

Town of Fortville
Utility Street Standards

SECTION 02732 - FORCE MAINS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Specifications for force main pipe, fittings, valves, and appurtenances are included in this Section.
- B. Definitions: All pipe, fitting and valve size, and all reference to pipe diameter on the drawings or in the specifications are intended to be nominal size or diameter and shall be interpreted as such.
 - 1. AWWA, where used in these specifications, shall mean American Water Works Association.
 - 2. ANSI, where used in these specifications, shall mean American National Standard Institute.
 - 3. ASTM, where used in these specifications, shall mean American Society for Testing & Materials.
- C. This specifications cover the following types of material:
 - 1. Ductile Iron
 - 2. Polyvinyl Chloride (PVC).

1.2 PIPE MARKING

Each length of pipe shall bear the name or trademark if the manufacturer, the location of the plant, and the date of manufacture. Each length shall likewise be marked to designate the class or strength of the pipe. The marking shall be made on the exterior of the pipe barrel near the bell or groove end and shall be plainly visible.

1.3 RELATION TO WATER MAINS

- A. Sanitary force mains must be laid at least 10 feet horizontally from any existing or proposed water main. The distance shall be measured edge to edge. Should specific conditions prevent this separation, the Contractor shall notify the Town Superintendent for specific instructions regarding the treatment of the separation.
- B. Whenever the force main crosses a water main, it should be laid to provide a minimum vertical distance of 18 inches between the outside of the force main and the outside of the water main. The force main can be either above or below the water main.

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PART 2 - PRODUCTS

2.1 GENERAL

All pipe, fittings, valves, and appurtenances shall be as shown on the drawings and specified in this Section. All pipe, fittings valves, and appurtenances shall be new and unused.

2.2 DUCTILE IRON PIPE

- A. Ductile iron pipe shall meet the requirements of ANSI Specification A21.51 (AWWA Standard C151) and the additional requirements specified herein. Design and manufacture pipe for a working pressure of 150 psi plus 100 psi surge and a safety factor of 2 and a depth of cover indicated on the drawings and specified in this Section. Minimum thickness pressure class shall be class 150.
1. Pipe joints shall be push-on type. Joints shall meet the requirements of ANSI/AWWA A21.11/C111. Restrained joints shall be Lok-Fast, Lok-Tyte, or equal.
 2. Mark each length pipe. Marking shall include pipe class, casting period, manufacturer's name or trademark, and year of manufacture. Marking shall meet the requirements of ANSI Specification A21.51 (AWWA Standard C151).
- B. Lining and Coating: Outside surfaces of the pipe and fitting shall be bituminous coated complying with ANSI/AWWA A21.51/C151 and ANSI/AWWA A21.10/C100.

2.3 PVC PIPE

- A. Polyvinyl Chloride (PVC) Force Mains
1. Pipe
 - a. Polyvinyl chloride pipe shall meet the requirements of AWWA Standard C900. The color of the pipe shall be blue. Design and manufacture pipe for a working pressure of 150 psi plus 100 psi surge and a safety factor of 2. The depth of cover shall be as indicated on the drawings and specified in this Section. The dimension ratio shall not be greater than 18. (DR18)
 - b. Polyvinyl chloride pipe shall have cast-iron-pipe-equivalent outside diameter.

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- c. Pipe joints shall be push-on type. Joints shall meet the requirements of AWWA Standard C900. Do not use solvent-cement joints.
- d. Mark each length of pipe. Marking shall meet the requirements of AWWA Standard C900.

2.4 FITTINGS

- A. Fittings shall be ductile iron. Fittings shall meet the requirements of ANSI/AWWA C110. Design and manufacture fittings for a pressure rating of 150 psi.
 - 1. Fitting joints shall be restrained mechanical joints or restrained push-on joints. Joints shall meet the requirements of ANSI/AWWA A21.11/C111. Restrained joints shall be used instead of thrust blocking. Restrained joints shall be Lok-Fast, TR Flex, Lok-Ring, or equal. Restrained joints shall be Lok-Fast, TR Flex, Lok-Ring, or equal. Pipe connecting to restrained joint fittings shall also have restrained joints as indicated on the drawings and specified in this Section.
 - 2. Mark each fitting. Marking shall meet the requirements of ANSI/AWWA C110.

