

SECTION 02661

DUCTILE-IRON WATER MAIN PIPE

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes the material standards for ductile-iron pipe used in potable water supply systems. This Section also includes fittings, joints, tapping, testing, disinfection, and connection requirements for the installation of ductile-iron pipe.
- B. Related Requirements
 - 1. Section 02315 – Utility Trenching, Backfill and Compaction
 - 2. Section 02660 – Water Main Systems
 - 3. Section 02668 – Polyethylene Encasement for Ductile-Iron Pipe Systems

1.2 MEASUREMENT AND PAYMENT

- A. Water main, service connections, taps and any other appurtenances will be measured and paid for as described in the related Sections for water main installation.
- B. The costs for all testing and disinfection required by State and public health officials prior to connection to the existing water supply system will not be paid separately, and are to be included unit price bid for water main as described in Part 1.2.A

1.3 REFERENCES

- A. Abbreviations and Acronyms
 - 1. ANSI – American National Standards Institute (www.ansi.org)
 - 2. AWWA - American Water Works Association (www.awwa.org)
 - 3. NSF – National Sanitation Foundation
 - 4. ASTM – American Society for Testing and Materials
 - 5. DIPRA – Ductile Iron Pipe Research Association
 - 6. MEOP – Maximum Expected Operating Pressure
 - 7. MTM – Manual for the Michigan Test Methods
- B. Definitions
 - 1. Working Pressure – the maximum anticipated, sustained operating pressure applied to the pipe exclusive of transient and surge pressures, also referred to as Maximum Expected Operating Pressure.
 - 2. Surge Pressure – the transient internal hydrostatic pressure that the pipeline is subjected to because of pressure waves created by the conveying fluid's velocity change.
 - 3. Test Pressure – the internal hydrostatic pressure specified in the contract documents to which the pipeline will be subjected to during the hydrostatic pressure test and testing allowance test.
 - 4. Restrained Joint – a type of joint designed to resist forces that act to separate a joint, such as thrust caused by internal pressure, external pulling forces, etc. Standard push-on and mechanical joints by themselves do not provide significant restraint against axial thrust forces.

- C. Reference Standards
1. ANSI/AWWA (www.awwa.org)
 - a. ANSI/AWWA C600 Installation of Ductile-Iron Mains and their Appurtenances
 - b. ANSI/AWWA C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
 - c. ANSI/AWWA C110 Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in. for Water and Other Liquids
 - d. ANSI/AWWA C111 Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
 - e. ANSI/AWWA C115 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
 - f. AWWA C116 – Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior of Ductile Iron and Gray-Iron Fittings
 - g. ANSI/AWWA C150 - Thickness Design of Ductile-Iron Pipe
 - h. ANSI/AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water and Other Liquids
 - i. ANSI/AWWA C153 - Ductile-Iron Compact Fittings, 3 in. through 24 in. and 54 in. through 64 in. for Water Service
 - j. ANSI/AWWA C600 – Installation of Ductile Iron Water Main and their Appurtenances
 - k. ANSI/AWWA C651 Disinfecting Water Mains
 - l. AWWA M41 Manual of Water Supply Practices, Ductile-Iron Pipe and Fittings
 2. Unless otherwise specified, references to documents shall mean the latest published edition of the referenced document in effect at the bid date of the project.

1.4 SUBMITTALS

- A. Pipe manufacturer's specific technical data with the physical properties of pipe and pipe dimensions pertinent to this project.
- B. Manufacturer's specific technical data for all fittings, special fittings, couplings, clamps and other appurtenances to be used on the project.
- C. Sworn Statement of Compliance with Specifications as described in AWWA/ANSI C151/A21.51 shall be furnished for all materials to be supplied.
- D. Classification and MDOT pit number of aggregate for bedding and initial backfill materials.

