

Section 7

Force Mains

A. General

1. Force mains described and specified in this section are sewers which convey sewage under high pressure from pumping stations to locations in the gravity sewer system. Low-pressure sewers used with grinder pumps are specified in Section 6 of these specifications.
2. Force mains shall be installed in strict accordance with these specifications, and any applicable practices and precautions required for gravity sewer are equally applicable to the installation of pressure sewers. These include, but are not limited to, excavation, pipe bedding, concrete encasement and backfilling.
3. The use of polyvinyl chloride pipe (PVC) and fittings will not be permitted.

B. Design Criteria

1. Diameter and Slope

The diameter shall be determined by the flow required to be conveyed and shall not be less than 4 inches. During the installation of a force main, the pipe shall be laid at a constantly increasing grade to each air release manhole or point of discharge. The Applicant shall provide sufficient construction control to assure that there are no sags or decrease in slope in the force main which could tend to accumulate and trap air.

2. Depth of Sewers

A minimum cover of 3.5 feet over the top of the pipe shall be maintained.

3. Separation of Utilities

Refer to Section 2 – Gravity Sewers for these requirements.

4. Thrust Restraint and Blocking

Thrust restraints shall be provided at all tees, bends, wyes, pipe ends or other locations that could become disconnected in the event of a pressure surge.

5. Air Release Valves

The use of air release valves will only be considered if it is demonstrated that they are absolutely necessary and that no alternatives are possible.

C. Materials and Equipment

1. Ductile Iron Pipe and Fittings.

(References to ASTM, AWWA and ANSI Specifications imply latest edition.)

a. Ductile Iron Pipe

- (1) Pipe shall conform to ANSI Specification A21.51, AWWA C151 and ASTM A746 for the material class or pressure designated and ANSI A21.50 and AWWA C150, for wall thickness. Pipe shall be supplied in standard lengths as much as possible.
- (2) Ductile iron pipe shall be by U.S. Pipe and Foundry Company, American Ductile Iron Pipe Company or Griffin Pipe Products Company.

b. Joints

- (1) Joints shall be rubber-gasket push-on type or rubber-gasket mechanical joint type conforming to AWWA C111. Gasket shall be of SBR.
- (2) Restrained joints shall be push-on restrained joints (U.S. Pipe and Foundry Co.'s. Field Lok 350 Gaskets or equal) as manufactured by the pipe supplier or manufacturer subject to the Authority's approval. The restraint provided shall be standard restrained joint or bolt-less, integral restraining system. Restrained joints shall be suitable for the specified test pressure. Mechanical joint retainer glands ("Megalug") as manufactured by EBAA Iron Inc. of Texas can be selected for restraining the mechanical joint of ductile iron pipe for field closures as approved by the Authority. The minimum number of restrained joints required for resisting forces at fittings and changes in direction of pipe shall be determined from the length of restrained pipe on each side of fittings and changes in direction necessary to develop adequate resisting friction with the soil.
- (3) Sleeve type couplings shall be ductile iron mechanical joint solid sleeves.

c. Minimum Thickness

Thickness design shall be per AWWA C150, except provide minimum Class 52.

d. Ductile Iron Fittings

- (1) Pipe fittings shall be ductile iron with pressure rating of 350 psi for 24-in and smaller piping and 250 psi for 30-in and larger piping. Fittings shall meet the requirements of AWWA C110 or AWWA C153 as applicable. Fittings shall have the same pressure rating, at a minimum, of the connecting pipe.
- (2) Closures shall be made with mechanical joint ductile iron solid sleeves and shall be located in straight runs of pipe at minimum cover outside the limits of restrained joint sections. Location of closures shall be subject to approval of the Engineer.

e. Interior Lining

- (1) Cement mortar lining shall only be used in pipe and fittings that are continuously filled or full flow not exposed to the atmosphere. The cement mortar lining with an asphalt seal coat shall conform to ANSI Specification A21.4 or AWWA C104, latest edition, except the thickness of linings should not be less than 1/8-inch.
- (2) Hydrogen sulfide resistant linings shall be used in all pipe and fittings with partial flow depth or exposed to the atmosphere (in the vicinity of air release valves, terminal manholes, etc.). These linings shall be one of the following:
 - (a) Protecto 401 ceramic-filled amine cured epoxy lining shall be as manufactured by Indurall. The lining thickness shall be 40 mils minimum. Application shall be performed by an applicator approved by the coating manufacturer, in accordance with manufacturer's instructions and under controlled conditions at the applicator's shop or the pipe manufacturer's plant. Applicator shall submit a certified affidavit of compliance with manufacturer's instructions and requirements specified herein.
 - (b) Calcium aluminate mortar shall be made of fused calcium aluminate cement and fused calcium aluminate aggregates as manufactured by Lafarge Calcium Aluminates or approved equal. The minimum lining thickness shall be 0.125 inch for 6 through 12 inch pipe, 0.1875 inch for 14 through 24 inch pipe and 0.250 inch for 30 through 54 inch pipe. The interior and exterior of the spigot end and the interior of the socket end, including a portion of the pipe barrel, shall be coated with a minimum of 8 mils of epoxy prior to lining.

