

SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Water piping to connect HVAC equipment, including the following:
 - 1. Chilled water and drain piping.
 - 2. Extension of domestic water make-up piping.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- D. Section 23 07 11, HVAC AND BOILER PLANT INSULATION: Piping insulation.
- E. Not used
- F. Section 23 09 23, INSTRUMENTATION AND CONTROLS FOR HVAC: Temperature and pressure sensors and valve operators.

1.3 QUALITY ASSURANCE

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC, which includes welding qualifications.
- B. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and not more than one year old.
- C. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be the same manufacturer as the grooved components.
 - 1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Pipe and equipment supports.
 - 2. Pipe and tubing, with specification, class or type, and schedule.
 - 3. Pipe fittings, including miscellaneous adapters and special fittings.
 - 4. Flanges, gaskets and bolting.
 - 5. All specified hydronic system components.

- C. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and not more than one year old.
- D. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- E. As-Built Piping Diagrams: Provide drawing as follows for cooling coil condensate piping systems and equipment.
 - 1. One complete set of reproducible drawings.
 - 2. One complete set of drawings in electronic format (Autocad, pdf, or other approved format).

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
 - B1.20.1-83.....Pipe Threads, General Purpose (Inch)
 - B16.5-03.....Pipe Flanges and Flanged Fittings
 - B16.9-03.....Factory-Made Wrought Buttwelding Fittings
 - B16.11-05.....Forged Fittings, Socket-Welding and Threaded
 - B16.14-91.....Ferrous Pipe Plugs, Bushings, and Locknuts with
Pipe Threads
 - B16.22-01.....Wrought Copper and Copper Alloy Solder-Joint
Pressure Fittings
 - B16.23-02.....Cast Copper Alloy Solder Joint Drainage Fittings
 - B16.24-01.....Cast Copper Alloy Pipe Flanges and Flanged
Fittings, Class 150, 300, 400, 600, 900, 1500 and
2500
 - B31.9-04.....Building Services Piping
 - B40.100-05.....Pressure Gauges and Gauge Attachments
- C. American National Standards Institute, Inc. (ANSI):
 - B16.1 00.....Cast Iron Pipe Flanges and Flanged Fittings,
Class 25, 125 and 250
 - B16.3 00.....Malleable Iron Threaded Fittings Classes 150 and
300
 - B16.5 03.....Pipe Flanges and Flanged Fittings NPS ½ through
NPS 24
 - B16.9 03.....Factory Made Wrought Butt Welding Fittings

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- B16.11 01.....Forged Fittings, Socket Welding and Threaded
- B16.14 91.....Ferrous Pipe Plugs, Bushings and Locknuts with
Pipe Threads
- B16.18-01.....Cast Copper Alloy Solder joint Pressure fittings
- B16.22 00.....Wrought Copper and Bronze Solder Joint Pressure
Fittings
- B16.24 01.....Cast Copper Alloy Pipe Fittings and Flanged
Fittings: Class 150, 300, 400, 600, 900, 1500 and
2500
- B31.1 01.....Power Piping
- D. American Society for Testing and Materials (ASTM):
 - A47/A47M-99 (2004).....Ferritic Malleable Iron Castings
 - A53/A53M-06.....Standard Specification for Pipe, Steel, Black and
Hot-Dipped, Zinc-Coated, Welded and Seamless
 - A106/A106M-06.....Standard Specification for Seamless Carbon Steel
Pipe for High-Temperature Service
 - A126-04.....Standard Specification for Gray Iron Castings for
Valves, Flanges, and Pipe Fittings
 - A181/A181M-01.....Standard Specification for Carbon Steel Forgings,
for General-Purpose Piping
 - A183-03 Standard Specification for Carbon Steel Track
Bolts and Nuts
 - A216/A216M-04 Standard Specification for Steel Castings, Carbon,
Suitable for Fusion Welding, for High Temperature
Service
 - A234/A234M 04 Piping Fittings of Wrought Carbon Steel and Alloy
Steel for Moderate and High Temperature Service
 - A307-04 Standard Specification for Carbon Steel Bolts and
Studs, 60,000 PSI Tensile Strength
 - A536-84 (2004) Standard Specification for Ductile Iron Castings
 - A 615/A 615M-04 Deformed and Plain Carbon Steel Bars for Concrete
Reinforcement
 - A653/A 653M-04 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron
Alloy Coated (Galvannealed) By the Hot-Dip Process
 - B32-04 Standard Specification for Solder Metal
 - B61-02 Standard Specification for Steam or Valve Bronze
Castings
 - B62-02 Standard Specification for Composition Bronze or
Ounce Metal Castings

