



Standard Specification for 12 to 60 in. [300 to 1500 mm] Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications¹

This standard is issued under the fixed designation F2881; 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 nonpressure 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 and health practices and determine the applicability of regulatory limitations prior to use.*

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

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. Current edition approved March 1, 2011. Published March 2011. DOI: 10.1520/F2881-11.

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.

- [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](#) Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
- [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](#) 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](#) 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

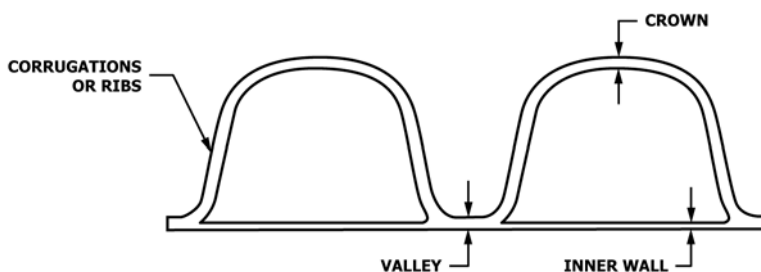


FIG. 1

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 restrains 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,

³ Available from 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 Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://dodssp.dla.mil>.

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, 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.

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.

TABLE 1 Polypropylene Compound Properties

Property	ASTM Test Method	Units (SI Units)	Minimum Value	Maximum Value
Melt Flow Rate	D1238	g/10 min	0.25 at 230°C	1.50 at 230°C
Density	D792, D1505	lb/in ³ (g/cm ³)	0.0325 (0.900)	0.0343 (0.950)
Tensile Strength at Yield	D638	psi (N/mm ²)	3,500 (24)	5,000 (34)
Elongation at Yield	D638	% (%)	5 (5)	25 (25)
Flexural Modulus (1% secant)	D790 Procedure B	psi (N/mm ²)	175,000 (1,200)	325,000 (2,250)
IZOD Impact Strength (73°F (23°C))	D256	ft-lb/in ² (kJ/m ²)	23.8 (50)	No Break
Oxidative-Induction Time (392°F (200°C))	D3895	min	25	200

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**) or stainless steel (Specification **A666**).

5.6.1 The Specification **D4389** 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**.

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**.

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 6—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 7—Fittings may be fabricated from the pipe by a variety of

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]

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 Test Method 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 8—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 longterm material properties and installation quality.

6.6.4 Optional retaining bands, when used and tested in accordance with 6.6.3, shall show no signs of cracking, separation, splitting or delamination from the pipe during this test.

6.7 *Perforations*—Perforations shall be cleanly cut, placed in the valley of the corrugation rib, and uniformly spaced along the length and circumference of the pipe. Dimensions of the perforations and the minimum perforation inlet area shall be as listed in Table 3. Other perforation dimensions and configurations shall be permitted, where required to meet the needs of the specifier. All measurements shall be made in accordance with 7.3.4. Pipe connected by bell and spigot joints shall not be perforated in the area of the bells and spigots.

6.8 *Creep Rupture Strength*—Specimens fabricated in the same manner and composed of the same materials as the finished pipe shall have a 50-year creep rupture tensile strength at 73°F (23°C) not less than 1000 psi (7 MPa), when determined in accordance with 7.7.

6.9 *Creep Modulus*—Specimens fabricated in the same manner and composed of the same materials as the finished pipe shall have a 50-year tensile creep modulus at 73°F (23°C)

at the stress level of 500 psi (3.5 MPa) not less than 27,000 psi (186 MPa). The creep modulus shall be determined in accordance with 7.8.

NOTE 9—The 50-year creep rupture strength and 50-year creep modulus values, determined by the test methods in 7.7 and 7.8, are used to define the slope of the logarithmic regression curves to describe the required material properties sampled from the product. They are not to be interpreted as service life limits.

6.10 *Installation Requirements*—The pipe manufacturer shall provide the purchaser with the requirements for the proper installation of the pipe and the minimum and maximum allowable cover height for specific traffic and non-traffic loading conditions. The installation requirements shall be based on D2321 with a design that satisfies the safety factors specified in the AASHTO LRFD Bridge Design Specifications, LRFD, Section 12 for Thermoplastic Pipe for earth and live loads, with consideration for impact and multiple vehicle presences.

