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Standard Specification for 12 to 60 in. [300 to 1500 mm] Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications[1]

This standard is issued under the fixed designation F2881/F2881M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers requirements and test methods for dual wall polypropylene pipe and fittings. The nominal inside diameters covered are 12 to 60 in. [300 to 1500 mm].

1.2 The requirements of this specification are intended to provide pipe and fittings suitable for underground use for non-pressure storm sewer systems. Pipe and fittings produced in accordance with this specification shall be installed in compliance with Practice D2321.

1.3 This specification covers pipe and fittings with an interior smooth wall and an annular corrugated profile outer wall (Fig. 1).

1.4 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 The following precautionary statement caveat pertains only to the test method portion, Section 7, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards*:[2]

A666 Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
D618 Practice for Conditioning Plastics for Testing
D638 Test Method for Tensile Properties of Plastics
D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
D1505 Test Method for Density of Plastics by the Density-Gradient Technique
D1600 Terminology for Abbreviated Terms Relating to Plastics
D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
D2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
D2444 Practice for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.62 on Sewer.
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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

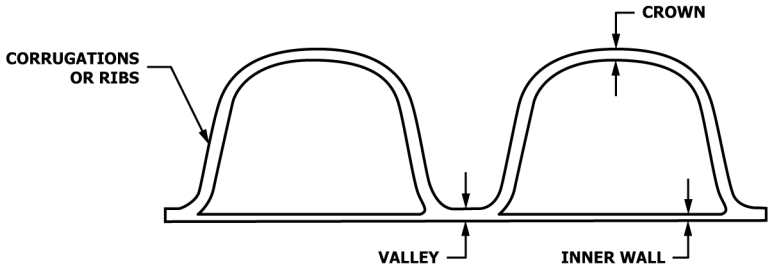

FIG. 1 Interior Smooth Wall and an Annular Corrugated Profile Outer Wall

D2990 Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
D3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
D3895 Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
D4101 Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials
D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique
D4389/D4389M Specification for Finished Glass Fabrics Woven From Rovings
D6992 Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method
F412 Terminology Relating to Plastic Piping Systems
F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

2.2 *AASHTO Standard:*[3]

LRFD, Section 12 AASHTO LRFD Bridge Design Specifications Section 12 – Buried Structures and Tunnel Liners
M288 Geotextile Specification for Highway Applications

2.3 *Federal/Military Standards:*[4]

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)
MIL-STD-129 Marking for Shipment and Storage

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology F412 and abbreviations are in accordance with Terminology D1600, unless otherwise specified. The abbreviation for polypropylene is PP.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *dual wall, n*—In this case, the dual pipe wall construction provides an interior wall in the waterway and includes ribs, corrugations, or other shapes, which can be either solid or hollow, that helps brace the pipe against diametrical deformation.

3.2.2 *silt-tight joint, n*—Joint that prevents the passage of silt or soil, does not restrict water passage.

3.2.3 *water-tight joint, n*—Joint that retrains the passage of water to not exceed a specified limit.

4. Ordering Information

4.1 Orders for product made to this specification shall include the following information to adequately describe the desired product:

4.1.1 This ASTM designation and year of issue,
4.1.2 Diameters,
4.1.3 Total footage of each pipe diameter involved,
4.1.4 Pipe laying length,
4.1.5 Joint requirements
4.1.6 *Fitting type(s):*
4.1.6.1 Size and type of fittings, including mainline and branch diameters, and
4.1.6.2 Number of fittings per diameter.

5. Materials and Manufacture

5.1 *Pipe and Fabricated Fittings—Polypropylene Compounds*—Polypropylene compounds used in the manufacture of the dual wall pipe and fittings shall have the minimum properties as shown in Table 1. Polypropylene compounds shall be comprised of the base unfilled copolymer polypropylene virgin resin and all additives, colorants, UV inhibitors and stabilizers. Conditioning,

[3] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.
[4] Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.dla.mil.

TABLE 1 Polypropylene Compound Properties

~~Property~~	~~ASTM Test Method~~	~~Units [SI Units]~~	~~Minimum Value~~	~~Maximum~~
~~Melt Flow Rate~~	~~D1238~~	~~g/10 min~~	~~0.25 at 230 °C~~	~~1.50 at 23~~
~~Density~~	~~D792, D1505~~	~~lb/in.^{3} [g/cm^3]~~	~~0.0325 [0.900]~~	~~0.0343 [0.~~
~~Tensile Strength at Yield~~	~~D638~~	~~psi [N/mm^2]~~	~~3500 [24]~~	~~5000 [3~~
~~Elongation at Yield~~	~~D638~~	~~% [%]~~	~~5 [5]~~	~~25 [25~~
~~Flexural Modulus (1 % secant)~~	~~D790 Procedure B~~	~~psi [N/mm^2]~~	~~175 000 [1200]~~	~~325 000 [2~~
~~IZOD Impact Strength (73 °F [23 °C])~~	~~D256~~	~~ft-lb/in.^{2} [kJ/m^2]~~	~~23.8 [50]~~	~~No Bre~~
~~Oxidative-Induction Time (392 °F [200 °C])~~	~~D3895~~	~~min~~	~~25~~	~~200~~

