

Sample Ductile Iron Pipe Specification

1. GENERAL

Ductile iron pipe (DIP) and fittings shall comply with ISO 2531, with additional requirements as herein specified. The quality system of the pipe manufacturer shall also be registered to an ISO 9000 quality standard by an accredited registrar.

2. DUCTILE IRON PIPE

2.1 Push-on Joints:

Ductile iron socket and spigot pipes shall be Push-On Joint cast in nominal 6 meter lengths in accordance with ISO 2531. The socket shall be scientifically designed with a unique gasket recess containing a dividing buttress, and the joint shall be manufactured to such tolerances that the gasket is self-centered, securely confined, and firmly compressed for a permanent, tight, trouble free joint.

2.2 Restrained Joints:

Restrained joints shall be boltless restrained joints, utilizing Push-On Joint sealing members.

2.3 Flanged Pipe:

Flanged pipe such as flange x spigot pipe, flange x flange pipe, socket x flange pipe, shall be statically cast or fabricated from class K12 or heavier wall thickness ductile iron in accordance with ISO 2531. Flanges shall be screwed-on or integrally cast. Flanges shall be flat faced or raised face at the manufacturer's option. Puddle flanges or wall collars for placement in concrete walls shall be factory welded or integrally cast.

2.4 Testing:

DIP shall be tested in accordance with ISO 2531, with additional requirements as herein specified.

2.5 Material:

Ductile iron (DI) used in the manufacture of pipe shall be in accordance with ISO 2531, with additional requirements as herein specified.

2.6 Dimensional requirements

2.6.1 Outer diameter

The outer diameter of the spigot should comply with the following tolerances:

100-300 mm diameter + 1.00 mm-1.50 mm

350-600 mm diameter + 1.00 mm-2.00 mm

700-1000 mm diameter + 1.00 mm-1.50 mm

1200-1600 mm diameter + 1.00 mm-2.50 mm

2.6.2 Tolerance on Masses

The tolerances on the standard masses are given in the table below.

Tolerance on Masses

Type of casting		Tolerance on standard mass %
Pipes centrifugally cast	Up to DN 200 inclusive	±8
	Above DN 200	±5
Pipes not centrifugally cast		±8

2.7 Markings:

Each pipe shall be marked per ISO 2531, with the following by labeling, painting, cast-on or cold stamped marking, depending on the mark itself and the product: (stenciling or marks on the outside of pipe shall be 25mm high for 400mm and smaller; and 50mm high for 450mm and larger pipe sizes).

2.7.1 Size.

2.7.2 Class.

2.7.3 Weight

2.7.4 ISO 2531.

2.7.5 Length, if the pipe is not a nominal 6 meter length.

2.7.6 Gauged/Calibrated pipe shall have a green band painted behind the bell indicating that the pipe is suitable for field cutting.

2.7.7 Manufacturer's name or trademark.

2.7.8 Year of manufacture.

2.7.9 Two circumferential lines on the spigot to provide a visual means of checking that the spigot is properly inserted in the joint.

3. FITTINGS

3.1 Push-On Fittings:

Ductile iron socket fittings shall be Push-On Joint fittings manufactured in accordance with ISO 2531. Bends and reducers shall be Class K12 and tees shall be Class K14.

3.2 Restrained Joints:

Restrained joints shall be boltless restrained joints, utilizing Push-On Joint sealing members.

3.3 Flanged Joints:

Flanged fittings shall be PN10, PN16, or PN25 with dimensions per ISO 7005-2. Flanges may be flat or raised faced at manufacturer's option. All flanges on statically cast fittings shall be integrally cast.

3.4 Testing:

Each fitting shall be subjected to a factory air test of 1 bar in accordance with ISO 2531.

3.5 Material:

DI used in the manufacture of fittings shall be in accordance with ISO 2531.