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- B88-03 Standard Specification for Seamless Copper Water
Tube
- B209 04 Aluminum and Aluminum Alloy Sheet and Plate
- C177 97 Standard Test Method for Steady State Heat Flux
Measurements and Thermal Transmission Properties
by Means of the Guarded Hot Plate Apparatus
- C478-03 Precast Reinforced Concrete Manhole Sections
- C533 03 Calcium Silicate Block and Pipe Thermal Insulation
- C552 03 Cellular Glass Thermal Insulation
- D 3350-02 Polyethylene Plastics Pipe and Fittings Materials
- C591-01 Unfaced Preformed Rigid Cellular Polyisocyanurate
Thermal Insulation
- D1784 03 Rigid Poly (Vinyl Chloride) (PVC) Compounds and
Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
- D1785 03 Poly (Vinyl Chloride) (PVC) Plastic Pipe,
Schedules 40, 80 and 120
- D2241 04 Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe
(SDR Series)
- D2464 99 Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe
Fittings, Schedule 80.
- D3139 98 Joints for Plastic Pressure Pipes Using Flexible
Elastomeric Seals
- F439-06 Standard Specification for Chlorinated Poly
(Vinyl Chloride) (CPVC) Plastic Pipe Fittings,
Schedule 80
- F441/F441M-02 Standard Specification for Chlorinated Poly
(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40
and 80
- F477-02 Elastomeric Seals Gaskets) for Joining Plastic
Pipe
- E. American Water Works Association (AWWA):
- C110/03.....Ductile Iron and Grey Iron Fittings for Water
- C203 00.....Coal Tar Protective Coatings and Linings for
Steel Water Pipe Lines Enamel and Tape Hot
Applied
- F. American Welding Society (AWS):
- A5.8/A5.8M-04.....Specification for Filler Metals for Brazing and
Braze Welding
- B2.1-02.....Standard Welding Procedure Specification
- G. Copper Development Association, Inc. (CDA):
- CDA A4015-95.....Copper Tube Handbook

- H. Expansion Joint Manufacturer's Association, Inc. (EJMA):
EMJA-2003.....Expansion Joint Manufacturer's Association
Standards, Eighth Edition
- I. Manufacturers Standardization Society (MSS) of the Valve and Fitting J.
National Sanitation Foundation (NSF):
14 03.....Plastic Piping System Components and Related
Materials
- J. Sheet Metal and Air Conditioning Contractors National Association
(SMACNA):
HVAC Duct Construction Standards, 2nd Edition 1997

PART 2 - PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES

Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

2.2 PIPE AND TUBING

- A. Chilled Water and Vent Piping:
 - 1. Steel: ASTM A53 Grade B, seamless or ERW, Schedule 40.
 - 2. Copper water tube option: ASTM B88, Type K or L, hard drawn.
- B. Extension of Domestic Water Make-up Piping: ASTM B88, Type K or L, hard drawn copper tubing.
- C. Cooling Coil Condensate Drain Piping:
 - 1. From air handling units: Copper water tube, ASTM B88, Type M, or schedule 80 flame retardant polypropylene plastic.
 - 2. From fan coil or other terminal units: Copper water tube, ASTM B88, Type L for runouts and Type M for mains.
- D. Pipe supports, including insulation shields, for above ground piping:
Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

2.3 FITTINGS FOR STEEL PIPE

- A. 50 mm (2 inches) and Smaller: Screwed or welded joints.
 - 1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
 - 2. Forged steel, socket welding or threaded: ASME B16.11.
 - 3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
 - 4. Unions: ASME B16.39.
 - 5. Water hose connection adapter: Brass, pipe thread to 20 mm (3/4 inch) garden hose thread, with hose cap nut.