2.5 ADAPTERS

- A. Adapters from polyvinyl chloride force mains to victaulic or flange joint valves or fittings shall be ductile iron. Adapters shall meet the requirements of ANSI/AWWA C110. Design and manufacture adapters for a pressure rating of 150 psi.
- B. Line the inside surfaces of adapters with cement mortar lining and bituminous seal coating. Cement mortar lining and bituminous seal coating shall meet the requirements of ANSI/AWWA C104/A21.4. Coat outside surfaces of adapters with bituminous coating. Outside shall meet the requirements of ANSI/AWWA C110.
- C. Adapter ends connecting to polyvinyl chloride force mains shall have plain ends or mechanical joints. Mechanical joints shall meet the requirements of ANSI/AWWA C111/A21.11.
- D. Adapter ends connecting to victaulic or flange joints valves or fittings shall have joints complying with the specifications for the applicable valves or fittings.
- E. Adapters from ductile iron force mains to victaulic or flange joints valves or fittings shall be cast iron or ductile iron. Adapters shall meet the requirements of

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ANSI/AWWA C110. Design and manufacture adapters for a pressure rating of 150 psi.

1. Adapter ends connecting to ductile iron force mains shall have plain ends, push-on joints, mechanical joints, or restrained push-on joints. Adapters with plain ends, push-on joints, or mechanical joints may be used where restrained joints are not required. Adapters shall have restrained push-on joints where restrained joint piping is required as indicated on the drawings and specified in this Section. Mechanical joints and push-on joints shall meet the requirements of ANSI/AWWA A21.11/C111.
 2. Restrained joints shall be Lok-Fast, Lok-Tyte, or equal.
 3. Adapter ends connecting to victaulic or flange joint valves or fittings shall have joints complying with the specifications for the applicable valves or fittings.
 3. Gaskets
 - a. Gaskets for polyvinyl chloride push-on joints shall meet the requirements of AWWA Standard C900.
 - b. Gaskets for mechanical joints shall meet the requirements of ANSI/AWWA C111/A21.11
 4. Nuts and Bolts.
 5. Nuts and bolts for mechanical joints shall be high strength, heat treated, cast iron. Nuts shall be hexagon nuts. Bolts shall be tee head bolts. Nuts and bolts shall meet the requirements of ANSI/AWWA C111/A21.11.
- F. Gaskets for mechanical joints and push-on joints shall meet the requirements of ANSI/AWWA A21.11/C111.
- G. Nuts and bolts for mechanical joints shall be high strength, heat treated, cast iron. Nuts shall be hexagon nuts. Bolts shall be tee head bolts. Nuts and bolts shall meet the requirements of ANSI/AWWA A21.11/C111.
1. Nuts and bolts for restrained push-on joints shall meet the requirements of the joint manufacturer.
- H. Polyethylene encasement for ductile iron force mains, when specifically called for on the drawings, shall meet the requirements of ANSI Specification A21.5 (AWWA Standard C105).

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2.6 SEWAGE AIR AND VACUUM VALVES

Sewage combination air vacuum valves shall be as follows:

<u>Size</u>	<u>Specification</u>
2" x 1"	Apco No. 401 SC, Val-Matic Co. No 301 BWA, or equal
2" x 2"	Apco No. 402 SC, Val-Matic Co. No 302 BWA, or equal
3" x 3"	Apco No. 403 SC, Val-Matic Co. No 303 BWA, or equal

2.7 AIR AND VACUUM VALVE CHAMBERS

- A. Air and Vacuum valve chambers shall be 4-foot diameter precast concrete manhole barrels with precast concrete flat slab tops. Precast manhole barrels shall meet the requirements of ASTM C478.
- B. Air and vacuum valve chamber access frames and cover shall be Neenah R-1915-G, or equal. Cast the work "SEWER" in each cover.

2.8 BURIED LOCATOR WIRE

- A. A #10 locator wire shall be placed along the entire length of PVC force main.