3.6 Markings:

Each fitting shall be marked per ISO 2531, with the following by labeling, painting, cast-on or cold stamped marking, depending on the mark itself and the product:

3.6.1 Size.

3.6.2 Type of bend: i.e., 1/4, 1/8, 1/16, 1/32.

3.6.3 ISO 2531.

3.6.4 Year of manufacture for fittings greater than 300mm.

3.6.5 Manufacturer's name or trademark.

3.7 WELDED-ON OUTLETS

3.7.1 Outlet Size and Parent Pipe Size:

Welded-on outlets shall be limited to branch outlets having a nominal diameter not greater than 70% of the nominal diameter of the main line pipe or 800mm whichever is smaller (see Table No. 1), with all fabrications subject to further requirements of the following specification with regard to design and manufacture. The MANUFACTURER shall have the capability to furnish welded-on outlets as a radial (tee) outlet, tangential outlet, or lateral outlet fabricated at a specific angle to the main line pipe (in 15° increments between 45° and 90° from the axis of the main line pipe), as indicated on the drawings.

Table No. 1

Main Line Nominal Dia.	Max. Branch Outlet Nominal Dia.		Main Line Nominal Dia.	Max. Branch Outlet Nominal Dia.
450mm	300mm		800mm	500mm
500mm	350mm		900mm	600mm
600mm	400mm		1000mm	800mm
700mm	500mm		1200mm	800mm
			1400mm	800mm
			1500mm	800mm
			1600mm	800mm

3.7.2 Outlet Joint Types: The joints on welded-on branch outlets shall be flexible joints meeting the requirements of ANSI/AWWA A21.11/C111 and ISO 2531. When connections are not buried directly in the ground and otherwise are not potentially subject to beam loads or misalignment in service, flanged PN10, PN16 or PN25 outlet joints can be furnished.

3.7.3 Design and Testing:

3.7.3.1 The pipe wall thickness and weld reinforcement design for welded-on outlet fabrications shall provide a minimum safety factor of 2.5 for all outlet offerings based on the yield strength of the pipe and deposited weld material and while subjected to the maximum rated working pressure. The Pressure Diameter Value (PDV), as defined by the following formula, shall be 6000 or less:

$$PDV = 0.562Pd^2 / (D\sin^2 \theta),$$

Where,

P = working pressure (in kg/cm²)

d = branch outside diameter (in mm)

D = main pipe outside diameter (mm)

θ = branch diameter angle of deflection from the axis of the main pipe

3.7.3.2 The manufacturer shall confirm the design method with proof of design hydrostatic tests of weakest outlet configurations. The MANUFACTURER shall, at the request of the OWNER or OWNER's ENGINEER, provide representative proof test results confirming the design, hydrostatic test results, and safety factors.

Reinforcing welds shall be placed using electrode material meeting requirements of AWS A5.15 Class E70T1-C or E70T1-C1. In addition, electrode material shall be proven capable of producing a weld joint with a Charpy V-notch impact strength of 13.5 J (when transverse impact specimens are machined from butt-weld joined ductile iron pipe coupons) when tested at 21° C + - 6° C. Carbon steel electrodes are not acceptable.

Upon request, the MANUFACTURER shall provide test results indicating typical physical properties of the utilized weld material (an all-weld sample), as well as typical physical properties from transverse tensile and impact specimens machined from butt-weld joined ductile iron pipe coupons, to show the suitability or equivalence of the electrodes used.

3.7.3.3 Parent pipe and branch outlet candidate pipe shall be centrifugally cast ductile iron pipe manufactured in accordance with this standard. Minimum classes for parent and outlet pipe shall be K12 per ISO 2531.

3.7.3.4 All welded-on outlet pipes shall be standard rated for a working pressure of 16 kg/cm². For any application involving working pressures in excess of 16 kg/cm², the manufacturer shall supply design information and test results to the Owner or Owner's Engineer confirming the suitability of the fabricated pipes for such applications.

