SECTION 23 21 00

HYDRONIC PIPING

1.0 GENERAL

1. DESCRIPTION
   1. All work specified in this Section is governed by the Common Work Results for HVAC Section 23 05 00.
   2. This Section 23 21 00 and the accompanying drawings cover the provisions of all labor, equipment, appliances, and materials and performing all operations in connection with the construction of the piping systems as specified herein and as shown for the heating, ventilating and air conditioning (HVAC) systems. These piping systems include, but are not limited to, the following:
      1. Condenser water supply and return (CWS&R)
      2. Heating Hot water supply and return (HHWS&R)
      3. Refrigerant suction and liquid (RS&RL)
      4. Drains (DR)
      5. Valves and Accessories
2. INTENT
   1. It is the intent of this Section of the specifications to provide complete and operable piping systems as shown and specified which are free of leaks, properly vented, free of noise, vibration and sweating, and fabricated so as to fit the space allotted and to exhibit a minimum resistance to fluid flow.
   2. The word "piping" is defined to mean all piping, fittings, joints, hangers, coatings, valves, cocks, test and sensor wells and accessories necessary for the HVAC piping systems described, shown and specified.
3. GENERAL REQUIREMENTS
   1. Provide all reducing fittings, flanges, couplings and unions of the size and type of material to match the piping to each piece of equipment, valve and accessory.
   2. Union joints or flanges shall be provided in each pipeline connected to each piece of equipment and elsewhere as indicated and specified. Unions shall match the piping system in which they are installed.
      1. Unions or flanges shall be provided between all copper to steel connections in water-carrying piping. These unions shall be dielectric, insulating type.
   3. All changes in direction and branches shall be made with manufactured fittings.
   4. In all water piping systems, changes in horizontal pipeline sizes shall be made with eccentric reducers installed flat on top for proper air venting. Reducing tees, reducing elbows and concentric reducers shall only be allowed for changing pipe sizes in vertical risers and for making connections to equipment and accessories from vertical risers.
   5. In refrigerant, drain, steam and condensate piping systems, eccentric reducers shall be installed with the flat side on bottom to maintain the bottom of the pipe flush for proper condensate and oil drainage. Reducing tees, reducing elbows and concentric reducers shall only be allowed for changing pipe sizes in vertical risers and for making connections to equipment and accessories from vertical risers.
   6. All pipe joints shall be cut square and all burrs shall be removed.
   7. All butt-weld pipe elbows shall be long radius type.
   8. Fabrication of a bullhead tee connection is strictly prohibited.
   9. Each pump shall be provided with a straight run of piping into the suction of a length not less than five (5) times the suction pipe size indicated and/or shall be equipped with a suction diffuser. Straight runs shall be provided whenever feasible.
   10. Open ends of pipelines not currently being handled shall be plugged during installation to keep dirt, water and foreign material out of the system.
   11. Horizontal water supply and return piping shall be installed level or, where space permits, slope up in the direction of flow at 1/2 to 1 percent of the run.
   12. Horizontal refrigerant and drain piping shall slope down in the direction of flow at a minimum slope of 1/8" per foot of run.
   13. All Welders employed at this project shall be qualified under the requirements of ANSI Specification B31.1.0, Section 127.5. Evidence of Welders' qualifications shall be submitted before any welds are made.

2.0 PRODUCTS

1. PIPE AND FITTINGS
   1. All pipe and fittings shall be products of a domestic Manufacturer.
   2. Pipe and fittings shall be as listed and outlined below:
      1. Condenser Water Supply & Return, 2 1/2" & Larger: Material 1
      2. Condenser Water Supply & Return, 2" & Smaller: Material 5
      3. Heating Hot Water Supply & Return, 2 1/2” & Larger: Material 1
      4. Heating Hot Water Supply & Return, 2” & Smaller: Material 5
      5. Refrigerant Suction and Liquid, All Sizes: Material 4
      6. Condensing Appliance Drain Upstream of Neutralization, All Sizes: Material 7
      7. All other drains\*, All Sizes: Material 6

\*Note: As an option, on cooling coil condensate drains (which are not installed in a plenum) and all outdoor cooling tower drains only, the drain piping may be Schedule 40 PVC with solvent joints; subject to advance approval by the Local Authorities. Fittings shall meet ASTM D2466 and solvent shall meet ASTM D2564.