6.11 *Structural Data*—If requested by the purchaser, the pipe manufacturer shall provide data to enable verification of structural design safety factors, including pipe profile geometry, wall centroid, wall area, wall moment of inertia, and material strain limits.

NOTE 10—For perforated pipe applications, the size of the embedment zone and permeability of the embedment material provide the desired level of infiltration or exfiltration. The pipe or embedment zone shall be wrapped with a geotextile designed to prevent migration of fine soils into the pipe or embedment zone. Where a geotextile is not used, the gradation of the embedment material shall be compatible with the perforation size to avoid backfill migration into the pipe.

7. Test Methods

7.1 Conditioning:

7.1.1 *Referee Testing*—When conditioning is required for referee tests, condition the specimens in accordance with Procedure A of Practice D618 at $73.4 \pm 3.6^\circ\text{F}$ [$23 \pm 2^\circ\text{C}$] for not less than 40 h prior to test. Conduct tests under the same conditions of temperature. The selection of the sample or samples of the pipe and fittings shall be as agreed upon between the owner and the seller. In case of no prior agreement, any sample selected by the testing laboratory shall be deemed permitted.

TABLE 3 Perforation and Dimensions

Pipe Inside Diameter		Type of Perforation			
		Circular			
		Maximum Diameter		Minimum Inlet Area	
in.	[mm]	in.	[mm]	in.	[mm]
12	[300]	$\frac{3}{8}$	[10]	1.5	[40]
15	[375]	$\frac{3}{8}$	[10]	1.5	[40]
18	[450]	$\frac{3}{8}$	[10]	1.5	[40]
21	[525]	$\frac{3}{8}$	[10]	2.0	[30]
24	[600]	$\frac{3}{8}$	[10]	2.0	[40]
27	[675]	$\frac{3}{8}$	[10]	2.0	[40]
30	[750]	$\frac{3}{8}$	[10]	2.0	[40]
36	[900]	$\frac{3}{8}$	[10]	2.0	[40]
42	[1050]	$\frac{3}{8}$	[10]	2.0	[40]
48	[1200]	$\frac{3}{8}$	[10]	2.0	[40]
54	[1350]	$\frac{3}{8}$	[10]	2.0	[40]
60	[1500]	$\frac{3}{8}$	[10]	2.0	[40]

7.1.2 Quality Control Testing—Condition specimens for a minimum of 4 h prior to test in air or 1 h in water at $73.4 \pm 3.6^\circ\text{F}$ [$23 \pm 2^\circ\text{C}$] without regard to relative humidity.

7.2 Test Conditions—Conduct tests other than those for routine quality control purposes in the standard laboratory atmosphere of $73.4 \pm 3.6^\circ\text{F}$ [$23 \pm 2^\circ\text{C}$], in the referenced test method or in this specification.

7.3 Dimensions:

7.3.1 Inside Diameter—Measure the inside diameter in accordance with Test Method **D2122**.

7.3.2 Laying Length—Measure pipe laying length in accordance with Test Method **D2122**. These measurements may be taken at ambient temperature.

7.3.3 Minimum Inside Diameter, and Wall, Crown, Valley and Liner Thickness—Measure the thickness of each wall component in accordance with Test Method **D2122**. Each specimen shall be cut perpendicular to the longitudinal axis of the pipe. This circumferential cut shall be made directly through a corrugation allowing a plain view of the inner wall 360° around the circumference in order to obtain a minimum of eight measurements in accordance with Test Method **D2122**. Each specimen shall also be cut along the longitudinal axis of the pipe to measure the longitudinal profiles for two full corrugation periods to obtain a minimum of eight measurements for each section thickness.

7.3.4 Perforations—Measure dimensions of perforations on a straight specimen without external forces applied. Linear measurements shall be made with an instrument with calibration increments of 0.01 in (0.25 mm).

7.4 Pipe Stiffness—Select a minimum of three pipe specimens and test for pipe stiffness $F/\Delta y$, as described in Test Method **D2412**, except for the following conditions:

7.4.1 The test specimens shall be at least one diameter or 24-in. [609 mm] in length, whichever is less, but shall not be less than three full corrugations. The exact length shall be an integer multiple of the corrugation pitch.