3.7.3.5 Prior to the application of any coating or lining in the outlet area all weldments for branch outlets to be supplied on this project shall be subjected to an air pressure test of at least 1 bar. Air leakage is not acceptable. Any leakage shall be detected by applying an appropriate foaming solution to the entire exterior surface of the weldment and adjoining pipe edges or by immersing the entire area in a vessel of water and visually inspecting the weld surface for the presence of air bubbles. Any weldment that shows any signs of leakage shall be repaired and re-tested in accordance with the manufacturers' written procedures.

3.7.4 Quality Assurance

3.7.4.1 The manufacturer shall have a fully documented welding quality assurance system and maintain resident quality assurance records based on ANSI/AWS D11.2, the *Guide for Welding Iron Castings* or equal. The manufacturer shall maintain appropriate welding procedure specification (WPS), procedure qualification (PQR), and welder performance qualification test (WPQR) records as well as appropriate air test logs documenting air leakage tests on all welded on outlet pipes furnished to the project.

3.7.4.2 Prior to the start of manufacturing any proposed manufacturer not meeting ISO 9001 or 9002 registration requirements shall submit to the OWNER or OWNER's ENGINEER the name of an Independent Inspection Agency and the agency's qualifications. Submitted qualifications shall include but are not limited to the following:

- List of project references for projects of similar type and size
- Resumes for inspection and testing personnel
- Capacities for chemical and mechanical testing of material specimens
- Frequencies for all instrument and testing equipment certifications

3.7.4.3 The independent inspection agency shall be responsible for all of the following:

- Verify compliance to written welding procedures, specification (WPS), and procedure qualification (PQR).
- Verify qualification of all welders (WPQR) per ANSI/AWS D11.2 criteria
- Document use of Ni-Rod FC 55 cored wire or Ni-Rod 55 electrodes manufactured by INCO Alloys, Stoodly Cast-Weld 55-0 cored wire, or an electrode with equivalent performance properties. The independent testing agency shall provide test results indicating typical physical properties of the utilized weld material (an all-weld sample), as well as typical physical properties from transverse tensile and impact specimens machined from butt-weld joined ductile iron pipe coupons to show the suitability or equivalence of the electrodes used.
- Witness and document all air testing of outlet welds

4. JOINT ACCESSORIES

4.1 Gaskets:

Push-On Joint gaskets shall be molded SBR rubber per ANSI/AWWA C111/A21.11 and ISO 4633.

4.2 Flanged Joints Accessories:

4.2.1 Flange joint gaskets shall be 3mm nominal thickness, ring or full face SBR rubber.

4.2.2 Bolts, nuts, and washers shall be galvanized steel.

4.3 Pipe Joint Lubricant for Push-On Joints:

Fastite lubricant shall be certified to the requirements of ANSI/NSF 61 standard for contact with potable water.

5. LININGS

5.1 Pipe:

5.1.1 General:

DIP shall be internally lined with sulphate resisting cement mortar lining in accordance with ISO 4179, by a high speed, centrifugal process. The quality system of the manufacturer shall be registered to an ISO 9000 quality standard by an accredited registrar. Grinding of linings shall not be allowed. The finished cement lining shall be uniformly smooth. In addition to complying with ISO 4179, the linings shall also comply with the following additional requirements.

5.1.2 Material:

The cement used shall be a sulphate resisting Portland Cement meeting the requirements of ASTM C-150 Type II, ASTM C-150 Type V, and the chemical requirements of BS 4027. Sand shall consist of inert, hard, strong, and durable silica grains. The water used in the cement mortar shall be potable, and free from injurious quantities of organic matter, alkali, salt or other impurities that might reduce the strength, durability, or other desirable qualities of the lining. All material in contact with water shall be certified to meet the requirements of ANSI/NSF Standard 61.

5.1.3 Mortar:

The cement mortar shall contain not less than one part of cement to two parts of sand, by volume.