1.5 QUALITY ASSURANCE

- A. Purchase ductile-iron pipe from a manufacturer who produces pipe in accordance with the requirements of AWWA/ANSI C151/A21.51
- B. Visually inspect all pipe, fittings and other materials delivered to the project site for compliance with the specifications and physical condition. Any non-compliant or defective pipe or other materials shall be immediately removed from the project site.

PART 2 PRODUCTS

2.1 WATER MAIN PIPE

- A. Ductile-iron pipe for water main shall be manufactured in accordance with ANSI/AWWA C151.
- B. Pipe will be tagged with the manufacturer's name, trademark, pipe size, class or nominal thickness, appropriate legend such as AWWA C151, date of manufacture, and point of origin. Pipe delivered to site not tagged as indicated above will be rejected.
- C. Dimensions and thickness of ductile-iron pipe will be based on the Special Thickness Class as listed in ANSI/AWWA C150, meeting the following minimum requirements:

Size (Nominal Inside Dia. Inches)	Outside Dia. (Inches)	Thickness (Inches)	Special Thickness Class
6	6.90	0.37	54
8	9.05	0.39	54
12	13.20	0.43	54
16	17.40	0.46	54
20	21.60	0.51	55
24	25.80	0.56	56
30	32.00	0.63	56

- D. Pipe will be lined with cement-mortar lining in accordance with ANSI/AWWA C104. Cement-mortar lining shall be double thickness.
- E. All pipe must be NSF/ANSI 61 listed by the manufacturer.
- F. Pipe Joints:
 - 1. Push-on joints
 - a. Are standard and will be provided except where otherwise noted or specified on the plans or standard details.
 - b. Manufactured in accordance with ANSI/AWWA C111.
 - c. Manufacturers
 - 1) Tyton by U.S. Pipe
 - 2) Fastite by American Cast Iron Pipe Company
 - 3) Owner approved equal
 - 2. Mechanical joints
 - a. Install where called for on the plans or standard details
 - b. Manufactured in accordance with ANSI/AWWA C111.
 - 3. Restrained joints
 - a. Install where called for on the plans or standard details
 - b. Push-on type specifically designed by the pipe manufacturer to provide full restraint
 - c. Capable of being disassembled after installation.

- d. Restraint systems using wedges or other devices embedded in the gasket are prohibited unless otherwise indicated
 - e. Manufactured in accordance with ANSI/AWWA C111.
 - f. Manufacturers
 - 1) TR-Flex by U.S. Pipe
 - 2) Flex-Ring by American Cast Iron Pipe Company
 - 3) Owner approved equal
 - 4. The pressure rating of pipe joints shall meet the minimum requirements as listed in ANSI/AWWA C111.
- G. Bolts and nuts for mechanical joints shall be
- 1. Manufactured of low alloy steel conforming with the material characteristics listed in ANSI/AWWA C111.
 - 2. Coated with a minimum two (2) coats of fluoropolymer epoxy coating and heat cured.
 - 3. Manufacturers
 - a. Cor-Blue by Birmingham Fasteners
 - b. R-Blue by Romac Industries
 - c. Owner approved equal

2.2 FITTINGS

- A. Standard fittings for ductile-iron pipe shall be gray-iron or ductile-iron, manufactured in accordance with ANSI/AWWA C110.
- B. Compact fittings for ductile-iron pipe shall be ductile-iron, manufactured in accordance with ANSI/AWWA C153.
- C. Coatings
 - 1. Conformance with fitting type (AWWA C110 or C153) for interior and exterior coatings
 - 2. Double thickness cement liner
- D. Cast the manufacturer's mark, nominal diameter of openings, number of degrees in fractions of a circle (for bends), and pressure rating on the fitting.
- E. Special fittings, where called for on the plans, shall be furnished under manufacturer's standards, with overall dimension, wall thicknesses, and other provisions as applicable in accordance with ANSI/AWWA C110 or C153.
- F. Fitting Joints:
 - 1. The pressure rating of fitting joints shall meet the minimum requirements as listed in ANSI/AWWA C111.
 - 2. Push-on joints
 - a. Standard joint for fittings
 - b. Manufactured in accordance with ANSI/AWWA C111.
 - 3. Mechanical joints
 - a. To be used where called for on the drawings or standard details,
 - b. Manufactured in accordance with ANSI/AWWA C111.
 - 4. Flange joints,
 - a. Flange joints are not to be buried underground unless specifically called for in the Drawings.
 - b. Manufactured in accordance with ANSI/AWWA C111 and C115.