* 1. The pipe, fittings and joints shall be as outlined below:
     1. Material Type 1:
        1. Pipe - Black steel, Schedule 40 (standard weight for 12" and larger sizes), meeting ASTM A53 and ANSI B36.10.
        2. Fittings - Carbon steel selected to match adjacent pipe per ANSI B36.10. Fittings shall meet ASTM A106 Grade B, ASTM A234 and ANSI B16.9. \*\*Option: Victaulic Installation-Ready couplings and OGS fittings for 2 – 12” and Victaulic AGS couplings and fittings for 14” and larger. The couplings shall be installed with pad to pad contact of the housing, allowing for visual verification of correct installation.
           1. Rigid: Victaulic style 107V (12” and smaller) and style W07 (14” and larger)
           2. Flexible: Victaulic style 177N (8” and smaller), style 77 (10” and 12”) and style W77 (14” and larger)
           3. Gaskets: Grade EHP EPDM (12” and smaller) and Grade E Flush Seal EPDM (14” and larger)
        3. Flanges - Carbon steel meeting A105 Class 150, selected to match adjacent equipment, pipe, valves, fittings, etc. Flanges shall meet ANSI B16.5. Gasket faces shall be raised and meet ANSI B46.1 modified spiral serrated surface finish requirements. \*\*Option: flanges for grooved piping systems shall have flange adapters: Victaulic styles 741/W741 for direct connection to class 125/150 flanged components. Style 743 for direct connection to class 300 flanged components.
        4. Joints - Beveled, butt-welded. Option: Grooved mechanical system
     2. Material Type 2:
        1. Pipe - Black steel, Schedule 40 meeting ASTM A120 standards.
        2. Fittings - 150 lb. class black malleable iron meeting ASME B16.3.
        3. Joints - Screwed with tapered threads per ASME B1.20.1 standards with Teflon pipe joint compound applied to male threads only.
     3. Material Type 3:
        1. Pipe - Same as Type 1, except Schedule 80 (extra strong on 10" and larger).
        2. Fittings - Same as Type 1 except no Victaulic fittings.
        3. Flanges - Same as Type 1, except extra strong bore and no Victaulic flanges.
        4. Joints - Same as Type 1 except no grooved mechanical systems.
     4. Material Type 4:
        1. Pipe - Type L hard drawn copper tubing meeting ASTM B88 or ASTM B280.
        2. Fittings - Wrought copper meeting ASME B16.22.
        3. Joints - Silver brazed with sil-fos or silver solder.
     5. Material Type 5:
        1. Pipe - Same as Type 4.
        2. Fittings - Same as Type 4.
        3. Joints - Same as Type 4, except that a solder meeting ASTM B32 may be utilized in a soldered joint suitable for 150 lb. service.
     6. Material Type 6:
        1. Pipe - Copper drainage tube DWV meeting ASTM B306.
        2. Fittings - Wrought copper solder-joint drainage fittings meeting AMSE B16.29.
        3. Joints - Soldered with a solder meeting ASTM B32.
     7. Material Type 7:
        1. Pipe – DWV Solid Wall Schedule 40 PVC.
        2. Fittings – Schedule 40 PVC meeting ASTM D246.
        3. Joints – Solvent welded, meeting ASTM D2564.