5.1.4 Lining Thickness:

Cement lining thicknesses shall be per ISO 4179 and as shown in the table below. For 450mm and larger pipe, the exposed edges of the lining shall be essentially square and perpendicular with the axis of the pipe.

Pipe Size	Nominal Lining Thickness (mm)	Mean Minimum Thickness (mm)	Minimum Value at One Point
100mm - 300mm	3.0	2.5	1.5
350mm - 600mm	5.0	4.5	2.5
700mm - 1200mm	6.0	5.5	3.0
1400mm - 1600mm	9.0	8.0	4.0

NOTE: For some service conditions, greater lining thicknesses may be preferred. Consult the Manufacturer for specific recommendations.

5.1.5 Surface Preparation:

All surfaces to be mortar lined shall be cleaned as necessary to remove foreign matter that could interfere with the adherence of the cement mortar or protrude through the lining.

5.1.6 Lining Equipment and Process:

Linings shall be manufactured using centrifugal pipe rotational equipment which sustains high-speed acceleration on the applied lining. The mortar of the lining is cast centrifugally inside the pipe. Grinding of linings shall not be allowed. The minimum centrifugal force for application of the lining shall be 45 G for 400mm and smaller and 60 G for 450mm and larger. Simultaneous controlled vibration shall be applied to the pipe during high-speed rotation to produce a lining of such high density and firm compaction that it will immediately allow laitance washing with a large volume of water. The manufacturer shall certify that the linings have been applied according to these specifications. The mortar shall be mixed in batches. The amount of cement and sand entering into each batch shall be measured by weight. The quantity of mixing water entering into each batch shall be measured automatically by an adjustable device, or it shall be otherwise measured to ensure that the correct quantity of water is being added.

5.1.7 *Washing and Finish:*

After the mortar has been distributed, the rotational speed and vibration shall be increased to produce a mortar lining with a uniformly smooth, firm surface. Immediately after lining, the surface of the lining shall be washed with water to remove excess laitance.

5.1.8 *Curing:*

Cement mortar linings shall be adequately cured in a facility with controlled atmosphere. Linings shall be furnished standard without seal coat.

5.1.9 *Cracks and Repairs:*

Linings with cracks greater than 0.6mm in width are unacceptable. All repairs of damage shall be reasonably smooth and may not project into the waterway.

5.2 *Fittings:*

Fittings shall be internally lined with cement mortar lining composed of similar quality cement, sand, and mixing water constituents as per pipe, and lining thicknesses shall be equal to or greater than those for comparable size pipe.

5.3 *Flanged Pipes:*

Flanged pipes shall be internally lined with a cement mortar lining composed of similar quality cement, sand, and mixing water (see 5.1.2 (above)), and lining thicknesses shall be equal to or greater than those for comparable sizes of other pipes.

5.4 *Seal Coat:*

Seal coat may be supplied for cement mortar linings for pipe, flanged pipe, and fittings, if necessary for special service conditions. Standard products are furnished without seal coat in accordance with ISO 4179.

6. EXTERNAL COATINGS

6.1 Coating for DIP and Fittings:

Ductile Iron pipe and fittings shall be externally coated with a black bituminous paint with a mean dry film thickness of not less than 70 microns with a local minimum thickness of 50 microns. The coating shall be smooth, neither brittle when cold nor sticky when exposed to the sun, and shall be strongly adherent to the pipe.

6.2 Sockets and Spigots of DIP and Fittings:

All cement mortar lined ductile iron pipe and fittings shall have a coating of black bituminous paint approximately 50 microns thick on the inside of sockets and the outside of spigots.

7. ADDITIONAL EXTERNAL PROTECTION

7.1 Polyethylene Sleeves:

Polyethylene sleeves, if required, shall fully comply with ANSI/AWWA C105/A21.5 and ASTM A674. The nominal thickness shall be 250 microns.