PART 3 - EXECUTION

3.1 INSTALLATION

Suitable tools and equipment shall be used for the safe and convenient handling and laying of pipe. Great care shall be taken to prevent pipe coatings or wrappings from being damaged. Carefully examine all pipe for cracks and other defects. No pipe or fittings shall be laid which are known to be defective. If pipe or fittings are discovered to be cracked, broken or defective after being laid, they shall be removed and replaced with sound material. Thoroughly clean all pipe and fittings before installation. All pipe and appurtenances should be kept clean until accepted as completed work.

- A. The Contractor shall furnish and set all line and grade stakes (HUB) and stakes for bench marks. The bench marks shall be set in strategic locations of the project in order to facilitate the Contractor's installation.
- B. Pipe laying shall commence at the lowest point in the proposed sewer line. Lay the pipe with the bell end of bell and spigot pipe or with the receiving groove end of tongue and groove pipe pointing upgrade. Do not drop or dump pipe or fittings into the trench. Lower pipe by hand, by means of hoists or ropes or

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by other suitable tools or equipment so products, coatings and linings are not damaged.

Lay each pipe on an even firm bed as specified so that no uneven strain will come in contact with any part of the pipe. Particular care shall be exercised to prevent the pipes from bearing on the sockets. Hand dig all bell holes for bell and spigot pipe. Do not lay pipe in water or when trench or weather conditions are unsuitable for proper installation.

Completely shove home all pipe (to the assembly mark) in accordance with manufacturers recommendations. On pipe of the tongue and groove type thirty (30) inches and larger in diameter, pressure must be applied to the center of each pipe as it is laid by a winch and cable or other mechanical means.

Where the piping is to be constructed parallel to or close to existing buried utilities, the exact location of which is unknown, adjust the alignment of the piping to least interfere with these utilities, unless otherwise shown or specified.

Whenever pipe and special castings are required to be cut, the cutting shall be done by skilled workmen in such manner as to leave a smooth end at right angles to the axis of the pipe without damage to the pipe casting or cement lining. Cutting torches shall not be used.

Potable water piping shall be laid at least ten feet horizontally from any existing sanitary sewer or force main. The distance shall be measured from edge of pipe to edge of pipe. Potable water piping crossing sewers or force mains shall be laid to provide a minimum vertical distance of 18 inches between the outside of the potable water piping and the outside of the sewer force main. The 18-inch separation shall be apply whether the potable water piping is over or under the sewer or force mains. Lay potable water piping at crossings of sewers and force mains so a full length of pipe is centered.

- C. During all intermissions in construction of the force main pipe, the open face of the last pipe laid shall be plugged, covered or bulkheaded so as to prevent sand, water, earth or other materials from entering the pipe.

3.2 JOINTING

A. Polyvinyl Chloride (PVC) Push-On Joints

1. Clean the bell and spigot of the pipe sections being joined. Wipe the outside of each spigot and inside of each bell clean of all dirt and other foreign matter. Wipe each bell and spigot dry. Wipe each gasket clean of all dirt, dust, and other foreign matter.

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2. Seat a gasket in the bell of the receiving pipe. Thoroughly lubricate the spigot end of the pipe being installed. Use the lubricant furnished by the pipe manufacturer. Center the spigot end of the pipe being installed in the bell of the receiving pipe. Support the pipe being installed so the pipe being stalled is jointed along the centerline of the receiving pipe. Push or pull the pipe being installed home. After jointing, check the gasket to ensure the gasket has not been pushed out of its seat and the gasket is uniformly compressed around the pipe.
3. Deflect pipe after jointing, if deflection is required. The amount of deflection shall not exceed the limits recommended by the pipe manufacturer.