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Flexural Modulus (1 % secant)	D790 Procedure B	psi [N/mm^2]	175 000 [1200]
IZOD Impact Strength (73 °F [23 °C])	D256	ft-lb/in.^{2} [kJ/m^2]	23.8 [50]
Oxidative-Induction Time (392 °F [200 °C])	D3895	min	25

sampling, preparation and testing of molded specimens shall be in accordance with the requirements in Specification D4101. Compounds shall be tested and validated on an annual basis or for any new formulations. Compounds that have higher performance properties shall be permitted provided the density of the base resin shall not exceed 0.0343 lb/in^3 (0.950 g/cm^3) and all other product requirements are met.

NOTE 1—Stress-cracking has not been shown to be a concern with polypropylene resins, so no slow-crack growth test protocol has been developed for assessing it.

5.2 *Color and Ultraviolet Stabilization for Pipe and Fabricated Fittings*—The pipe shall be colored or black. Black polypropylene compounds shall have between 2.0 and 3.0 percent carbon black when tested in accordance with the procedures in Test Method D4218. Colored polypropylene compounds shall be protected from Ultraviolet (UV) degradation with UV stabilizers.

NOTE 2—Pipe users should consult with the pipe manufacturer about the outdoor exposure life of the product under consideration.

5.3 *Rework Plastic*—Clean polypropylene rework plastic, generated from the manufacturer's own production of the product and having the same minimum physical properties, may be used by the manufacturer, provided that the pipe produced meets all the requirements of this specification.

5.4 *Elastomeric Seal Materials*—Elastomeric compounds and thermoplastic elastomeric compounds used in the manufacture of sealing rings or gaskets shall meet the requirements of Specification F477.

5.5 *Lubricant*—The lubricant used for assembly of gasketed joints shall have no detrimental effect on the gasket or the pipe.

5.6 *Optional Bell Retaining Bands*—Bell retaining bands, if used, shall meet the requirements in 6.6.4 and shall be made of corrosive resistant materials such as fiberglass (Specification D4389/D4389M) or stainless steel (Specification A666).

5.6.1 The Specification D4389/D4389M fiberglass roving shall be an E type glass, free of any alkali, dirt or other impurities. The band shall consist of a continuous, overlapping filament fiber and not a fabric.

NOTE 3—Compound and material properties are typically tested to validate a formulation; they are not routine quality assurance tests. Users requiring such testing for quality assurance purposes should insert these criteria in their project specifications.

6. General Requirements

6.1 *Workmanship*—The pipe and fittings shall be homogeneous throughout and be as uniform as commercially practical in color, opacity, and density. The pipe walls shall be free of cracks, holes, blisters, voids, foreign inclusions, or other defects that are visible to the naked eye and that may affect the wall integrity. The ends shall be cut cleanly and squarely through valleys.

6.1.1 Visible defects, cracks, creases, splits, in pipe are not permissible.

6.2 *Dimensions and Tolerance:*

6.2.1 *Nominal Size*—The nominal size for the pipe and fittings shall be the inside diameter shown in Table 2.

6.2.2 *Laying Length*—The pipe shall be supplied in any laying length agreeable to both the owner and the manufacturer. Laying length shall not be less than 99 % of stated quantity when measured in accordance with 7.3.2.

6.2.3 *Minimum Wall, Crown, Valley and Liner Thickness*—The minimum thickness of pipe sections shall meet the requirements given in Table 2 when measured in accordance with 7.3.3.

NOTE 4—The outside diameters and the corrugation pitch of products manufactured to this specification are not specified; therefore, compatibility between pipe and fittings made to this specification from different manufacturers should be verified.

6.3 *Pipe Stiffness*—Minimum pipe stiffness at 5 % deflection shall meet the requirements given in Table 2 when tested in accordance with 7.4.