8. INSPECTION, TESTING, AND QUALITY CONTROL

8.1 Standards:

Inspection and testing of products shall be carried out in accordance with the following standards:

8.1.1 Ductile Iron Pipe and Fittings - ISO 2531.

8.1.2 Gaskets - SBR rubber per ANSI/AWWA C111/A21.11 for Push-On and Mechanical Joints.

8.1.3 Linings - ISO 4179.

8.1.4 Coatings - ANSI/AWWA C151.A21.51

8.1.5 Polyethylene Sleeves - ANSI/AWWA C105/A21.5 and ASTM A674.

8.2 Material Tests:

8.2.1 Standard Mechanical Property Tests:

Mechanical tests will be performed for pipe and fitting manufacture in accordance with ISO 2531, with additional requirements as herein specified.

8.2.2 Impact Testing:

In addition to standard mechanical testing requirements per ISO 2531, the impact resistance of DIP furnished shall be confirmed by Charpy impact testing full wall thickness samples machined from pipe produced for the project. Impact sampling and testing shall be performed at least once every hour. These samples shall be machined and tested in accordance with Sec. 51-12.2 of ANSI/AWWA C151/A21.51 and ASTM E23 as applicable, and the minimum acceptance value for the test results corrected to a 10.2mm (0.40") wall thickness shall be 9.5 Joules (7 ft-lb) for tests to be performed at $21^{\circ} \pm 6^{\circ}$ Celsius ($70^{\circ} \pm 10^{\circ}$ Fahrenheit). An additional low temperature impact test shall be made from at least 10 percent of sample coupons taken for the required $21^{\circ} \pm 6^{\circ}$ Celsius ($70^{\circ} \pm 10^{\circ}$ Fahrenheit) impact tests. The minimum acceptance value corrected to a 10.2mm (0.40") wall thickness for these tests to be performed at -40° Celsius (-40° Fahrenheit) shall be 4.1 Joules (3 ft-lb).

8.3 Hydrostatic Tests for DIP:

Hydrostatic testing of pipe shall be performed in accordance with ISO 2531 at the internal test pressures given in the below table.

Work test pressure

DN mm	Work test pressure kg/cm ²	
	Pipe centrifugally cast	
	<i>K9</i>	<i>K7</i>
100	50	-
150	50	-
200	50	-
250	50	-
300	50	-
350	50	-
400	50	-
450	80	-
500	76	-
600	70	55
700	60	51
800	60	49
900	60	47
1000	58	45
1200	40	40
1400	40	40
1500	40	40
1600	40	40

8.4 Fitting Tests:

One bar air tests of fittings shall be performed in accordance with ISO 2531.

8.5 Certifications and Records:

The manufacturer must supply a signed certificate stating that all DIP and fittings fully comply with these specifications.

8.6 Visual Inspection and Dimensional Tests:

Pipes and fittings shall have adequate visual inspection of external coating and internal lining surfaces and adequate measurements of wall thicknesses, spigot outside diameters, socket inside diameters, and other product dimensions to insure that the products furnished meet project specifications.

9. LININGS FOR SEWER SERVICE

9.1 Internal lining requirements for sewer service - pipe flowing full (pH > 5.5)

Cement lining as shown in section 5 with seal-coat as shown in section 5.4. Cement shall be sulfate resisting Type 5 per ASTM C150 or approved equal.

9.2 Internal lining requirements for sewer service - pipe not flowing full with potential of generating acid on crown of the pipe (pH < 5.5)

9.2.1 Materials

9.2.1.1 Special Lining for Sewer Service

AMERICAN can furnish 100mm – 1600mm (4"-64") PROTECTO 401 Ceramic Epoxy-lined ductile iron pipe and fittings. This third-party designed and - applied lining is amine cured with novalac and ceramic quartz pigment for an approximately 1000 microns (40-mil) thick, high-build lining. **For features of and stipulations regarding assembly of pipes furnished with this lining, users and installers of pipes with this lining should refer to the website <http://www.protecto401.com/>.**