

SECTION 23 21 15 – UNDERGROUND HYDRONIC PIPING

PART 1 – GENERAL

1.1 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for chilled-water piping installed underground.
- B. This Section does not include chilled water piping installed inside buildings or utility tunnels.
- C. Drawings and general provisions of Contract, including General Conditions, apply to the work of this Section. Section 23 0100 “Basic Mechanical Requirements” and Section 23 0500 “Basic Mechanical Materials and Methods” apply to the work of this Section.
- D. Related Sections include the following:
 - 1. Division 23 Section “Hydronic Piping” for chilled water piping installed inside buildings or utility tunnels.
 - 2. Division 23 Section “Basic Mechanical Materials and Methods” for general piping materials and installation requirements, and for labeling and identifying hydronic piping.
 - 3. Division 23 Section “Valves” for general-duty ball and butterfly valves.
- E. The following two types of piping systems and methods are included in this Section:
 - 1. Traditional open-trench method.
 - 2. Directional boring method.

1.2 DEFINITIONS

- A. DI: Ductile iron.
- B. PVC: Polyvinyl chloride plastic.

1.3 REFERENCED STANDARDS

- A. ASTM D1784: Standard for Rigid PVC Compounds and Chlorinated PVC Compounds.
- B. ASTM D2837: Standard Test Method for Obtaining Hydrostatic Design Basis for Thermo- plastic Pipe Materials.
- C. ASTM D3139: Standard Specification for Joints for Plastic Pipes Using Flexible Elastomeric Seals.
- D. ASTM F477: Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- E. AWWA C900: Standard for PVC Pressure Pipe Fabricated Fittings, 4-inch through 12-inch, for Water Distribution.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing hydronic piping systems with a minimum working-pressure rating of 150 psig.

1.5 SUBMITTALS

- A. Submit product data for the following:
 - 1. Pipe, valves and fittings.
 - 2. Restraining devices.
 - 3. Valve boxes and vent boxes.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For valves and specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves according to the following:
 - 1. Ensure that valves are dry and internally protected against rust and corrosion.
 - 2. Protect valves against damage to threaded ends and flange faces.
 - 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves according to the following:
 - 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 - 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Stacking of the pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.
- G. Protect flanges, fittings, and specialties from moisture and dirt.
- H. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.8 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Owner's Representative no fewer than seven days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Owner's Representative written permission.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Ball Valves: Subject to compliance with requirements, provide ball valves by the following:
 - 1. Conbraco Industries, Inc.; Apollo Div.; Model 77-100.
- B. Butterfly Valves: Subject to compliance with requirements, provide buried butterfly valves by one of the following:
 - 1. General Signal; DeZurik Unit.
 - 2. Mueller Co.; Water Products Div.
 - 3. Henry Pratt Company.
 - 4. Val-Matic Valve & Manufacturing Corp.
- C. Relief Valves: Subject to compliance with requirements, provide air/vacuum relief valves by one of the following:
 - 1. Crispin-Multiplex Manufacturing Co.
 - 2. GA Industries, Inc.
 - 3. Val-Matic Valve & Manufacturing Corp.
- D. PVC Pipe Joint Restraints: Subject to compliance with requirements, provide PVC pipe joint restraint by one of the following:
 - 1. Traditional open-trench method: Use EBAA Megalug 2000 PV retainers, and/or Certainteed Certa-Lok C900/RJ couplings, or approved equal.
 - 2. Directional boring method: Use Certainteed Certa-Lok C900/RJ couplings.

2.2 BURIED PIPING

- A. PVC Pipe: AWWA C900, Pressure Class 150, dimension ratio DR 18; equivalent outside diameter to ductile iron pipe, with precision-machined grooves for use with pipe manufacturer's proprietary coupling system, Certa-Lok C900/RJ restrained joint PVC pipe.
- B. Pipe and couplings shall be made from unplasticized PVC compounds having a minimum cell classification of 12454, as defined in ASTM D1784. The compound shall qualify for a Hydrostatic Design Basis (HDB) of 4000 psi for water at 73.4F, in accordance with the requirements of ASTM D2837. As defined in AWWA C900, pipe and couplings shall be homogeneous throughout and free from voids, cracks, inclusions, and other defects, and shall be as uniform as commercially practicable in color, density, and other physical characteristics.

