by the installer to comply with installation requirements.
1. Tin-Antimony Solder: ASTM B32, Grade 95TA.
  2. Lead-Free Solder: ASTM B32, Grade HB. Harris "Bridgit" approved.
  3. Silver Solder: ASTM B32, Grade 96.5TS.
- D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges. Pressure and temperature rating required for the service indicated.
- F. 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.

- G. Strainers: "Y-pattern," 300-psig ductile iron body, or Class 125 cast iron body with tapped blow-off connection and removable 20 mesh stainless steel screen. Victaulic Style 732 / W732, NIBCO, or engineer approved equal.
- H. Tracer Wire: 14 gauge, single strand, copper wire with blue insulation for water, green for sanitary and storm sewers, and yellow for gas. 3M "DBY" direct bury splice kit required at all splices.
- I. Valves up to 12":
  - 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 CWP, Victaulic P589.
  - 2. Gate (to 3"): Bronze body, non-rising stem, 200 psi WOG, T/S-133.
  - 3. Gate (4" to 12"): Iron body, non-rising stem, solid wedge, bolted bonnet, 200 psi WOG, F-619.
  - 4. Globe (shutoff): Bronze body, Teflon disc, 200 psi WOG, T/S-211Y.
  - 5. Globe (throttling): Bronze body, full plug stainless steel disc, 600 psi WOG, T-276AP.
  - 6. Butterfly: Ductile iron body, aluminum bronze, stainless steel, or electroless-nickel coated ductile iron disc, pressure responsive seat, and stem offset from the disc centerline to provide complete 360-degree circumferential seating. 300 psi WOG, Lugged body – LD-2000, Wafer body – WD-2000, Grooved body Victaulic Vic-300 MasterSeal / AGS-Vic300.
  - 7. Check: Bronze or iron body spring-assisted swing check for vertical or horizontal installation, 230 psi WOG, T/S-413B and F-918B, or Victaulic Series 716 and W715.

### 2.03 HEATING 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. Triple Duty Valve: Combination spring loaded vertical check, calibrated balancing and shut off valve with balance point memory in angle or straight pattern as required or as shown on the Drawings. Bell & Gossett, Taco, Armstrong, Thrush, Victaulic, Wheatley or approved substitute.
  - 1. Triple Duty Valve Assembly: Valve assembly shall consist of a Victaulic Vic300 MasterSeal butterfly valve with memory stop and a Series 779 Venturi-Check. For 14" and larger sizes, AGS-Vic300 butterfly valve with a Series W715 check valve.

Automatic Flow Control Valves: Stainless steel ball valve with blow-out proof stem. Valve shall include forged brass body rated for 600 WOG and 325 deg. F. with differential pressure taps. Teflon ball seals and stainless steel flow cartridge. Flow control cartridge shall be replaceable for altering flows within the range of the valve size. Provide with label of flow rate. Nexus UM series or equal Griswold, TA Hydronics or approved
- C. Circuit Setter and Balancing Valves: Globe style with calibrated handle style balancing fitting with differential pressure taps, brass or bronze body and trim. TA Hydronics STAD series, or equal Nexus, Wheatley or approved substitute. Valves shall only be used where specifically called out for balance valve, otherwise use flow control valve.
- D. Flow Balancing Valves: Globe valve style balancing valve with differential pressure taps, locking position stop, and position readout. Brass or bronze body and trim up to 2", iron body over 2". Nibco, Tour & Andersson, Armstrong, Oventrop, or approved substitute.