7.4.2 Locate the first specimen in the loading machine between two corrugations parallel to the loading plates. The specimen must lay flat on the plate within $\frac{1}{8}$ in. (3 mm). Use the first location as a reference point for rotation of 90° . Rotate the second specimen 450 and 900. Test each specimen in one position only.

7.4.3 The deflection indicator shall be readable and accurate to $+0.001$ in. ($+0.02$ mm).

7.4.4 The parallel plates must exceed the samples in length.

7.5 Flattening—Flatten the three test specimens from **7.4** between parallel plates until the pipe inside diameter is reduced by 40 %. It is permissible to increase the rate of loading for this test from $0.5 + 0.02$ in./min [$12.5 + 0.5$ mm/min] to a maximum rate of $2 + 0.02$ in./min [$50 + 0.02$ mm/min] to reduce the test times for large diameter pipe. The test specimens, when examined under normal light and the unaided eye, shall show no splitting, cracking, breaking, or separation of the pipe walls.

7.6 Impact Resistance—Test pipe specimens in accordance with Test Method **D2444**, except six specimens shall be tested or six impacts shall be made on one specimen. Tests shall be

conducted using either a 20 lb (9 kg) Tup B or 30 lb (15 kg) Tup B and a flat-plate specimen Holder B. The center of the falling tup shall strike on a corrugation crown. All pipes must pass.

7.6.1 Test specimens shall be cut valley-to-valley and equal in length to one-half of the nominal diameter but not less than 18-in. (457 mm).

7.7 Creep Rupture Strength—Determine creep rupture strength at 73°F (23°C) in accordance with the tensile creep test methods in **D2990**, except as follows. Test shall include an additional stress level selected so as to produce rupture at approximately 10,000 h. Alternately, use time-temperature superposition methods.

7.8 Creep Modulus—Determine creep modulus at 73°F (23°C) in accordance with tensile creep test methods in **D2990**, except as follows. Test duration shall be 10,000 h. Tests shall include a minimum of 5 stress levels that are selected in approximately even increments up to and including 500 psi [3.45 MPa]. Alternately, use time-temperature superposition methods.

NOTE 11—The time-temperature superposition method in Test Method **D6992** may be used to determine the tensile creep modulus and tensile creep rupture strength. These tests are intended to validate a material's proof-of-performance qualification and are not standard quality assurance tests.

8. Inspection

8.1 Inspection of the product shall be as agreed upon between the owner and the manufacturer as part of the purchase contract. Unless otherwise specified in the contract or purchase agreement, the manufacturer is responsible for the performance of all inspection and test requirements specified herein.

8.2 Notification—If inspection is specified by the owner, the manufacturer shall notify the owner in advance of the date, time, and place of testing of the pipe or fittings, or both, so that the purchaser may be represented at the test.

8.3 Access—The inspector shall have free access to those parts of the manufacturer's plant that are involved in work performed under this specification. The manufacturer shall afford the inspector all reasonable facilities for determining whether the pipe or fittings, or both, meet the requirements of this specification.

9. Rejection and Rehearing

9.1 If the results of any test(s) do not meet the requirements of this specification, the test(s) shall be conducted again in accordance with an agreement between the owner and the manufacturer. There shall be no agreement to lower the minimum requirement of the specification by such means as omitting tests that are a part of the specification, substituting or modifying a test method, or by changing the specification limits. In retesting, the product requirements of this specification shall be met, and the test methods designated in this specification shall be followed. If, upon retest, failure occurs, the quantity of product represented by the test(s) does not meet the requirements of this specification.

10. Certification

10.1 When specified in the purchase order or contract, a manufacturer's or independent laboratory's certification shall be furnished to the owner that the products shipped, as identified by the lot description of 11.1 and 11.2, were manufactured, sampled, tested, and inspected at the time of manufacture in accordance with this specification and have been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished. Where requested, certified actual inside diameter, extrusion line and shift the pipe was produced shall be provided.

11. Markings

11.1 *Pipe*—Each length of pipe in compliance with this specification shall be clearly marked with the following information: this designation ASTM F2881, the nominal size, the legend PP, the manufacturer's name, trade name or trademark, plant location, and date of manufacture. The marking shall be applied at the time of manufacture to the pipe. It shall be

placed, at least, at each end of each length of pipe or spaced at intervals of not more than 10 ft [3.0 m].