- C. Pipe shall be furnished in standard lengths of 20 feet.
- D. Pipe shall be legibly and permanently marked in ink with the following information.
 - 1. Manufacturer and Trade Name
 - 2. Nominal Size & DR Rating/Pressure Class
 - 3. Manufacturing Date Code
- E. Restrained Mechanical-Joint, Ductile-Iron Pipe: AWWA C151 mechanical joint pipe; 150 psi working pressure; minimum thickness Class 52; with integrally cast bell, gland, and rubber gasket.
- F. Restrained Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and stainless-steel bolts.
 - 2. Lining: Standard cement lining with asphalt coating.
 - 3. Encasement: AWWA C105, high-density, cross-laminated polyethylene film of 0.004- inch minimum thickness.

2.3 JOINING MATERIALS

- A. Fitting Restraints for PVC Pipe to DI Fitting Connection: AWWA C111 mechanical joint. Provide retainer type packing glands with rubber gasket, for use with PVC pipe and conforming to Uni-B-13-92 and FM approved. EBAA Megalug 2000 PV or approved equal.
 - 1. Rods, Nuts and Washers: $\frac{3}{4}$ " SS304 all thread rods, nuts and washers, or EBAA Mega Bond Coating System.
- B. Fitting Restraint for PVC Pipe to DI Fitting Connection: AWWA C110 mechanical joint. Provide retainer type packing glands, for use on all classes of ductile iron pipe and UL listed and FM Approved EBAA Megalug 1100 or approved equal.
 - 1. Rods, Nuts and Washers: $\frac{3}{4}$ " SS304 all thread rods, nuts and washers, or EBAA Mega Bond Coating System.
- C. Fitting Restraints for Pipe Couplings: Use Certainteed Certa-Lok C900/RJ proprietary couplings system. Substitute couplings systems must be submitted and approved prior to bid and shall have been tested and approved by an independent third-party laboratory for continuous use at rated pressure. Copies of Agency approval reports or product listing shall be provided to the Engineer.
 - 1. The pipe shall be joined using a separate PVC coupling with beveled edges, built-in sealing gaskets and restraining grooves. The restraining splines shall be square or rectangular, and made from Nylon 101.
 - 2. The pipe shall be joined using non-metallic couplings which, together, have been designed as an integral system for maximum reliability and interchangeability. High- strength flexible thermoplastic splines shall be inserted into matting precision-machined grooves in the pipe and coupling to provide full 360 degree restraint with evenly distributed loading.
 - 3. Couplings shall be designed for use at the rated pressure of the pipe with which they are utilized, and shall incorporate twin elastomeric sealing gaskets meeting the requirements of ASTM F477. Joints shall be designed to meet the leakage test requirements of ASTM D3139.

2.4 BURIED COMPONENTS

- A. Valve Sizes: Same as upstream pipe size, unless otherwise indicated.
- B. Valve Flanges: ASME B16.1 for cast-iron valves and ASME B16.24 for bronze valves.
- C. Valve Threaded Ends: With threads according to ASME B1.20.1.
- D. Material Substitution: Ductile iron is acceptable anywhere cast iron is specified.
- E. Class Substitution: If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- F. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "CHILLED WATER" and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter. A precast concrete valve box with a manhole cast in the top would be an acceptable substitution.
 - 1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- G. Relief Vents:
 - 1. Vents are to be installed at high points of the system.
 - 2. Service Saddle
 - a. Services saddles for pipes 2-inches thru 24 inches diameter shall be Mueller DR2S Series Ductile Iron with stainless steel single strap.
 - 3. Air/Vacuum Relief Valves: Spirotop Automatic Air Vent
 - a. Standard: AWWA C512
 - b. Pressure Rating: 300 psig.
 - c. Body Material: Solid brass
 - d. Nominal Size: 1-inch NPS.
 - 4. Vent Boxes:
 - a. Roadway, parking lots and service drives: Heavy duty, street rated cast iron with hot dip galvanized finish. Removable cover shall be checkered steel with stainless steel cover screws shall be marked "CHILLED WATER." Junction box shall have an H-20 load rating and be suitable for installation in roadway. Minimum dimensions shall be 12" x 12" x24" (L x W x D).
 - b. Grass and sidewalks: Vent box shall be 18" PVC pipe, ASTM F679, SDR 35, with cast iron water well cover. Lid shall be marked "CHILLED WATER."
- H. Ball Valves: Provide Series 77-140-series "Apollo" ball valves by Conbraco Industries, Inc.; or Watts B6080-SS. Products of manufacturers other than these are considered Substitutions and are not permitted, except as provided under the General Conditions and Division 01 Specifications. The Owner has no obligation to accept any substitution.
 - 1. Minimum SWP rating: 150-psig.
 - 2. Minimum CWP rating: 600-psig.
 - 3. Body: ASTM B584 bronze, two-piece construction.
 - 4. Ball: Type 316 stainless steel, full port.
 - 5. Stem: Blowout-proof Type 316 stainless steel; extended-length stem to accommodate insulation.