B. Mechanical Joints

1. Remove lumps, blisters, and excess bituminous coating from the bell and spigot end of each iron pipe, fittings, and valve. Wire brush the outside of each iron pipe or fitting spigot and inside of each bell. Wipe each bell, spigot, and ring gland clean of all dirt, oil, grease, and other foreign matter. Wipe each bell, spigot, and ring gland dry. Wipe each gasket clean of all dirt, dust, and other foreign matter.
2. Brush each spigot and gasket with soapy water. Slip a ring gland followed by a gasket over the spigot. Center the end of the pipe, fitting, or valve being installed on the end of the receiving pipe, fitting, or valve. Support the pipe, fitting, or valve being installed so the pipe, fitting, or valve being installed is jointed along the centerline of the receiving pipe, fitting, or valve. Push or pull the pipe, fitting, or valve being installed home. Push the gasket into position. Move the gland into position against the face of the gasket. Loosely assemble the joint bolts and nuts. Evenly tighten the nuts using a torque wrench. The torque shall be within the range listed in the following table:

<u>Pipe Size</u>	<u>Bolt Size</u>	<u>Torque Range</u>
4" thru 24"	3/4"	75 to 90 ft.-lb.

3. Deflect pipe, fittings, or valves after jointing, if deflection is required. The amount of deflection shall not exceed the limits shown in the following table:

<u>Pipe Size</u>	<u>Maximum Deflection Angle</u>	<u>Maximum Deflection Based Upon 18-Foot Pipe Length</u>
4"	8°-18'	31"

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6"	7°-7'	27"
8"	5°-21'	20"
10"	5°-21'	20"

C. Flange Joints

1. Remove antirust coating from machined surfaces. Clean joint surfaces of the pipe, fittings, and valves being joined. Wipe surfaces clean of all dirt, oil, grease, and other foreign matter. Wipe surfaces dry. Wipe each gasket clean of all dirt, dusts, and other foreign matter.
2. Align the flange of the pipe, fitting, or valve being installed with the flange of the receiving pipe, fitting, or valve. Support the pipe, fittings, and valves being joined so the flanges are properly aligned. Lubricate bolts and nuts with a graphite and oil mixture prior to installation of the bolts and nuts. Install gasket between the flanges. Loosely assemble bolts and nuts. Check gasket to ensure the gasket is in proper position. Evenly tighten bolts and nuts. Tighten bolts and nuts so the joint will not leak. Do not overtorque bolts and nuts.

3.3 TRENCHING

The width of the trench at and below the top of the force main shall be only as wide as is necessary for proper installation and backfilling. The trench width shall be consistent with safety requirements and manufacturer's recommendations for the type of pipe. The minimum width of trench shall be 1.25 times the outside diameter (O.D) plus 12-inches

The integrity of the sewer pipe and structures is predicated upon the proper bedding procedures and width of trenches. Should these limits be exceeded, the Contractor shall be responsible for remedial measures as may be required.

The pipe trench shall not be excavated more than one hundred (100) feet in advance of pipe laying. Whenever pipe trenches are excavated below the designed bedding bottom, the Contractor shall fill the over-excavation with mechanically compacted No. 8 (1/4-inch to 3/4-inch) crushed stone or No. 8 fractured face aggregate.

All rock, boulders and stones 6-inches in diameter and larger encountered in trenches shall be removed. Boulders or rocks are not to be used for trench backfill. Remove any rock encountered to six (6) inches below the pipe, and replace with No. 8 crushed stone or No. 8 fractured face aggregate, compacted.

In cases where material is deposited along open trenches, the material shall be placed so that no damage will result to the work or adjacent property as a result of rain or other surface wash.

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If the bottom of the trench is of undesirable material, an additional six (6) inches of trench bottom shall be excavated and filled with Class 2 crushed stone and compacted using a hand held mechanical tamper. Where the distance to stable ground is excessive, the Town Superintendent shall order in writing, other types of foundation as deemed necessary.

3.4 BEDDING

Bedding material shall be compacted No. 8 crushed stone or No. 8 fractured face aggregate unless otherwise shown on plans. Bedding shall be placed in the trench bottom such that after the pipe has been placed, imbedded to grade, and aligned, there remains a 4-inch minimum depth of material below the pipe barrel and a minimum of 3-inches below the bell.

A. Plastic or Flexible Pipe

Bedding shall be placed around the sides of the pipe up to the springline (1/2 the Outside Diameter). This material shall be shovel sliced or otherwise carefully placed and "walked" or hand tamped to ensure compaction of the haunch area and complete filling of all voids. From the springline to twelve (12) inches above the crown of the pipe, bedding shall be added in six (6) lifts and "walked" in for compaction. Backfilling of the remainder of the trench shall be as specified.