1. Coil-Hook-up Connections: Victaulic Koil-Kits Series 799 or 79V may be used at coil connections. The kit shall include a Series 786/787/78K circuit balancing valve, Series 78Y Strainer-Ball, Series 78U Union-Port fitting, with Series 78T ball valve and required coil hoses. A Style 793 and/or 794 differential pressure controller shall be provided as required. A meter shall be provided by the valve manufacturer that shall remain with the building owner after commissioning.
- E. Pressurized Precharged Expansion Tank: Precharged diaphragm type hydropneumatic tank with all necessary air elimination fittings. Install with ball valve on piping connection. Amtrol, Taco, Bell & Gossett, Armstrong, Wheatley or approved substitute.
- F. Air Separators: Coalescing or centrifugal separation operation. Fabricated steel rated for 125 psi pressure with threaded, grooved, or flanged connections. Unit pressure drop shall not exceed one foot at design flow rate. Unit shall include internal air coalescing medium or galvanized steel strainer and perforated air collecting tube. Submittals shall include unit air and dirt elimination efficiencies at design flow. Include sediment collection area and bottom blowdown valve with hose connection. Install with high capacity float operated air vent. Spirovent, Bell & Gossett, Thrush, Taco, Armstrong, Caleffi, or approved.

## 2.04 HYDRONIC PUMPS

- A. In-Line Circulators: Pipe mounted, in-line arrangement with mechanical seals with ceramic seal seats, suitable for continuous operation at 225 deg. F at head and capacity stated on Drawings. Cast iron impeller casing, oil lubricated bronze journal and thrust bearings or regreasable ball bearings (manufacturer's standard), 1750 rpm standard frame motor. Provide pressure gauge tapings on suction and discharge flanges. 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. Impeller to be retrimmed during balancing as required, see Section 230590. Bell & Gossett, Taco, Armstrong, Aurora, Pattereson, Wilo, Grundfos or approved substitute.
- B. Small In-Line Circulators: Pipe mounted, in-line arrangement suitable for hot or cold water service at head and capacity stated on Drawings. Cast iron bronze casing, pumped, fluid lubricated and cooled aluminum oxide upper and lower radial bearings and metal impregnated carbon thrust bearing, stainless steel shaft and impeller and liquid filled. Minimum horsepower as indicated on Drawings and not less than will be required at any point of the impeller curve. Provide pressure gauge tapings on suction and discharge flanges. Mount in a manner to allow disassembly of pump and motor without disturbing piping. Taco, Grundfos, Wilo, Bell & Gossett, or approved substitute.

## 2.05 BACKFILL MATERIALS

- A. Subbase Materials: A graded mixture of gravel, sand, crushed stone or crushed slag.
- B. Finely-Graded Subbase Material: Well graded sand, gravel, crushed stone or crushed slag, with 100% passing a 3/8" sieve.
- C. Backfill Material: Soil material suitable for compacting to the required densities, and complying with AASHTO designation M145, Group A-1, A-2-4, A-2-5. or A-3.

## 2.06 SNOW MELT CONTROLLER

- A. Provide Uponor single zone snow melt control system with slab ice sensor.

- B. Provide all conductors, conduit, sensors, and devices to operate system. See drawings for control schematic. Refer to manufactures installation guide for required conductor size and wiring.

## **PART 3 EXECUTION**

### **3.01 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.

Comply with ANSI B31 Code for Pressure Piping.

- 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.
- C. Piping: Install for services as specified in Part 2. The following are Contractor's options.
  - 1. Heating Water Piping: Standard black schedule 40 steel pipe and 125 pound black cast screwed or approved welding fittings for pressures up to 75 psi. Welded connections on all piping underground, piping in tunnel or tile or otherwise inaccessible and on all equipment room headers 4" and over. Weldolets, Threadolets, or schedule 80 shaped nipples may be used for take-offs up to half the nominal size of main.