6. Packing: PTFE or TFE.
 7. Ends: Threaded. Sweat end connections will be rejected.
 8. Handle: Vinyl-covered steel lever with memory stop; and zinc-plated steel nut.
- I. Butterfly Valves: Valve shall conform to AWWA C504; sizes NPS 3 and larger.
1. Type: Rubber seated.
 2. Minimum CWP rating: 150-psig.
 3. Body and bonnet: ASTM A536 ductile-iron, extended neck.
 4. Packing: Field-replaceable EPDM or BUNA-N sleeve and stem seals.
 5. Stem and Stem Hardware: Type 316 stainless steel.
 6. Disc: Aluminum bronze.
 7. End Connections: Flanged (in vaults); or Mechanical Joint compatible with AWWA C111 fittings.
 8. Operator: Gear drive with fully-greased packed actuator with stops in the open and closed position.

PART 3 – EXECUTION

3.1 EARTHWORK

- A. Refer to Division 23 Section “Utility Excavation and Backfill” for excavating, trenching, and backfilling.
- B. Refer to Division 23 Section “Directional Boring” for trenchless installation requirements.

3.2 BURIED PIPING APPLICATION

- A. Except where otherwise noted, the Contractor may choose among the following two types of piping systems and methods:
 1. Traditional open-trench method: Direct-bury, including but not limited to excavation of pipe trench, bedding, backfill, and site restoration; using PVC pipe with Certainteed Certa-Lok C900/RJ proprietary couplings and restrained joint, ductile iron fittings and concrete thrust blocking at changes of direction.
 2. Directional boring method: Use PVC pipe, Certainteed Certa-Lok C900/RJ proprietary couplings system and restrained joint, ductile iron fittings and concrete thrust blocking at changes of direction.

3.3 BURIED PIPING INSTALLATION

- A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings. Clean pipe of debris prior to installation.
- B. Open Trench Method:
 1. Remove any standing water in the bottom of trench.
 2. Bed the pipe on a layer of granular fill material with clearance between the pipes as detailed on the Drawings.

3. Do not backfill piping trench until field quality-control testing has been completed and results approved.
 4. Bury piping with depth of cover over top at least 30 inches and as detailed on the Drawings if applicable.
 5. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
 6. Install piping free of sags and bends.
- C. Directional Boring Method: Refer to Division 23 Section "Directional Boring."
- D. Install components with pressure rating equal to or greater than system operating pressure.
- E. Install fittings for changes in direction and branch connections. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, anchors, tie-rods and clamps, and other supports, install per manufacturer's recommendations.
- F. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for sleeves and mechanical sleeve seals through tunnel and exterior building walls.
1. Connect to hydronic piping where it passes through the tunnel and exterior building walls. Hydronic piping inside the tunnel and building walls is specified in Division 23 Section "Hydronic Piping." Extend new hydronic service piping and connect to existing hydronic piping systems in locations and pipe sizes indicated.
- G. Protect open ends of pipe at the end of each workday, with a temporary hard cap or inflatable plug.
- H. All ferrous components, including but not limited to cast or ductile iron pipe, fittings, valves, and specials, shall be externally wrapped with AWWA C105, high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.