B. Ductile Iron

Bedding shall be placed around the sides of the pipe up to the springline (1/2 the Outside Diameter). This material shall be shovel sliced or otherwise carefully placed and "walked" or hand tamped to ensure compaction of the haunch area and complete filling of all voids. From the springline to the top of the pipe, bedding shall be added in six (6) lifts and "walked" in for compaction. Backfilling of the remainder of the trench shall be as specified.

3.5 BACKFILL

A. Materials

Class I Angular, six (6) to forty (40) millimeters (1/4 to 1-1/2 inch) graded stone such as crushed stone. INDOT Classification No.5, No.8, No.9, and No. 53. A No. 8 gravel containing a minimum 50% mechanical crush count, and meeting the following nominal size and percents passing will be considered an equivalent Class I material: 100% passing 1" sieve, 75-95% passing 3/4" sieve, 40-70% passing 1/2" sieve and 0-15% passing No.4 Sieve.

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- Class II Coarse sands and gravels with maximum particle size forty (40) millimeters (1-1/2 inch), including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil types GW, GP, SW and SP and INDOT classification for “B” borrow material are included in this class.
- Class III Fine sand and clay gravels, including fine sands, sand-clay mixtures and gravel-clay mixtures. Soil types GM GC, SM and SC are included in this class. These materials are not acceptable for pipe bedding.
- Class IV Silt, silty clays and clays, including organic clays and silts of medium to high plasticity and liquid limits. Soil types MH, ML, CH and CL are included in this class. These materials are not acceptable for pipe bedding.

Materials shall be agreed upon prior to construction. No significant deviation from this standard will be permitted without authorization.

B. Placement

1. Areas Subject to Vehicular Traffic

In areas under proposed or existing paved roads or under or within five feet of pavement, sidewalks, curbs, gutters or similar structures, granular backfill material complying with the requirements of the Indiana Department of Highways Standard Specifications, most recent edition, shall be used. The material shall be placed in uniform layers not exceeding six (6) inches, loose measurement. Within three (3) feet of the force main pipe the backfill material shall be thoroughly and uniformly compacted with hand held mechanical tampers. The remaining backfill material shall be compacted with mechanical tampers. A minimum compaction of 95 percent Standard Proctor Density shall be achieved within the backfill material.

Jetting or flooding of the backfill or other alternative compaction methods and materials shall NOT be used without the approval of the Engineer, Owner and applicable jurisdictional authority.

2. Areas NOT Subject to Vehicular Traffic

Areas five (5) feet or more from the paved surfaces shall be carefully backfilled with clean fill material free of rocks larger than 6-inches in diameter, frozen lumps of soil, wood or other extraneous material and installed and compacted as noted above.

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3.6 THRUST RESTRAINT

All plugs, reducers, fittings, and bends, unless otherwise specified, shall be provided with thrust blocks or suitably restrained joints, as shown on plans. Thrust restraint may be cast-in-place concrete blocking, mechanical devices, or structural methods.

Mechanical thrust restraint devices shall be pressure rated by the manufacturer and shall not exert forces when assembled to the pipe or fitting that will cause damage or failure. Vertical and horizontal thrust blocks made of concrete shall have a compressive strength of not less than 4000 psi after 28 days. The blocks shall be placed between solid ground and the fitting to be anchored.

The mass of the block and/or the area of bearing on the pipe and on the ground shall be as shown on the plans. The blocking shall, unless otherwise shown or directed, be located to contain the resultant thrust force and still allow the pipe and fitting joints to be accessible for repair. Concrete for thrust blocks shall be properly mixed by a truck or portable mixer. At no time shall bags of premixed concrete be used for thrust restraints unless properly mixed with a portable mixer.

Restraining mechanisms for push-on or mechanical joints may be used instead of or in concert with concrete backing, if so indicated in the plans and specifications. Tie rods, clamps, or other components of dissimilar metal shall be protected against corrosion by hand application of a suitable coating or by encasement of the entire assembly with 8-mil loose polyethylene film in accordance with ANSI/AWWA C105/A21.5

3.7 AIR/RELEASE VALVE

Where ever possible sanitary sewer force mains shall be constructed without high points and with the top of the force main below the hydraulic grade line at the minimum pumping rate, so that air release valves are not needed.