- c. Coated with a rust inhibitor immediately after drilling
 - d. Manufactured with a single piece full-face rubber gasket with a minimum thickness of 1/8 inch unless otherwise indicated.
- 5. Restrained joints
 - a. To be used where called for on the drawings or standard details.
 - b. Manufactured in accordance with ANSI/AWWA C111.
 - c. Will be a mechanical joint restraint system used in conjunction with mechanical joint fittings,
 - d. Manufacturers
 - 1) Mega-Lug by EBAA Iron, Inc.,
 - 2) Owner approved equal.
 - e. Tightly adherent, corrosion resistant coatings shall be used on all exposed metal components of the restrained joint system.
 - 1) Wedges, actuating hardware, or other exposed threaded components shall be coated with a minimum two (2) coats of fluoropolymer epoxy coating and heat cured.
 - 2) Primary restraint castings shall be coated with a polyester coating, electrostatically applied and fusion bonded.
- G. Bolts, nuts, and washers for mechanical, flange and restrained joints shall be;
 - 1. Manufactured of low alloy steel conforming with the material characteristics listed in ANSI/AWWA C111.
 - 2. Coated with a minimum two (2) coats of fluoropolymer epoxy coating and heat cured.
 - 3. Manufacturers
 - a. Cor-Blue by Birmingham Fasteners
 - b. R-Blue by Romac Industries
 - c. Owner approved equal

2.3 GASKETS:

- A. Provide gaskets for push-on, mechanical or flange joints as follows:
 - 1. For standard use, provide rubber gaskets made of vulcanized styrene butadiene rubber (SBR), meeting the requirements of ANSI/AWWA C111.
 - 2. In areas with possible hydrocarbon contamination, as shown on the plans, provide nitrile (acrylonitrile butadiene – NBR) gaskets, meeting requirements of ANSI/AWWA C111.
- B. Gasket dimensions are unique to each pipe manufacturer, and are not interchangeable. Provide new gaskets from the pipe manufacturer that are compatible with the type of pipe being supplied.
- C. Provide gasket lubricant that is recommended by the pipe manufacturer.

2.4 SERVICE SADDLES

- A. Heavy-duty double strap brass service saddles are required for the installation of corporation stops 2-inch and larger.
- B. Manufacturers
 - 1. Ford Meter Box 202B
 - 2. Owner approved equal

2.5 PIPE BEDDING:

- A. Bedding aggregate to meet grading requirements as specified below.
- B. Delineated as material between the bottom of the trench and the springline of the pipe.
- C. Material shall be a minimum 95% crushed in accordance with MTM 117, unless otherwise approved by the Owner.
- D. Slag and crushed concrete aggregates are prohibited.
- E. Aggregates to be supplied from approved manufacturers of prequalified aggregate sources, as identified in the MDOT Materials Source Guide, latest edition.

BEDDING MATERIAL GRADING REQUIREMENTS								
Material	Total Percent Passing (Sieve Size)							
	1 ½"	1"	¾"	½"	⅜"	No. 4	No. 8	Loss by Washing
MDOT 6A*	100	95-100	-	30-60	-	0-8	-	≤ 1.0
MDOT 17A*	-	100	90-100	50-75	-	0-8	-	≤ 1.0
MDOT 25A	-	-	100	95-100	60-90	5-30	0-12	≤ 3.0
MDOT 34G	-	-	-	100	95-100	-	0-5	≤ 3.0

* Requires Owner Approval

2.6 INITIAL BACKFILL

- A. Initial backfill materials shall match the pipe bedding materials.
- B. Delineated as material between the springline of the pipe and 12-inches above the top of the pipe.
- C. The use of excavated or borrow material from site or materials meeting any of the criteria of "Unsuitable Material" as described in Section 02315 is prohibited.