### **3.02 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. Solder Copper Tube and Fitting Joints: In accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in a manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens. "T-Drill" field formed tees may be utilized where the main is at least two pipe sizes larger than the branch.
- D. Braze Copper Tube and Fitting Joints: Where indicated, in accordance with ANSI/ASME B31.5. Pass a slow stream of dry nitrogen gas through the tubing at all times while brazing to eliminate formation of copper oxide.
- E. 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.
  3. Install welding rings for butt welded joints.
  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.
- F. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gasket.
- G. Plastic Pipe/Tube Joints: Comply with manufacturer's instructions and recommendations, and with applicable industry standards:
1. Heat Joining of Thermoplastic Pipe: ASTM D-2657.
  2. Making Solvent-Cemented Joints: ASTM D-2865 and ASTM F-402.
- H. Insulating (Dielectric) Fittings: Comply with manufacturer's instructions for installing unions or fittings. Install in a manner which will prevent galvanic action and stop corrosion where the "joining of ferrous and non-ferrous piping" is indicated. Use brass valve or nipple with diameter to length ratio of 1:8 or greater in place of dielectric unions for copper to ferrous pipe.
- I. Changes in Direction: Use fittings for all changes in direction. Run lines parallel with building surfaces.
- J. Line Grades: Pitch hydronic piping 1" to 40' minimum to low point drips or drains.
- K. Unions and Flanges: At all equipment to permit dismantling and elsewhere as consistent with good installation practice.
- L. Unions and flanges for servicing and disconnect are not required in installations with grooved mechanical joint couplings. (The couplings shall serve as disconnect points.)
- M. Expansion: Provide loops, swing joints, anchors, runouts and spring pieces to prevent damage to piping or equipment.
1. For water systems, Victaulic flexible couplings may be used to accommodate thermal growth, contraction, and for the elimination of expansion loops. (In accordance with the manufacturer's written recommendations.) Where loops are required, use flexible couplings on the loop.

### 3.03 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.

### 3.04 EXCAVATING

- A. General: Do not excavate for mechanical work until the work is ready to proceed without delay, to minimize the total time lapse from excavation to completion of backfilling. Comply with all applicable Federal and state safety regulations.
- B. Width: Excavate for piping with 6" to 9" clearance on both sides of pipe, except where otherwise shown or required for proper installation of pipe joints, fittings, valves and other work. Excavate for other mechanical work to provide minimum practical but adequate working clearances.
- C. Depth for Direct Support: For work to be supported directly on undisturbed soil, do not excavate beyond indicated depths, and hand-excavate the bottom cut to accurate elevations. Support the following work on undisturbed soil at the bottom of the excavations:
  - 1. Piping of 5" and less pipe/tube size.
  - 2. Cast-in-place concrete.
- D. Depth for Subbase Support: For large piping (6" pipe size and larger), tanks and where indicated for other mechanical work, excavate for installation of subbase material in the depth indicated, or, if not otherwise indicated, 6" below bottom of work to be supported.
- E. Depth for Exterior Piping: Excavate for exterior water-bearing piping so that the top of piping will not be less than 3' vertical distance below finished grade.
- F. Depth for Unsatisfactory Soil Conditions: Where unsatisfactory soil condition at the bottom of excavation exists, excavate additional depth as directed to reach satisfactory soil-bearing condition. Backfill with subbase material, compacted as directed, to indicated excavation depth.
- G. Rock and Boulder Removal: Refer to Division 1 for procedure on additional work, including additional excavating and backfilling, rock removal, etc.
- H. Excavated Materials: Store excavated material (temporarily) near the excavation, in a manner which will not interfere with or damage the excavation or other work. Do not store under trees (within the drip line). Retain excavated material which complies with the requirements for backfill material. Dispose of excavated material which is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material.

Remove unused material from project site, and dispose of in a lawful manner.
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**3.05 BACKFILLING**

- A. Do not backfill until installed mechanical work has been tested and accepted wherever testing is indicated. Install drainage fill where indicated, and tamp to a uniform firm density. Backfill with finely-graded subbase material to 6" above wrapped, coated and plastic piping and tanks, and to center line of other tanks (where recommended by tank manufacturer, use "pea gravel" backfill). Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to the required densities. Do not backfill with frozen materials.

**3.06 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 and Architect.
- E. Pumps: Mount in a manner to allow disassembly of pump and motor without disturbing piping.
- F. Mechanical contractor and balancing contractor shall be trained on installation, connection, and balancing procedures by certified representative of differential pressure control valves.

**3.07 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. Heating Water Piping Systems:
  - 1. Add cleaning chemical in proper concentration to clean system of manufacturing and installation contamination and residue.
  - 2. 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.
  - 3. Test for pH and add sufficient amount of the cleaning chemical to obtain a pH between 7 and 8.
  - 4. Clean all strainers and remove start-up strainers (from suction diffusers) after the system has operated for one week.

**3.08 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. Heating, 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.

**END OF SECTION**