1. VALVES
   1. All valves shall have the Manufacturer's name or trademark and the working pressure cast or stamped on the valve body.
   2. All valves utilizing packing shall be designed and constructed to allow repacking while under pressure.
   3. All valves shall be provided by a domestic Manufacturer.
   4. All valves ¾” and smaller shall be “full-port” type, and greater than ¾” may be “reduced-port” type.
   5. Valves on insulated lines shall be provided with stem extensions to provide clearance for specified pipe insulation. Provide preformed insulation to encase valve assembly in insulated piping systems.
   6. Valves shall be suitable for 125 psig and 40°F to 250°F or the system operating conditions, whichever is greater, UON.
   7. Ball Valves 2 inch and smaller for chilled water:
      1. Ball valves shall be two piece bronze body, large port with solid, smooth bore chrome plated brass ball, meeting MSS-SP110. Seats shall be reinforced TFE with Teflon packing ring and threaded adjustable packing nut. Valves to be Apollo Valves 32-100 or 70, depending on the pressure, or equal by Hammond UP8501, Watts B-6000, Milwaukee UPBA100, or Victaulic 722L or 78BL.
   8. Butterfly Valves for use in chilled and condenser water only shall be as follows:
      1. Butterfly valves shall be tapped full lug type designed to hold the valve against the upstream pipe flange independently of the downstream pipe flange meeting MSS-SP67. Valves shall be designed for use in systems with continuous operating temperatures between 40°F and 250°F. Valves sized 6" and smaller shall be provided with memory-stop manual lever type handles with locking quadrant; valves 8" and larger shall have worm-gear operators with cast or malleable iron handwheels. All valves shall be equipped with position indicator plates. Valves shall have cast iron body, bronze alloy disc, stainless steel stem, EPDM (EPT) replaceable seat liner. The valve liner design shall be such that it shall serve as a flanged seal and no separate gasket shall be required. Valves shall be Apollo Valves LD141 up to 200 psi or 215L/215W Series up to 300 psi, or approved equal by Hammond, Milwaukee, Mission, Demco, Keystone, Grinnell or Center Line. In grooved piping systems, valves shall be Victaulic Series 761, W761, 608, 461, or 861 as appropriate.
   9. Check Valves:
      1. Check valves 2-1/2” and larger shall be non-slam type with iron body, globe-type silent checks with bronze trim, stainless steel spring and flanged end connections. Flow area through the valve shall exceed the cross sectional area of the pipe in which the valve is installed by not less than 10%. Valves shall be Apollo Valves 910F up to 200 psi or 2” and under, 169T up to 600 psi or equal by Mueller Co., APCO, Metraflex Globe Style Silent Check Valve, Hammond IR 9354, or Milwaukee 1800. In grooved piping systems, valves shall be Victaulic 716, 779, W715, 416, or 816 as appropriate.
      2. Check valves 2” and smaller shall be y-pattern, swing-type with brass body, renewable bronze seat disc, and be MSS SP-80 factory-tested. Valves shall be Apollo Valves 164T for up to 200 psi CWP and 168T for up to 400 psi CWP or equal by Hammond, or Milwaukee.
      3. All check valves on pump discharges shall be non-slam type.
      4. All check valves shall be installed in an orientation allowed by the manufacturer’s recommendations.
      5. All check valves installed in insulated piping systems shall have the check valve location explicitly labeled on the outside of the insulation.
   10. Balancing Valves:
       1. Pressure Dependent:
          1. Valves 3” and smaller shall have a lead-free brass body, 304 stainless steel ball, EPDM stem ring, and provide positive shut-off. Each balancing valve shall be equipped with two gauge taps with check valves and drip caps. Valves shall be B&G Circuit Setter Plus, or equal by FlowDesign, Hays, Nexus, Illinois, Tour & Andersson, or Armstrong. Valves shall be rated at 300 psig at 200°F.
          2. Valves 4” and larger have cast iron body, brass (through 8”) or stainless steel (through 12”) disc with EPDM insert, Teflon-graphite packing, nitrile gasket, EPDM seal ring, and nickel-plated steel bushing. Each balancing valve shall be equipped with two gauge taps with check valves and drip caps. Valves shall be B&G Circuit Setter Plus, or equal by FlowDesign, Hays, Nexus, Illinois, Tour & Andersson, Watts, or Armstrong. Valves shall be rated at 175 psi at 250°F in flanged connection or 300 psig at 250°F in grooved connection, as required by the system and installation location.
          3. Where piping is required to be insulated, provide preformed insulation to encase valve assembly.
       2. Pressure Independent:
          1. Valves 2” and smaller shall have a combination DZR brass body with and have a removable stainless steel flow regulating cartridge accurate to +-5% of the specified flowrate over the differential pressure control range, typically 2-32 psi. Valve shall be suitable for 400 psig, or the systems operating conditions, whichever is greater, working pressure and the maximum system temperature. Each valve shall include a minimum of two gauge taps. Valves shall be Flowdesign Autoflow YR, or equal by B&G, Hays, Nexus, Illinois, Tour & Andersson, Watts, or Armstrong.
          2. Valves 2.5” and larger shall have a ductile iron body and have a removable flow regulating canisters accurate to +-5% of the specified flowrate over the differential pressure control range, typically 2-32 psi. Valve shall be suitable for 600 psig, or the systems operating conditions, whichever is greater, working pressure, the maximum system temperature. Each valve shall include a minimum of two gauge taps. Valves shall be Flowdesign Autoflow WS, or equal by B&G, Hays, Nexus, Illinois, Tour & Andersson, Watts, or Armstrong.
          3. Pressure independent valves shall have label permanently affixed to the valve body indicating flowrate and control pressure.
          4. Where piping is required to be insulated, provide preformed insulation to encase valve assembly.