PART 3 EXECUTION

3.1 DELIVERY, HANDLING, AND STORAGE

- A. Deliver and unload pipe in a manner such that damage to the pipe or coatings is prevented. Materials found to be damaged at the point of installation will be rejected and must be removed from the project site.
- B. Unload pipe from trucks and handle using a suitable lifting device with slings or padded forks or hooks to prevent damage to the coated exterior surface or internal lining of the pipe.
- C. Neatly stack pipe using timbers and chock blocks. Stacks shall not exceed six feet in height.

- D. Store rubber gaskets in a cool location, out of direct sunlight and out of contact with petroleum products.
- E. Materials shall only be stored in areas designated by the Owner. Security for stored materials is the responsibility of the Contractor.

3.2 LAYING PIPE

- A. Install ductile-iron water main pipe in accordance with ANSI/AWWA C600 Type 5 laying condition unless specifically noted otherwise, except that the initial backfill layer shall extend 12-inches above the type of pipe.
- B. Complete trenching and excavation in accordance with Section 02315, with the following specific requirements pertaining to installation of ductile-iron pipe:
 - 1. The minimum width of trench at top of pipe shall be the nominal pipe diameter plus 24 inches.
 - 2. Excavate trench a minimum of 4 inches minimum below the outer surface of the pipe.
 - 3. Place pipe bedding material to the centerline of the pipe.
 - 4. Place initial backfill material to the top of the pipe.
- C. Inspect each pipe and fitting for defects before lowering into the trench, and while suspended.
 - 1. Ring with a light hammer to detect cracks.
 - 2. Defective, damaged or unsound pipe shall immediately be removed from the construction site.
 - 3. The interior of each pipe shall be inspected for cleanness and cleared of all dirt and foreign matter before being lowered into the trench.
- D. Lower all pipe and fittings carefully into the trench using a backhoe, a crane, ropes, or other suitable tools or equipment in such a manner as to prevent damage to water main materials, coatings, encasements and linings.
- E. Unless otherwise approved, pipe shall be laid with bell ends facing in the direction of laying.
 - 1. After a length of pipe is placed in the trench, the spigot shall be centered in the bell of the adjacent pipe, the pipe shoved into position and brought to true alignment and there secured with bedding material tamped under and on each side of the pipe, excepting at bell holes.
 - 2. No earth or other foreign matter shall be allowed to enter the joint space.
- F. When the temperature is above 60 degrees F., the spigot of each pipe laid shall be brought tightly home in the bell of the preceding pipe.
 - 1. When the temperature is below 60 degrees F., the pipe shall be laid with the spigot end approximately 1/16" from the face of the bell to allow for expansion.
- G. Whenever deflections at joints are required by changes in grade or alignment, or to plumb valve stems, the deflection at any bell and spigot joint shall not exceed that which will cause the spigot end of pipe to be away from home in the bell of the adjacent pipe a distance of one-quarter inch at the point of greatest opening.

- H. Where necessary to cut pipe, cutting shall be done with approved tools and cut ends of pipe shall be square and regular.
 - 1. Cut ends and rough edges must be ground smooth.
 - 2. Cut ends to be used with push-on joints must be beveled.
 - 3. Cutting shall be done in a manner to avoid damage to lining and coating.
- I. To prevent trench water from entering the pipe, joints which for any reason may not be completed as the pipe is laid shall be thoroughly packed with approved material, in a manner to make them watertight.
 - 1. Open ends of fittings shall be tightly closed with approved plugs and well packed as shall the end of the last pipe laid whenever work is not in progress.
- J. Tools or other objects shall not be stored or left in the pipe.
- K. Install polyethylene encasement over all ductile-iron pipe and fittings in accordance with Section 02668.
- L. Hoist polyethylene encased pipe using wide-belt nylon slings, padded caliper clamps, or an equivalent method that will not cause damage to the encasement film.