3.4 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
1. Ductile-Iron Piping, Gasketed Joints Piping: AWWA C600 and AWWA M41.
 2. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
- B. Make pipe joints for EBAA Megalug and/or Certainfeed Certa-Lok C900/RJ proprietary couplings systems in strict accordance with the respective manufacturer's written instructions.

3.5 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install hydronic distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
1. Concrete thrust blocks. Concrete is specified in Division 03 "Cast-in-Place Concrete."
 2. Locking mechanical joints.
 3. Set-screw mechanical retainer glands.
 4. Proprietary couplings systems as specified in Part 2 of this Section.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and branches. Include anchorages for gasketed-joint PVC piping according to AWWA M23.

- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.6 BURIED VALVE INSTALLATION

- A. Buried Valve Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Drawings indicate valve types to be used.
- B. AWWA Butterfly Valves: Comply with AWWA C600 and AWWA M44.
- C. MSS Valves: Install as component of connected piping system.
- D. Relief Valves: Comply with AWWA C512. Install in vault with shutoff valve on inlet.

3.7 IDENTIFICATION

- A. Open-trench method: Install continuous underground detectable warning tapes during back filling of trenches for underground hydronic distribution piping. Locate 12 inches below finished grade, directly over piping. Refer to Division 23 Section "Utility Excavation and Backfill" for warning-tape materials and devices and their installation. Also, install custom-color #12 AWG THWN electrical tracer wire during the pipe installation for underground hydronic distribution piping. Locate directly on piping and adhere with tape or bands. Terminate tracer wire within building or utility tunnel with a minimum 24-inch length neatly coiled and clipped to the wall.
- B. Directional boring method: Install custom-color #12 AWG THWN electrical tracer wire during bored pipe installation for underground hydronic distribution piping. Locate directly on piping and adhere with tape or bands. Terminate tracer wire within building or utility tunnel with a minimum 24-inch length neatly coiled and clipped to the wall.
- C. Tracer wire described above shall be furnished and installed in custom insulation colors matching Missouri State University standard.
 - 1. Purple with white stripe shall be used for chilled water supply.
 - 2. Pink with white stripe shall be used for chilled water return.

3.8 FIELD QUALITY CONTROL

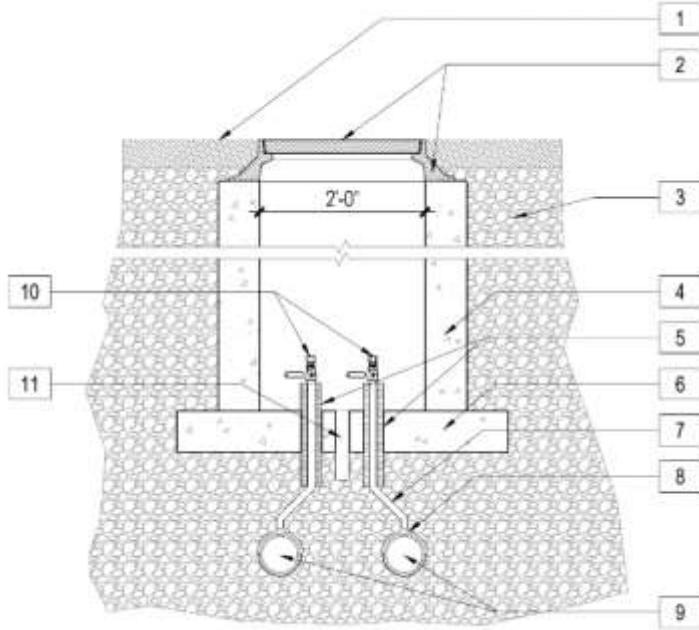
- A. Prior to testing, a safety/testing procedure meeting will be held.
- B. Prepare hydronic piping for Hydrostatic testing according to ASME B31.9 and Missouri State University standard testing procedure as follows:
 - 1. Air tests are not allowed under any circumstances.
 - 2. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 3. Isolate equipment. Do not subject equipment to test pressure.
 - 4. Install relief valve set at pressure no more than one-third higher than test pressure.
 - 5. Fill system with water.
 - 6. Use vents installed at high points to release trapped air while filling system, see drawings.
 - 7. Pressure gauges shall be stainless steel Bourdan tube, liquid filled, mechanical with 0 psi to 200 psi range (effective pressure range 50 psi to 175 psi).