- B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints. Contractor's option: Grooved mechanical couplings and fittings are optional.
 - 1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
 - 2. Welding flanges and bolting: ASME B16.5:
 - a. Water service: Weld neck or slip-on, plain face, with 6 mm (1/8 inch) thick full face neoprene gasket suitable for 104 degrees C (220 degrees F).
 - 1) Contractor's option: Convoluted, cold formed 150 pound steel flanges, with teflon gaskets, may be used for water service.
 - b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.
- C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gage connections.
- D. Grooved Mechanical Pipe Couplings and Fittings (Contractor's Option): Grooved Mechanical Pipe Couplings and Fittings may be used, with cut or roll grooved pipe, in water service up to 110 degrees C (230 degrees F) in lieu of welded, screwed or flanged connections. All joints must be rigid type.
 - 1. Grooved mechanical couplings: Malleable iron, ASTM A47 or ductile iron, ASTM A536, fabricated in two or more parts, securely held together by two or more track-head, square, or oval-neck bolts, ASTM A449 and A183.
 - 2. Gaskets: Rubber product recommended by the coupling manufacturer for the intended service.
 - 3. Grooved end fittings: Malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A53 or A106, designed to accept grooved mechanical couplings. Tap-in type branch connections are acceptable.

2.4 FITTINGS FOR COPPER TUBING

- A. Solder Joint:
 - 1. Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
 - 2. Mechanically formed tee connection in water and drain piping: Form mechanically extracted collars in a continuous operation by drilling

pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting.

B. Bronze Flanges and Flanged Fittings: ASME B16.24.

2.4 DIELECTRIC FITTINGS

- A. Provide where copper tubing and ferrous metal pipe are joined.
- B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.
- C. 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.
- D. Temperature Rating, 99 degrees C (210 degrees F).

2.5 SCREWED JOINTS

- A. Pipe Thread: ANSI B1.20.
- B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.6 FIRESTOPPING MATERIAL

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

2.7 SCREWED JOINTS

- A. Pipe Thread: ANSI B1.20.
- B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.8 VALVES

- A. Asbestos packing is not acceptable.
- B. All valves of the same type shall be products of a single manufacturer.
- C. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2400 mm (8 feet) or more above the floor or operating platform.
- D. Shut-Off Valves
 - 1. Ball Valves (Pipe sizes 2" and smaller): MSS-SP 110, screwed or solder connections, brass or bronze body with chrome-plated ball with full port and Teflon seat at 2760 kPa (400 psig) working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.
 - 2. Butterfly Valves (Pipe Sizes 2-1/2" and larger): Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation. MSS-SP 67, flange lug type or

grooved end rated 1205 kPa (175 psig) working pressure at 93 degrees C (200 degrees F). Valves shall be ANSI Leakage Class VI and rated for bubble tight shut-off to full valve pressure rating. Valve shall be rated for dead end service and bi-directional flow capability to full rated pressure. Not permitted for direct buried pipe applications.

- a. Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 65-45-12 electro-plated.
- b. Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
- c. Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.
 - 1) Valves 150 mm (6 inches) and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.
 - 2) Valves 200 mm (8 inches) and larger: Enclosed worm gear with handwheel, and where required, chain-wheel operator.
 - 3) 3. Gate Valves (Contractor's Option in lieu of Ball or Butterfly Valves):
 - a) 50 mm (2 inches) and smaller: MSS-SP 80, Bronze, 1034 kPa (150 psig), wedge disc, rising stem, union bonnet.
 - b) 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke. MSS-SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.

E. Globe and Angle Valves

1. Globe Valves

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves.

2. Angle Valves:

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Angle valves shall be union bonnet with metal plug type disc.

- b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for angle.
- F. Check Valves
 - 1. Swing Check Valves:
 - a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.), 45 degree swing disc.
 - b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.
 - 2. Non-Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut-off. Provide where check valves are shown in chilled water and hot water piping. Check valves incorporating a balancing feature may be used.
 - a. Body: MSS-SP 125 cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.
 - b. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.
- G. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size.
 - 1. Ball or globe style valve.
 - 2. A dual purpose flow balancing valve and adjustable flow meter, with bronze or cast iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure.
 - 3. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.
- H. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of at least 10 times the minimum required for control. Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs:
 - 1. Gray iron (ASTM A126) or brass body rated 1205 kPa (175 psig) at 93 degrees C (200 degrees F), with stainless steel piston and spring.
 - 2. Brass or ferrous body designed for 2067 kPa (300 psig) service at 121 degrees C (250 degrees F), with corrosion resistant, tamper proof, self-cleaning piston/spring assembly that is easily removable for inspection or replacement.

3. Combination assemblies containing ball type shut-off valves, unions, flow regulators, strainers with blowdown valves and pressure temperature ports shall be acceptable.

4. Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.

I. Manual Radiator/Convactor Valves: Brass, packless, with position indicator.

2.9 STRAINERS

A. Y Type.

1. Screens: Bronze, monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows: 1.1 mm (0.045 inch) diameter perforations for 100 mm (4 inches) and larger: 3.2 mm (0.125 inch) diameter perforations.

B. Suction Diffusers: Specified in Section 23 21 23, HYDRONIC PUMPS.

2.10 FLEXIBLE CONNECTORS FOR WATER SERVICE

A. Flanged Spool Connector:

1. Single arch or multiple arch type. Tube and cover shall be constructed of chlorobutyl elastomer with full faced integral flanges to provide a tight seal without gaskets. Connectors shall be internally reinforced with high strength synthetic fibers impregnated with rubber or synthetic compounds as recommended by connector manufacturer, and steel reinforcing rings.

2. Working pressures and temperatures shall be as follows:

a. Connector sizes 50 mm to 100 mm (2 inches to 4 inches), 1137 kPa (165psig) at 121 degrees C (250 degrees F).

b. Connector sizes 125 mm to 300 mm (5 inches to 12 inches), 965 kPa (140 psig) at 121 degrees C (250 degrees F).

3. Provide ductile iron retaining rings and control units.

2.11 HYDRONIC SYSTEM COMPONENTS

A. Tangential Air Separator: ASME Pressure Vessel Code construction for 861 kPa (125 psig) working pressure, flanged tangential inlet and outlet connection, internal perforated stainless steel air collector tube designed to direct released air into expansion tank, bottom blowdown connection. Provide Form No. U-1. Provide a removable stainless steel strainer element having 5 mm (3/16 inch) perforations and free area of not less than five times the cross-sectional area of connecting piping.

B. Diaphragm Type Pre-Pressurized Expansion Tank: ASME Pressure Vessel Code construction for 861 kPa (125 psig) working pressure, welded steel shell,

rust-proof coated, with a flexible elastomeric diaphragm suitable for a maximum operating temperature of 116 degrees C (240 degrees F). Provide Form No. U-1. Tank shall be equipped with system connection, drain connection, standard air fill valve and be factory pre-charged to a minimum of 83 kPa (12 psig).

- C. Pressure Reducing Valve (Water): Diaphragm or bellows operated, spring loaded type, with minimum adjustable range of 28 kPa (4 psig) above and below set point. Bronze, brass or iron body and bronze, brass or stainless steel trim, rated 861 kPa (125 psig) working pressure at 107 degrees C (225 degrees F).
- D. Pressure Relief Valve: Bronze or iron body and bronze or stainless steel trim, with testing lever. Comply with ASME Code for Pressure Vessels, Section 8, and bear ASME stamp.
- E. Automatic Air Vent Valves (where shown): Cast iron or semi-steel body, 1034 kPa (150 psig) working pressure, stainless steel float, valve, valve seat and mechanism, minimum 15 mm (1/2 inch) water connection and 6 mm (1/4 inch) air outlet. Air outlet shall be piped to the nearest floor drain.

2.12 GAGES, PRESSURE AND COMPOUND

- A. ASME B40.100, Accuracy Grade 1A, (pressure, vacuum, or compound for air, oil or water), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.
- B. Provide brass lever handle union cock. Provide brass/bronze pressure snubber for gages in water service.
- C. Range of Gages: Provide range equal to at least 130 percent of normal operating range.

2.13 PRESSURE/TEMPERATURE TEST PROVISIONS

- A. Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, norel self-closing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.
- B. Provide one each of the following test items to the Resident Engineer:
 - 1. 6 mm (1/4 inch) FPT by 3 mm (1/8 inch) diameter stainless steel pressure gage adapter probe for extra long test plug. PETE'S 500 XL is an example.

2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gage, 100 kPa (30 inches) Hg to 700 kPa (100 psig) range.
3. 0 - 104 degrees C (220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (one inch) dial, 125 mm (5 inch) long stainless steel stem, plastic case.

2.14 THERMOMETERS

- A. Mercury or organic liquid filled type, red or blue column, clear plastic window, with 150 mm (6 inch) brass stem, straight, fixed or adjustable angle as required for each in reading.
- B. Case: Chrome plated brass or aluminum with enamel finish.
- C. Scale: Not less than 225 mm (9 inches), range as described below, two degree graduations.
- D. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.
- E. Scale ranges:
 1. Chilled Water: 0-38 degrees C (32-100 degrees F).
 2. Hot Water: -1 - 116 degrees C (30-240 degrees F).