If high points in the force main cannot be eliminated, an APCO air release valve or approved equal shall be installed at each significant high point or as shown on plans where air could become trapped. The air release valve shall be installed in a manhole structure in accordance with these Standards. Provisions shall be required for draining the structure. A high point shall be considered significant if it is 2 feet or more above the minimum hydraulic grade line, or, when pumping is intermittent above the static head line.

Air release valves must be equipped with an exhaust pipe extending to a downward facing elbow with a corrosion resistant, twenty-four (24) mesh screened opening at an elevation of eighteen (18) inches above the ground.

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3.8 PRESSURE AND LEAKAGE TEST

Under the observation of the Town's Representative, Contractor shall test force mains for leakage after installation and prior to final acceptance. The hydrostatic pressure test shall be conducted in accordance with AWWA C600 and ASTM standards for testing pressure pipe.

A. Testing Equipment

The Contractor shall provide all equipment and tools necessary to conduct the hydrostatic test including, but not limited to, the following:

1. Hydrostatic test pump (jockey pump).
2. Four and one half (4 1/2") inch diameter calibrated pressure test gauge of range 0-150 psi graduated in 1 psi increments. The manufacturer's calibration papers and test date information shall be made available at the request of the Town.
3. All pipe plugs and/or caps required to perform the hydrostatic test.
4. Calibrated/graduated container to measure quantity of water required to be added during hydrostatic pressure test to maintain specified test pressure.

B. Hydrostatic Pressure Testing Procedures

The hydrostatic pressure test shall be conducted in accordance with the applicable AWWA standard based on force main material and in accordance with ASTM E103 - "Standard Method for Hydrostatic Leak Testing." In conjunction with and in addition to the aforementioned standards, the hydrostatic pressure test shall proceed as follows:

1. The force main shall be completely backfilled prior to testing.
2. The influent line and effluent discharge shall be appropriately plugged/bulkheaded. The plugs/bulkheads shall be equipped with a minimum of two (2) openings for filling/draining the pipeline and for bleeding air from the line. Thrust blocking restraints are required at each bulkhead and shall be installed in accordance with the bulkhead manufacturer's requirements.
3. The test line shall be filled with water at a slow rate to prevent air entrapment.
4. Trapped air shall be expelled through high point bleed off valves as the line is being filled.

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5. The test line shall be pressurized to 1.5 times the pump shut-off head as determined from the pump manufacturer's performance curves or to 100 psi whichever is greater.
6. Water shall be added to the test segment to maintain the test pressure for a period of no less than 2 hours and no more than 8 hours. The Town's Representative must be present for at least the first 2 hours of testing.

C. Allowable Leakage

Leakage shall be defined as the quantity of water that must be supplied into the pipe or section to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

The maximum allowable apparent leakage shall be determined by the following formula:

$$L = \frac{SD\sqrt{P}}{133,200}$$

Where:

- L = Allowable leakage, in gallons per hour
- S = Length of pipe tested, in feet
- D = Nominal diameter of the pipe, in inches
- P = Average test pressure during leakage test, in pounds per inch (gauge)

This formula is based upon an allowable leakage of 11.65 gallons per day per mile per inch diameter at a pressure of 150 psi. Allowable leakage per 1000 feet of pipe is as follows:

ALLOWABLE LEAKAGE PER 1000 FT. OF PIPELINE - GALLONS PER HOUR

Nominal Pipe Diameter. In.											
Avg. Test Pressure	3	3	6	8	10	12	14	16	18	20	24
200	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55
175	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38
150	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.56	1.84	2.21
125	0.25	0.34	0.50	0.87	0.84	1.01	1.18	1.34	1.51	1.68	2.01
100	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.60	1.80

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D. Failure of Test

If test results disclose leakage greater than allowable limits, the Contractor shall, at his own expense, locate and make approved repairs as necessary until the leakage is within the specified allowance. Additional tests performed after the repairs will be at the Contractors expense.

END OF SECTION 02732