   11. Control valves shall meet the requirements of the appropriate valve sections. Control valves shall be provided with electric operator/actuators which shall provide full modulation from closed to open and positive closure. Operators/actuators and all components shall be plenum-rated in return air plenums.
   12. Relief valves shall be sized to have the pressure and temperature relief capacities indicated by their service, including any piped discharge sizes and lengths. Relief valves shall be ASME rated and labeled.
2. FLEXIBLE PIPE CONNECTIONS
   1. \*\*Flexible piping connections for chillers, pumps, air-handling units, self-contained units, and other equipment shall be suitable for 150/300 psig working pressure or the system pressure at the installation location, whichever is greater, and the temperature of the system. Connections shall have braided stainless steel with internal corrugated hose with a length not less than their pipe size diameter. Connections for chillers only shall be fabric-reinforced neoprene.
   2. Flexible piping connections for individual small HVAC units such as fan coil units, water-source heat pumps, and water coils shall be provided with each unit or coil. Flexible supply and return hoses shall be a minimum of 24” and complete with service shut-off valves. Hose assembly shall be stainless steel outer braid and EPDM inner tube. Hoses shall have insulation to match insulation specification requirements. Hoses shall be rated for the system pressure and temperature in which they are installed and not less than 40°F to 250°F, 300 psig.
   3. Flexible piping connections are for vibration isolation only and shall not be used to align piping connections, for thermal expansion, or any other purpose.
   4. \*\*With Engineer approval, in lieu of a flexible piping connection on grooved piping systems, three (3) Victaulic Style 177, 77, or W77, as appropriate, flexible couplings may be used for vibration attenuation. The couplings shall be placed in close proximity to the source of the vibration, with no hard connections between, including supports. The couplings shall be placed in close proximity to the source of the vibration as part of Series 380, 381, 382, and 385 catalog drops.
3. STRAINERS
   1. Strainers shall be Y-type and rated for a minimum working pressure of \*\*125 psi \*\*400 psi CWP, or the systems operating conditions, whichever is greater. Strainers sized 2" and smaller shall have screwed end connections and be provided with 20 mesh Monel screens. Strainers sized 2 1/2" and larger shall have flanged ends and be provided with 1/16" perforated, 24 gauge stainless steel baskets except that strainer before open loop pumps shall be minimum ¼” perforated, 24 gauge stainless steel baskets with a maximum clean pressure drop of 2.0 psi. All strainers shall be provided with a blow-down connection complete with a full-size gate valve with hose end connection.
   2. Strainers shall be manufactured by Metraflex, Bell & Gossett, Flowdesign, Hoffman Specialties, Apollo Valves, or Mueller.
   3. \*\*On grooved piping systems Victaulic Series 732 or W732, as appropriate, Y-type strainers may be utilized. Style 382 and 385 drops may be utilized when a strainer is required around pumps or equipment connections – note to also see requirements about straight runs at connections.
4. AIR SEPARATORS
   1. Air separators shall be combination centrifugal air separators with system strainer and tangential connections. Vessels shall be designed for collecting entrained air from the water flowing thru them. Each vessel shall be of welded steel construction complying with ASME codes for not less than 125 psi working pressure, or the systems operating conditions, whichever is greater, and shall be so stamped and labeled. Piping connections shall be flanged. Internal strainer shall be removable and have a free area of not less than 5 times the area of the connecting pipe. Separators shall be provided with a factory enamel finish.
   2. In-line air separators shall be heavy duty cast iron with integral weir design. Vessels shall be designed for collecting entrained air from the water flowing through them. Each vessel shall be rated for 175 psi maximum working pressure and 300°F maximum temperature. In-line air separators B&G Rolairtrol or equal.
   3. Air separators shall be Bell & Gossett, Wessels, Armstrong or J.J Finnigan.
5. EXPANSION TANKS
   1. Expansion tanks shall be of welded steel construction for a minimum working pressure of 125 psi at 240°F, or the systems operating conditions, whichever is greater. Construction shall be in accordance with ASME codes and the tanks shall be so stamped and labeled.
   2. Expansion tanks shall be a precharged bladder type of welded steel construction for a minimum working pressure of 125 psi at 240°F, or the systems operating conditions, whichever is greater. Construction shall be in accordance with ASME codes and the tanks shall be so stamped and labeled. The expansion tank shall be supplied with a heavy duty butyl replaceable bladder, ring base, lifting rings, NPT system connection, 3/4" NPT drain and an air charging valve connection to facilitate adjusting precharge pressure.
   3. Expansion tanks shall be Apollo Valves, Amtrol, Bell & Gossett, Wessels, JJ Finnigan, Grundfos, or Watts.
6. AIR VENTS
   1. Air vents shall be located at the top of systems and risers. Automatic high capacity air vents shall be used where continual air removal is expected, such as at air separators. Manual high capacity air vents shall be used where large volumes of air removal are expected, and only during systems start-up/fill or maintenance, such as to the tops of risers. Manual air vents shall be used where small amounts of air removal are expected only during system start-up/fill or maintenance, such as branch piping high points.
   2. Air vents shall be provided with a gate valve or cock on their inlet. Vent outlet, where piped, shall be to the sanitary system with indirect discharge. Outlet piping shall be sized as recommended by the Manufacturer and no less than ¼”.