2.15 ELECTRICAL HEAT TRACING SYSTEMS

- A. Systems shall meet requirements of the National Electrical Code (NEC), Section 427.
- B. Provide tracing for outdoor piping subject to freezing temperatures (Below 38 degrees F) as follows:
 1. Chilled water all areas exposed to the weather.
- C. Heat tracing shall be provided to the extent shown on the drawings (Floor plans and Elevations).
- D. Heating Cable: Flexible, parallel circuit construction consisting of a continuous self-limiting resistance, conductive inner core material between two parallel copper bus wires, designed for cut-to-length at the job site and for wrapping around valves and complex fittings. Self-regulation shall prevent overheating and burnouts even where the cable overlaps itself.
 1. Provide end seals at ends of circuits. Wire at the ends of the circuits is not to be tied together.
 2. Provide sufficient cable, as recommended by the manufacturer, to keep the pipe surface at 2.2 degrees C (36 degrees F) minimum during winter outdoor design temperature, but not less than the following:
 - a. 75 mm (3 inch) pipe and smaller with 25 mm (1 inch) thick insulation: 4 watts per foot of pipe.

- b. 100 mm (4 inch) pipe and larger 38 mm (1-1/2 inch) thick insulation:
8 watts per foot of pipe.
- E. Electrical Heating Tracing Accessories:
 - 1. Power supply connection fitting and stainless steel mounting brackets.
Provide stainless steel worm gear clamp to fasten bracket to pipe.
 - 2. 13 mm (1/2 inch) wide fiberglass reinforced pressure sensitive cloth tape to fasten cable to pipe at 300 mm (12 inch) intervals.
 - 3. Pipe surface temperature control thermostat: Cast aluminum, NEMA 4 (watertight) enclosure, 13 mm (1/2 inch) NPT conduit hub, SPST switch rated 20 amps at 208 volts AC, with capillary and copper bulb sensor. Set thermostat to maintain pipe surface temperature at not less than 1.1 degrees C (34 degrees F).
 - 4. Signs: Manufacturer's standard (NEC Code), stamped "ELECTRIC TRACED" located on the insulation jacket at 3000 mm (10 feet) intervals along the pipe on alternating sides.

PART 3 - EXECUTION

3.1 GENERAL

- A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than 25 mm (one inch) in 12

m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.

- E. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat
- F. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.
- G. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- H. Provide manual or automatic air vent at all piping system high points and drain valves at all low points. Install piping to floor drains from all automatic air vents.
- I. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
 - 1. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
- J. Thermometer Wells: In pipes 65 mm (2-1/2 inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.
- K. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- L. Where copper piping is connected to steel piping, provide dielectric connections.

3.2 PIPE JOINTS

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three

threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.

- C. Mechanical Joint: Pipe grooving shall be in accordance with joint manufacturer's specifications. Lubricate gasket exterior including lips, pipe ends and housing interiors to prevent pinching the gasket during installation. Lubricant shall be as recommended by coupling manufacturer.

3.3 NOT USED

3.4 LEAK TESTING ABOVEGROUND PIPING

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer. Tests may be either of those below, or a combination, as approved by the Resident Engineer.
- B. An operating test at design pressure, and for hot systems, design maximum temperature.
- C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.

3.5 FLUSHING AND CLEANING PIPING SYSTEMS

- A. Water Piping: Clean systems using compounds described in 3.4,B of this specification section.
 - 1. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all drains at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 1.8 m/S (6 feet per second), if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage

- by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the COR.
2. Cleaning: Using products supplied in Section 23 25 00, HVAC WATER TREATMENT, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 1.8 m/S (6 feet per second). Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as
 3. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.
- B. Cleaning Compounds
1. Alkaline phosphate or non-phosphate detergent/surfactant/specific to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.
 2. All chemicals to be acceptable for discharge to sanitary sewer.

3.8 ELECTRIC HEAT TRACING

- A. Install tracing as recommended by the manufacturer.
- B. Coordinate electrical connections.

3.5 OPERATING AND PERFORMANCE TEST AND INSTRUCTION

- A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Adjust red set hand on pressure gages to normal working pressure.

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