3.3 JOINING PIPE

- A. Assemble push-on joints as described in ANSI/AWWA C600 and in accordance with pipe manufacturer's installation instructions; generally summarized as follows:
 - 1. Clean the groove, gasket, and bell socket and remove all foreign matter.
 - 2. Remove wet sand, mud or ice using a wire brush or scraping tool, or by flushing water.
 - 3. In cold weather (40 degrees F and below), warm the gaskets prior to placement.
 - 4. Insert gasket in bell socket and apply lubricant, checking that gasket is installed in correct direction
 - 5. Coat the pipe bells, spigots, and gaskets with the pipe manufacturer's recommended lubricant.
 - 6. Guide the plain end into the bell of the pipe with reasonably straight alignment and push the plain end into the bell.
 - 7. Bevel and smooth the outside edge of all field cuts as recommended by the manufacturer to reduce the opportunity for damage to the gasket.
 - 8. Deflect the joint only after it has been assembled.
 - 9. Install brass wedges
 - a. 2 wedges per joint for pipes 12 inch in diameter and less
 - b. 4 wedges per joint for pipes greater than 12 inch in diameter
- B. Assemble mechanical joints as described in ANSI/AWWA C600 and in accordance with pipe manufacturer's installation instructions; generally summarized as follows:
 - 1. Clean the socket and plain end and remove all foreign matter.
 - 2. Brush the gasket and plain end with soapy water or an approved lubricant to remove particles of grit or sand that could potentially damage the gasket.
 - 3. In cold weather (40 degrees F and below), warm the gaskets prior to placement.
 - 4. Place the gland on the plain end first, and then the gasket with the narrow edge toward the plain end

5. Insert the plain end into the socket and press the gasket firmly and evenly into the gasket recess
 6. Push the gland against the socket, insert bolts, and tighten bolts to the recommended torque and tightening pattern
 7. The deflection at any mechanical joint shall not exceed 75% of the maximum deflection recommended by the manufacturer of the joint used.
- C. Assemble restrained joints and joint restraint systems in accordance with applicable sections of AWWA C600 and the manufacturer's installation instructions.

3.4 PIPE BEDDING

- A. Prior to placement of bedding materials, remove any rocks, stones, dirt clods and debris larger than the maximum specified particle size from the trench.
- B. Place the required depth of bedding material on the trench subgrade that will rest below the utility bottom.
1. Do not compact the Inner Bedding.
 2. Carefully excavate bell or coupling holes from this bedding layer so that the bells or couplings support no part of the load and the pipe barrel lies flat on the trench bottom.
- C. Install utility
1. To line and grade as specified in the construction drawings.
 2. Refer to specific pipe material specification for installation requirements.
- D. Place Haunch Bedding to the springline of the utility.
1. Distribute bedding material evenly along the trench and equally on both sides of the pipe to maintain alignment.
 2. Shovel slice material to occupy voids along the bottom circumference of the utility.
 3. Hand tamp and consolidate material to minimize voids in lifts not exceeding 6 inches.
 - a. The use of mechanical compaction equipment is prohibited.
 - b. Monitor compaction efforts so as to not raise pipe during consolidation.
 4. At no time should there be more than one lift thickness difference in elevation of the material on one side of the pipe from the other.
- E. Place remainder of Bedding material, if specified, and hand tamp to minimize voids in lifts not exceeding 6 inches.
- F. Under no circumstance shall bedding materials be dropped or dumped into the trench.
- G. Blocking under pipe is strictly prohibited.
- H. Wrap the Pipe Zone with a geotextile separator when installing the utility beneath the ground water table in locations where the rapid movement of groundwater may result in the migration of soil fines into, out of, or between layers of the bedding material.