(c) Polyethylene lining shall consist of a blend of polyethylene powders applied to the interior of a preheated pipe. The nominal lining film thickness shall be 40 mils minimum. Polyethylene lining of ductile iron pipe shall be done at pipe manufacturer's plant; fittings shall be done at pipe manufacturer's plant, or at experienced shop approved by the pipe manufacturer. Applicator shall submit a certified affidavit of compliance with manufacturer's instructions and requirements specified herein.

f. Exterior Coating

(1) Buried pipe shall be installed with a bituminous coating in accordance with AWWA C151 and C110 respectively.

(2) Buried pipe in corrosive soils shall be installed with polyethylene encasement conforming to AWWA C105, where indicated on the drawings or as directed by the Authority. The polyethylene sheet shall be 8 mils thick minimum.

2. Plug Valves

- a. Plug valves shall be of the offset disc type, 1/4 turn, non-lubricated, serviceable (able to be repacked) under full line pressure and capable of sealing in both directions at the rated pressure. The disc shall be completely out of the flow path when open. Plug valves specified herein shall be by DeZurik, Valmatic or Clow.
- b. All buried valves shall open counter-clockwise and be especially constructed for buried service. Exterior ferrous metal surfaces of all buried valves shall be blast cleaned in accordance with SSPC SP 6 and given two shop coats of an approved two-component coal tar epoxy paint.
- c. All size plug valves shall have a minimum port area of 80 percent.
- d. Valves shall be rated at minimum 175 psi WOG (water, oil and gas) working pressure for sizes 4 inch to 12 inch inclusive and at minimum 150 psi WOG working pressure for sizes 14 inch and larger.
- e. All plug valves under this paragraph shall be performance, leakage and hydrostatically tested in accordance with AWWA C504, except as modified herein. At the above rated minimum working pressures, the valves shall be certified by the manufacturer as permitting zero leakage for a period of at least 30 minutes with pressure applied to the seating face.
- f. Valve bodies shall be of cast iron, 30,000 psi tensile strength, ASTM A126, Grade B, or of ductile iron, ASTM A536 and of the top entry, bolted bonnet

design, cast with integral flanges conforming to the connecting piping. All exposed bolts, nuts and washers shall have Type 316 stainless steel hardware.

- g. The valve disc shall be cast iron ASTM A126, Grade B, or ductile iron, ASTM A536, Grade 65 45-12, be removable without removing the valve from the line and have an integral upper and lower shaft which shall have seals on the upper and lower journals to prevent entrance of solids into the journals.
- h. Shaft bearings shall be permanently lubricated, rigidly backed TFE, stainless steel or bronze at both upper and lower stem journals. The operator shaft shall have easily replaceable seals, which shall be externally adjustable and repackable without removing the bonnet from the valve or shall have self adjusting packing.
- i. The valve seating surface shall provide full 360 degree seating by contact of a resilient seating material on the disc mating with welded in high nickel content overlay seating surface in the body.
- j. Discs shall have a full resilient facing of neoprene or Buna N.

3. Valve Boxes

All buried valves shall be provided with extension-type, roadway-type valve boxes. Valve boxes shall be cast iron and shall be two-piece telescoping screw-type construction. Valve boxes shall have 5 1/4-inch shafts, shall have covers marked "SEWER", and shall be coated inside and out with a tar or asphalt compound. Valve boxes shall be manufactured by Bingham & Taylor or Tyler Pipe.

4. Air Release Valves

- a. The valves shall be designed for sewage service and shall be non-clogging with cast iron or 316 stainless steel body, bronze or 316 stainless steel trim and 316 stainless steel floats. Valves shall be provided with shutoff valve, blow-off valve and quick disconnect hose connection and backflushing hose and valve.
- b. Valves shall have a venting capacity of 270 C.F.F.A.M. at 50 psig differential pressure and shall be similar to those manufactured by A.R.I., APCO, Golden-Anderson, Val-Matic or approved equivalent.
- c. Valve chamber shall be standard precast concrete manhole construction in accordance with ASTM C478, and shall be of adequate size to permit entry around valve for servicing and maintenance. Manhole base shall be

provided with drain. Manhole cover shall be adequately vented to ensure discharge or intake of free air.

5. Detectable Warning Tape

Detectable warning tape shall be polyethylene film encasing a metallic core, minimum 6" wide and 4 mils thick, color-coded green for sewer, bearing in black letter – CAUTION: SEWER LINE BELOW.

D. Installation

1. General

Ductile iron pipe shall be installed in accordance with AWWA C600.

2. Excavation

Refer to Section 2 – Gravity Sewers for these requirements.

3. Bedding

Refer to Section 2 – Gravity Sewers for these requirements.