* 1. Automatic high capacity air vents shall be B&G 107A or similar.
  2. Manual high capacity air vents shall be B&G 107A, or similar, with manual outlet valve.
  3. Manual air vents shall be B&G Hoffman Specialty 78 or similar.
  4. Automatic vent outlet shall be piped. Manual vent outlets shall be piped when in back-of-house areas, including mechanical rooms, penthouses, etc. Where manual vents are located in finished or public spaces, vent outlet shall have threaded hose connection for controlled drainage.

1. THERMOMETERS AND PRESSURE GAUGES
   1. Thermometers and pressure gauges shall be products of Trerice, Weksler or Weiss. Select all devices to operate within 20% of the midpoint of their scales under normal operating conditions. Gauges provided on pumps shall be compound type.
2. PRESSURE AND TEMPERATURE (P&T) TEST PLUGS
   1. Plugs shall be constructed of brass with two (2) self-closing Nordel cores and be complete with cap and gasket.
   2. Plugs shall be as manufactured by Peterson or Lancaster.
   3. Provide a complete test kit to the Owner at the time of final inspection. Test kit shall be complete with pressure gauge, thermometer, probes and carrying case.
3. \*\*VICTAULIC COUPLINGS
   1. Couplings, fittings, valves, and specialties manufactured by Victaulic may be utilized for Type 1 and 2 piping systems for equipment and connections, noise/vibration attenuation, and thermal pipe movement where specifically approved by the Engineer. When utilizing for riser design or thermal pipe movement, contractor must consult Victaulic’s PMD group to verify proper A10 anchor and flexible coupling/expansion joint locations. The Contractor shall provide product submittal data and indicate where the proposed use of Victaulic systems is intended prior to construction.