- I. Bedding in Rock Excavations:
 - 1. Utilities
 - a. A minimum of 6 inches of foundation cushioning is required between the bottom of the utility and the trench subgrade.
 - b. A minimum of 12 inches of clearance is required between the sides of the utility and the walls of the trench.
 - 2. Appurtenant Structures
 - a. A minimum of 8 inches of foundation cushioning is required between the bottom of manhole bases and other precast structures and appurtenances, and the trench subgrade.
 - b. A minimum of 18 inches of clearance is required between the sides of the structures and appurtenances and the walls of the excavation.

3.5 INITIAL BACKFILL

- A. Inspect pipe and fittings prior to Initial Backfill.
- B. Place Initial Backfill immediately after acceptance of utility Bedding compaction to protect the new utility installed.
- C. Observe specific pipe manufacturer's recommendations regarding methods of backfilling and compacting.
- D. Place Initial Backfill in lifts not exceeding 6 inches (loose thickness).
- E. Simultaneously fill the trench on both sides of the pipe in such a manner that injurious side pressures do not occur such that the pipe could be displaced or dislodged.
- F. Hand place, shovel slice, and hand tamp each lift of initial backfill solidly around and directly above the pipe.
 - 1. Utilize hand tamping to compact materials around the pipe.
 - 2. Do not use mechanical compaction equipment during Initial Backfill operations until material has been brought to 12 inches above the top of the pipe barrel.
- G. Exercise extreme care in backfilling operations to avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, distortion or damage to newly made joints.
- H. Compact the top of the Initial Backfill to not less than 95% of the maximum unit weight of the selected material as specified in Article 1.5.
- I. Refer to specific pipe material specification for additional initial backfill requirements.
- J. Remove and replace utility if broken or damaged during backfill installation and compaction.
- K. Repair damages, distortions, or misalignments that occurred during backfill installation and compaction, to the full satisfaction of the Owner.
- L. Do not enclose or cover up any of the Work prior to required inspections and quality control testing.

3.6 BACKFILL AND COMPACTION

- A. Backfill and compact water main trench in accordance with Section 02315.

3.7 HYDROSTATIC TESTING

- A. Refer to Section 02660 for general acceptance testing and hydrostatic testing requirements.
- B. Conduct the hydrostatic pressure test in accordance with ANSI/AWWA C600, Sec. 5.2. The specified test pressure is 150 psi or 1.5 times the MEOP of the test section, whichever is greater. The test method is generally summarized as follows:
 - 1. Slowly fill pipeline with water, venting entrapped air as necessary.
 - 2. Repair any visible leaks that occur during filling or at any point during the test.
 - 3. Gradually apply pressure up to the specified working pressure using a suitable pump connected to the pipeline, bleeding trapped air, and adding water as necessary until a stable pressure is held.
 - 4. Hydrostatic test begins after the pipeline is stabilized at the working pressure by increasing the pressure up to the specified test pressure and hold it within plus/minus 5 psi for the duration of the test, or a minimum of two hours.
 - 5. Carefully record the amount of makeup water added during the test. The hydrostatic test passes if the amount of makeup water does not exceed the testing allowance.
 - 6. If the testing allowance is exceeded, locate and repair any leaks and repeat test.

3.8 FLUSHING, CLEANING, AND DISINFECTION

- A. Disinfect the water main system in accordance with ANSI/AWWA C651 and as described in Section 02660.
- B. Duration of disinfection should not exceed 24 hours.
- C. Thoroughly flush system with fresh water upon successful completion of sampling.
- D. Sample again to verify the disinfectant chlorine level has been reduced to potable drinking water concentrations.

3.9 WATER SERVICE CONNECTIONS

- A. Refer to Section 02660 for general water service connection and installation requirements.
- B. Install mechanical service saddle on ductile iron water mains 16-inch and larger when required corporation stops are 2-inch in diameter or greater.

END OF SECTION