11.2 *Fittings*—Each fitting in compliance with this specification shall be clearly marked with the following information: this designation ASTM F2881, the nominal size, the legend PP, the manufacturer's name, trade name or trademark, plant location, and date of manufacture.

12. Packaging

12.1 All pipe and couplings and fittings shall, unless otherwise specified, be packaged for standard commercial shipment.

13. Quality Assurance

13.1 When the product is marked with this designation (ASTM F2881), the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.

14. Keywords

14.1 fittings; interior liner; PP; pipe; polypropylene; profile wall; storm sewer

SUPPLEMENTARY REQUIREMENTS

These requirements apply only to federal/military procurement, not domestic sales or transfers.

S1. Responsibility for Inspection

S1.1 Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection and test requirements specified herein. The manufacturer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless the owner disapproves. The owner shall have the right to perform any of the inspections and tests set forth in this specification, where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

NOTE S1—In U.S. federal contracts, the contractor is responsible for inspection.

S2. Packaging and Marking for U.S. Government Procurement

S2.1 *Packaging* —Unless otherwise specified in the contract, the materials shall be packaged in accordance with the manufacturer's standard practice in a manner ensuring arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rates. Containers and packing shall comply with Uniform Freight Classification rules or National Motor Freight Classification rules.

Marking—Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

NOTE S2—The inclusion of U.S. government procurement requirements shall not be construed as an indication that the U.S. government uses or endorses the products described in this document.

APPENDIXES

(Nonmandatory Information)

X1. AUTHORITIES

X1.1 Since this product has a wide variety of uses in storm sewer systems, approval for its use rests with various agencies. The installer should contact the relevant authority to obtain local installation guidelines.

X1.2 The pipe manufacturer(s) should be able to provide proof of product acceptance by specific agencies, when appropriate.

X2. STRUCTURAL DESIGN

X2.1 After the design engineer satisfies project requirements, such as deflection, local and global buckling, and bending stress, it is advisable to review conditions with particular respect to long-term strain. A long-term tensile strain limit of 3.3% is recommended for polypropylene pipe.

X2.2 When the pipe is buried deeply, where hydrostatic conditions exist or when excessive pipe deformations or deflections, or both, might develop, it is advisable to evaluate the strain and environmental conditions as indicated in the following sections.

X2.3 The following discussion is about tensile and compressive strains. It is presented in general form. The user is responsible for qualifying the pipe after reviewing the proposed conditions and the qualities of the manufacturer's product.

X2.3.1 Tensile Strain:

$$\varepsilon_T = \varepsilon_B - (\varepsilon_S + \varepsilon_H) \quad (X2.1)$$

where:

ε_T = total tensile strain

ε_B = tensile strain from pipe bending in either diametric, axial, or combined situations,

ε_S = compressive strain induced into the pipe walls by the soil weight above the pipe.

ε_H = external hydrostatic compressive strain.

X2.3.2 Compressive Strain

$$\varepsilon_C = \varepsilon_B + \varepsilon_S + \varepsilon_H \quad (X2.2)$$

where:

ε_C = total compressive strain

NOTE X2.1—AASHTO LRFD Bridge Design Specifications, LRFD, Section 12 is typically used for evaluation of structural design of thermoplastic pipe. Reference LRFD Section 12 for additional information.

X2.4 A modulus of elasticity and tensile strength for the material rated at 50 years is often used in the calculations leading to the determination of strain and thrust capacity. This value will vary directly in proportion to the stress level.

X2.4.1 The following long-term properties are recommended for design :

PP Engineering Properties	Short-Term – Initial psi (MPa) ^A	Long-Term – 50-year psi (MPa)
Tensile Strength	3,500 (24)	1,000 (7)
Modulus of Elasticity	175,000 (1,200)	27,000 (186)

^AShort-term values are determined by the material's cell class designation in [Table 1](#).

X3. MANHOLE CONNECTIONS

X3.1 Watertight connections to manholes require the exact outside dimensions of the pipe to properly size both the manhole opening as well as the resilient gasket connection between the manhole and pipe.

X3.2 Actual pipe outside dimensions vary per manufacturer and this material should be requested from the supplier prior to finalization of any storm sewer design or sizing.

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