- C. Test hydronic piping as follows:
1. Subject hydronic piping to hydrostatic test pressure that is not less than 1.5 times the design pressure.
 2. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
 3. Hydrostatic pressure should be held for 2 hours.
 4. Prepare a written report of testing and submit to Owner's Representative.

3.9 CLEANING

- A. Clean and flush hydronic distribution piping, following procedures described in AWWA C651. The system does not require disinfection. Clean and flush piping until no visible solids are present in samples as determined by Owner's Representative.
- B. Flush water supply is to be from a fire hydrant and 2-inch hose. Drain through 2-inch hose to storm sewer.
- C. Care shall be taken to prevent dirt and debris from entering piping system when removing test connections and making final tie-ins.
- D. Submit reports for all purging activities to Owner's Representative.

END OF SECTION 23 21 15

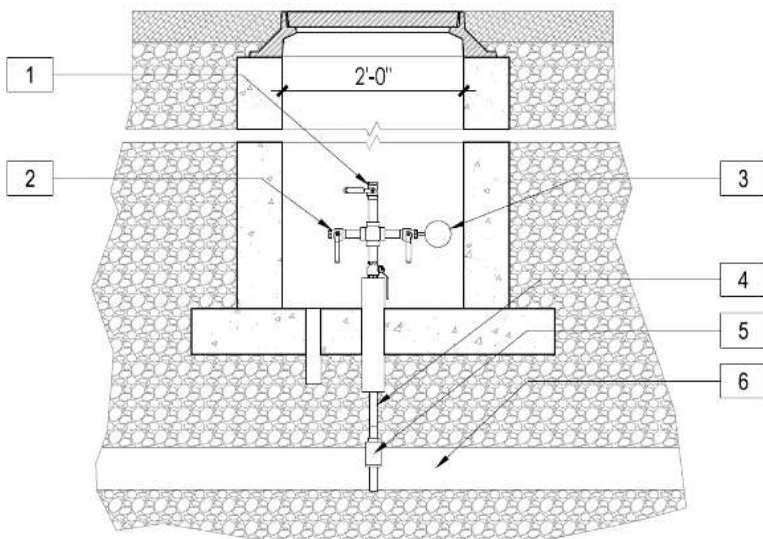


RELIEF VENT ACCESS DETAIL

RELIEF VENT KEYNOTES:

1. SURFACE MATERIAL AS SPECIFIED.
2. CAST IRON RING WITH MANHOLE COVER. RING TO BOLT DOWN TO PRECAST CONCRETE. MANHOLE TO BE MARKED "CHILLED WATER".
3. GRAVEL BACKFILL.
4. PRECAST CONCRETE RING.
5. ONE INCH THICK PIPE INSULATION.
6. CAST IN PLACE CONCRETE SLAB.
7. ONE INCH DIAMETER RISERS WITH 45 DEGREE BENDS.
8. SERVICE SADDLE.
9. CHILLED WATER SUPPLY/RETURN LINES.
10. ONE INCH BALL VALVES WITH $\frac{3}{4}$ " HOSE THREADS AND CAP.
11. TWO INCH CAST IRON DRAIN TO GRAVEL BACKFILL.

SEE PROJECT SPECIFICATIONS FOR PRODUCTS, MANUFACTURERS, AND PROCEDURES.



HYDROSTATIC PRESSURE TESTING SETUP

HYDROSTATIC PRESSURE TEST KEYNOTES:

1. ONE INCH BALL VALVE FOR SPIROTOP AIR VENT.
2. ONE INCH BALL VALVE FOR WATER HOSE CONNECTION.
3. ONE INCH BALL VALVE AND PRESSURE GAUGE.
4. ONE INCH DIAMETER RISER.
5. SERVICE SADDLE.
6. CHILLED WATER SUPPLY/RETURN LINES.

SEE PROJECT SPECIFICATIONS FOR PRODUCTS, MANUFACTURERS, AND PROCEDURES.