TABLE 2 Pipe Stiffness and Pipe Dimensions

Pipe Inside Diameter		Inside Diameter Tolerances		Minimum Pipe Stiffness at 5 % Deflection		Minimum Inner Liner Thickness		Minimum Valley Thickness		Minimum Crown Thickness	
in.	[mm]	in.	[mm]	lb/in/in	[kPa]	in.	[mm]	in.	[mm]	in.	[mm]
12	[300]	± 0.12	[± 3.0]	70	[482]	0.045	[1.1]	0.103	[2.6]	0.052	[1.3]
15	[400]	± 0.15	[± 3.8]	60	[413]	0.050	[1.3]	0.126	[3.2]	0.068	[1.7]
18	[450]	± 0.18	[± 4.6]	56	[386]	0.055	[1.4]	0.132	[3.4]	0.074	[1.9]
24	[600]	± 0.24	[± 6.1]	50	[344]	0.060	[1.5]	0.144	[3.7]	0.093	[2.4]
30	[750]	± 0.30	[± 7.6]	46	[317]	0.065	[1.7]	0.148	[3.8]	0.108	[2.7]
36	[900]	± 0.36	[± 9.1]	40	[275]	0.070	[1.8]	0.153	[3.9]	0.132	[3.4]
42	[1050]	± 0.42	[±10.7]	35	[241]	0.070	[1.8]	0.158	[4.0]	0.160	[4.1]
48	[1200]	± 0.48	[± 12.2]	30	[206]	0.072	[1.8]	0.179	[4.6]	0.165	[4.2]
54	[1350]	± 0.54	[± 13.7]	26	[175]	0.078	[2.0]	0.194	[4.9]	0.178	[4.5]
60	[1500]	± 0.60	[± 15.2]	25	[170]	0.085	[2.2]	0.215	[5.5]	0.180	[4.6]

NOTE 5—The 5 % deflection criterion, which was selected for testing convenience, is not a limitation with respect to in-use deflection. The engineer is responsible for establishing the acceptable deflection limit.

6.4 *Pipe Flattening*—There shall be no evidence of splitting, cracking, breaking, separation of seams, separation of the outer and inner wall, or combinations thereof, when tested in accordance with 7.5. Additionally, at or below the average deflection limit defined in Eq 1 for dual wall profiles the specimen shall be considered as failing this test when the load does not increase continuously with increasing deflection.

Average Buckling Deflection Limit:

$$\Delta = 0.0107 \cdot \left(\frac{D}{0.5\,(D_o - D_i)} \right) \tag{1}$$

$$\Delta = 1.07\ \% \cdot \left(\frac{D}{0.5\,(D_o - D_i)} \right) \tag{1}$$

where:

Δ = ~~minimum buckling deflection limit (in./in. [mm/mm])~~

$\underline{\Delta}$ = minimum buckling deflection limit (%)

D = mean diameter (centroid) of pipe (in. [mm])

$0.5\,(D_o - D_i)$ = height of the corrugation (outside diameter minus inside diameter) (in. [mm])

NOTE 6—Eq 1 is based on the results from NCHRP Report 631[5] and is defined as being derived from the standard parallel plate test equation and modified for polypropylene. The values for the diameter measurements are based on each producer's specific corrugation dimensions.

6.5 *Pipe Impact Strength*—There shall be no evidence of splitting, cracking, breaking, separation of seams, separation of the outer and inner wall, or combinations thereof, when conditioned in accordance with 7.1 and tested in accordance with 7.6 and examined under normal light and the unaided eye. The minimum pipe impact strength at 73 °F [23 °C] shall be 140 ft-lbf [190 J].

NOTE 7—Discoloration or "whitening" of the pipe during pipe flattening and impact tests is normal and does not represent a failure criteria for either test.

6.6 *Fabricated Fittings and Joining Systems:*

6.6.1 Only fabricated fittings and joining systems supplied or recommended by the pipe manufacturer shall be used. Fabricated fittings shall be installed in accordance with the manufacturer's recommendations and meet the same material requirements as the pipe.

NOTE 8—Fittings may be fabricated from the pipe by a variety of processes including hot plate welding, spin welding or other processes.

6.6.2 The joining system(s) shall be of a design that preserves alignment at the joints while maintaining the specified level of watertight requirements in accordance with 6.6.3.

6.6.3 Pipe and fittings shall be specified in 4.1.5 and have either silt-tight bell/spigot joints that utilize a gasket that complies with the requirements of Specification F477 or watertight bell/spigot joint that complies with the laboratory tests defined and described in Specification D3212 and utilizes a gasket that complies with the requirements of Specification F477. It is permissible to supply silt-tight bell/spigot joints with geotextile wrapping meeting the requirements of M 288 in lieu of a rubber gasket. Note that special provisions must be taken in order to join field cut pipe that must have watertight joints meeting the requirements of Specification D3212.

NOTE 9—Specification D3212 testing only confirms laboratory short-term watertight integrity of the joint design. If long-term watertight performance is required, field testing of the joint should be conducted a minimum 30-days after installation. This testing assesses the impact of long-term material properties and installation quality.

[5] National Cooperative Highway Research Program (NCHRP) Report 631: Updated Test and Design Methods for Thermoplastic Drainage Pipe. DOI: 10.17226/23045