4. Laying Pipe

a. Refer to Section 2 – Gravity Sewers for these requirements.

b. Construction Control

During the installation of a force main, the pipe shall be laid at a constantly increasing grade to each high point, air release manhole, or point of discharge, as indicated on the Drawings. The Contractor shall provide sufficient construction control to assure that there are no sags or loss in grade in the force main which could tend to accumulate air.

c. Permissible Deflection of Joints

If deflection is required, the amount of deflection shall not exceed the maximum limits as specified in the AWWA Standard C600, or those specified by the pipe manufacturer.

d. Fittings and Valves

(1) General

Valves and fittings shall be set and jointed to pipe in the manner specified previously for cleaning, laying and jointing pipe.

(2) Valve Chamber

Provide a precast concrete manhole for every air release and vacuum valve as specified in Section 5 – Precast Reinforced Concrete Manholes. The manholes shall be constructed of sufficient size to permit entry for valve repairs and protect the valve and pipe from impact where they pass through the manhole walls. All valves and fittings shall be supported as indicated on the detail drawings.

5. Thrust Restraint and Blocking

Restraint of pipe and fittings shall be provided at all tees, crosses, bends, wyes, pipe ends, or at other locations that have unbalanced pressure forces. Restraint shall be provided by one of the following:

a. Pipe manufacturer's restrained joint system as approved by the Authority.

(1) Provide computations for the embedment lengths required for the following minimum conditions:

Design pressure	=	150 psi
Depth of cover	=	3.5 feet
Safety factor	=	1.5
Soil type	=	cohesive granular
Soil internal friction angle	=	20 degrees
Soil cohesion	=	200 psf
Soil density	=	90 pcf

Ref. - "Thrust Restraint for Ductile Iron Pipe", DIPRA

(2) Minimum restrained lengths required for pipe anchorage with restrained joints as shown on the detail drawings.

b. Metal harness or tie rods

(1) Metal harness or tie rods of adequate strength to prevent movement shall be used.

(2) Restrained pipe length shall be the same as those for restrained joints.

- (3) Steel rods or clamps shall be suitable for bury. The minimum number shall be as follows:
 - (a) Use a minimum of two ¾-inch diameter rods for pipes 6 inches and smaller.
 - (b) Use a minimum of four 1-inch diameter rods for pipes 8 inches through 14 inches.
 - (c) Minimum restrained length required for pipe anchorage with metal harness and tie rods shall be the same as those indicated for restrained joint pipe.

c. Concrete anchor blocks

- (1) Concrete anchor blocks shall be designed for the same parameters as those for restrained joints with the additional condition of a minimum allowable soil bearing pressure of 2000 psf.
- (2) Minimum anchor blocks shall be as shown on the detail drawings.

6. Backfilling

Refer to Section 2 – Gravity Sewers for these requirements.

7. Surface Restoration

Refer to Section 2 – Gravity Sewers for these requirements.

E. Testing and Inspection

1. Notification

It is incumbent upon the applicant to notify the Authority a minimum of 24 hours in advance of when the work will be ready for inspection.

2. Pressure Test

- a. After the pipe has been laid and backfilled as specified, all newly laid pipe shall be subjected to a hydrostatic pressure of 150 pounds per square inch or 150% of the normal working pressure, whichever is greater, in accordance with AWWA C 600.
- b. Where any section of a force main is provided with concrete reaction backing, the hydrostatic pressure test shall not be made until at least five days have elapsed after the concrete reaction backing was installed. If high early strength cement is used in the concrete reaction backing, the

hydrostatic pressure test shall not be made until at least two days have elapsed.

- c. Air release valves shall be installed but isolated during testing of the pipeline.
- d. Duration of Pressure Tests

The duration of each pressure test shall be two hours.

- e. Procedure

Each section of pipe shall be slowly filled with water and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. The pump, pipe connections, and all necessary apparatus, including gauges, shall be furnished by the Contractor and are subject to approval by the Engineer. The Contractor will make all taps into the pipe, and furnish all necessary assistance for conducting the tests. The Contractor shall supply either a container calibrated in 0.1 gallon increments or a laboratory certified calibrated water meter calibrated to an accuracy of 0.1 gallons.

- f. Expelling Air Before Test

Before applying the specified test pressure, all air shall be expelled from the pipe. If permanent air release valves are not located at all high points, the Contractor shall make the necessary taps at such points before the test is made. After the test has been completed, the Contractor shall remove and plug the taps or leave them in place at the direction of the Engineer.

- g. Examination Under Pressure

Any cracks or defective pipes, fittings or valves discovered in consequence of this pressure test, shall be removed and replaced by the Contractor, and the test shall be repeated.

- h. If the pressure does not drop within the 2-hour test period, the test shall be deemed to be successful.

F. Detail Drawings

The relevant detail drawings are:

- 1 Right-of-Way Restoration

- 18 Force Main Connection to Manhole
- 22 Air Release Valve and Chamber
- 23 Thrust Blocks for Horizontal Bends and Lower Vertical Bends
- 24 Restrained DI Pipe Length

END OF SECTION