3.0 EXECUTION

1. ARRANGEMENT AND INSTALLATION
   1. Follow the general piping layout, arrangement, schematics, and details. Provide all offsets, air vents, drains and connections necessary to accomplish the installation. Automatic air vents shall be provided at all high points. Manual air vents shall be installed as required for system fill, troubleshooting, and testing. Fabricate piping accurately to measurements established at the project Site to avoid interference with ductwork, other piping, equipment, openings, electrical conduits and light fixtures.
   2. Make suitable provision for expansion and contraction with expansion loops and offsets. With Engineer approval, Victaulic Style 177, 77, and W77 flexible couplings, Style 155 expansion, and A10 anchors may be used to accommodate expansion and contraction. \*\*Victaulic’s PMD group shall be consulted to ensure proper application and design. Victaulic shall provide details and calculations where required.
   3. Pressure gauges and thermometers called to be permanently installed shall be easily visible from a standing position on the ground.
   4. All piping installed outside the building shall be secured to the structure. Coordinate with the Structural Engineer as needed. It is the Contractor’s responsibility to design and coordinate all supports. All supports shall be designed to withstand all code-required wind and seismic loads.
   5. Wind and seismic roof supports for piping shall be Mifab CZ or approved equal.
2. UNDERGROUND PIPING
   1. All underground piping shall have a minimum cover of 3'-0".
   2. Provide concrete thrust blocks at all changes of direction and secure all joints.
   3. All underground water lines shall be protected from corrosion with a continuous plastic sheathing or coating and wrapping. This sheathing or coating and wrapping shall be extended 6" to 12" above finished floor. See Section 23 07 19 for HVAC piping insulation.
3. REFRIGERANT PIPING INSTALLATION
   1. All refrigerant piping shall be sized in accordance with the Air Conditioning Equipment Manufacturer’s written instructions. Provide charging ports, solenoid valves, service valves, dryers, etc. at each piece of equipment.
   2. All brazing shall be done while the line is being flushed with carbon dioxide, nitrogen, or other inert gases.
   3. The inside of all tubing shall be thoroughly cleaned and internally wiped with a lintless, dry cloth.
   4. Suction lines shall drop below their coils before any horizontal run.
   5. Provide oil traps at least every ten feet for extended vertical risers.
   6. All oil traps shall be constructed from close-radius type fittings.
   7. Dryer cores shall be installed to remove horizontally or downward.
   8. Install external equalizer downstream of its expansion valve sensing bulb.
   9. Install expansion sensing valve bulb on top centerline of piping up to 5/8" size; install 45 degrees down from the horizontal centerline on pipe sizes 7/8" and larger.
   10. Refrigerant piping located in concealed locations shall be located a minimum of 1.5” from studs, joists, or similar members or shall be continuously protected by steel shield plates minimum 0.0575” thick, a minimum of 2” beyond the adjacency.
   11. Refrigerant piping shall be identified, on the outside of any insulation as applicable, in accordance with ANSI A13.1 in intervals not exceeding 20’ and within 5’ of assembly penetrations. Identification shall indicate refrigerant designation and safety group classification. A2L refrigerants shall include the label “WARNING – Risk of Fire. Flammable Refrigerant.”.
   12. Refrigerant piping shall be tested in accordance with ASME B31.5. Piping shall be pressurized at the lower of the lowest design pressure or lowest pressure relief setting. The design pressures shall be listed on the condensing unit nameplate.
   13. The Installing Contractor or Manufacturer shall sign and issue a certificate of piping test in accordance with ASHRAE 15 for all systems with 55 lbs or more of refrigerant. The certificate shall indicate the test date, photograph of the pressure gage at test pressure, refrigerant designation, test medium, and the field test pressure on the high and low sides of the system.
   14. Each refrigeration system shall have a permanent legible sign, securely attached, indicating the name and address of the Installer, the refrigerant number and amount, the lubricant identity and amount, and field test pressure.
4. REFRIGERANT SYSTEM OWNER’S RESPONSIBILITIES
   1. Note that the Owner shall be responsible for periodic tests of detectors, alarms, mechanical ventilation, etc. in accordance with Manufacturer’s specifications and requirements, and the the requirements of the AHJ.
   2. For systems containing 55 lbs or more of refrigerant, the person in charge of the premises shall provide a schematic drawing giving directions of operation of the system. Emergency shutdown procedures, including precautions in case of a breakdown or leak, shall be posted near the refrigerant compressor and address the shutdown instructions, the contact information to obtain service, the contact information for all entities to be contacted in the event of a reportable incident.
5. \*\*PIPE GROOVING AND INSPECTION
   1. Grooved Pipe Joint Construction: Square cut pipe ends and roll groove ends of pipe in accordance to manufacturer’s specifications. Gaskets shall be verified as suitable for the intended service and shall be coated on the lips with a thin uniform coat of lubricant in accordance with the manufacturer's published instructions. Any coupling requiring a special lubricant to meet the temperature and/or pressure requirements will not be accepted. For installation-ready coupling, housing shall engage both grooves, otherwise the housing shall be assembled over the gasket and shall engage both grooves. The nuts shall be uniformly tightened until the housing pads are firmly together, metal to metal allowing visual inspection, or until properly tightened per manufacturer’s specifications and instructions. Any coupling requiring a specific torque for installation shall be specifically labeled by the installing Contractor in the field to ensure proper torque has been achieved. A factory trained Representative shall provide on-site training for Contractor's field personnel in the use of grooving tools and installation of grooved joint products. The Representative shall periodically visit the jobsite and ensure Contractor is following best recommended practices in grooved product installation including visual inspection of installation. (A Distributor's Representative is not considered qualified to conduct the training or jobsite visit(s).) To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products and grooving tools utilized shall be supplied by a single Manufacturer with smart tools recommended. Groove depths shall be measured using a Victaulic Go-No-Go tape or 5200i tool to verify compliance with groove specifications.

END OF SECTION