Designation: ~~F2764/F2764M – 17~~ F2764/F2764M – 17$^{\varepsilon 1}$

Standard Specification for 6 to 60 in. [150 to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications[1]

This standard is issued under the fixed designation F2764/F2764M; 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.

ε[1] NOTE—Table 1 was editorially corrected in August 2017.

1. Scope*

1.1 This specification covers requirements and test methods for corrugated double and triple wall polypropylene pipe and fittings. The nominal inside diameters covered are 6 to 60 in. [150 to 1500 mm].

1.2 The requirements of this specification are intended to provide pipe and fittings for underground use for non-pressure sanitary 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 annular corrugated wall and an essentially smooth interior wall (that is, double wall) (Fig. 1) and pipe and fittings with an annular corrugated wall and an essentially smooth interior and exterior wall (that is, triple wall) (Fig. 2).

1.4 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 applies only to 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.*

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
D578/D578M Specification for Glass Fiber Strands
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

[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 April 1, 2017. Published May 2017. Originally approved in 2010. Last previous edition approved in 2016 as F2764/F2764M–16. ~~DOI:10.1520/D2764_F2764M–17.~~DOI:10.1520/D2764_F2764M–17E01.

[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**

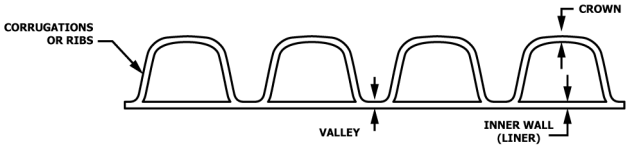

FIG. 1 Typical Corrugated Double Wall Pipe

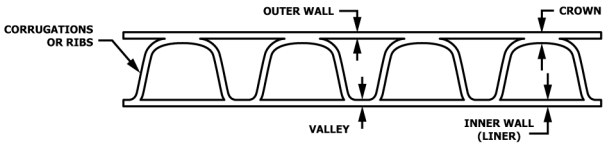

FIG. 2 Typical Corrugated Triple Wall Pipe

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
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
F2136 Test Method for Notched, Constant Ligament-Stress (NCLS) Test to Determine Slow-Crack-Growth Resistance of HDPE Resins or HDPE Corrugated Pipe
F2736 Specification for 6 to 30 in. (152 To 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe And Double Wall Pipe

2.2 *AASHTO Standards:*[3]

LRFD, Section 12 AASHTO LRFD Bridge Design Specifications Section 12 – Buried Structures and Tunnel Liners

2.3 *Federal Standard:*[4]

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

2.4 *Military Standard:*[4]

MIL-STD-129 Marking for Shipment and Storage

2.5 *NCHRP (National Cooperative Highway Research Program) Report:*[5]

NCHRP Report 631 Updated Test and Design Methods for Thermoplastic Drainage Pipe

3. Terminology

3.1 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 *double wall pipe, n*—In this case, the profile pipe wall construction provides an interior liner in the waterway and includes corrugations, which can be either solid (with a liner) or hollow (with no liner), that helps brace the pipe against diametrical deformation. The corrugation wall is exposed to the soil side of the pipe and is its exterior wall.

3.2.2 *triple wall pipe, n*—In this case, the triple pipe wall construction provides an interior wall in the waterway, an exterior wall to the soil, and includes corrugations, which can be either solid (with a liner) or hollow (with no liner), that helps brace the pipe against diametrical deformation.

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 American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

[4] DLA Document Services Building 4/D 700 Robbins Avenue Philadelphia, PA 19111-5094 http://quicksearch.dla.mil/

[5] The National Academies of Sciences, Engineering, and Medicine 500 Fifth Street, NW Washington, DC 20001 http://www.national-academies.org

4.1.2 Diameters,
4.1.3 Total footage of each pipe diameter involved,
4.1.4 Pipe laying length,
4.1.5 *Fitting type(s):*
4.1.5.1 Size and type of fittings, including mainline and branch diameters, and
4.1.5.2 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 pipe and fittings shall have the minimum properties as shown in Table 1. Polypropylene compounds shall be comprised of the base 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. For slow crack-growth resistance of the pipe corrugation, and inner and exterior walls, PP compounds shall be evaluated using the notched constant ligament stress (NCLS) test according to the procedure described in 7.7.1. The average failure time of the five test specimens shall exceed 100 h with no single test specimen's failure time less than 71 h. Compounds shall be tested and validated on an annual basis or for any new formulations. The minimum long-term (50-year) design values for modulus of elasticity and tensile strength for the PP compounds shall be 27 000 psi (186 MPa) and 1,000 psi (7.0 MPa), respectively.

5.2 *Color and Ultraviolet Stabilization for Pipe and 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.

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 of the gasket or on the pipe.

5.6 *Optional Bell Retaining Bands or External Wraps*—Monolithically formed bands or stiffening wraps in or on the external wall of the bell, when used, shall provide tensile restraint to bell expansion due to gasket insertion or internal hydrostatic pressure in accordance with 6.6.4. These bands shall be made of corrosion resistant materials such as fiberglass (Specification D578/D578M) or stainless steel (Specification A666). All metallic mechanical devices, including castings and bolt assemblies used to mechanically restrain the bell shall be constructed of corrosion resistant stainless steel materials meeting the physical properties and chemical composition requirements of A666, Type 302 through Type 316.

5.6.1 The D578/D578M fiberglass roving or chopped strand shall be an E or S type glass, free of any alkali, dirt or other impurities. The band shall consist of overlapping continuous or chopped filament fiber strand and not a fabric.

NOTE 1—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.

TABLE 1 Polypropylene Compound Properties

Property	ASTM Test Method	Units (SI Units)	Minimum Value	Maximum Value
Melt Flow Rate	D1238	g/10 min	0.15 @ 230°C	1.50 @ 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)	3500 (24)	4,500 (31)
Elongation at Yield	D638	% (%)	5 (5)	25 (25)
Flexural Modulus (1% secant)	D790B	psi (N/mm^2)	175 000 (1,200)	275,000 (1,900)
~~IZOD Impact Strength (730°F [230°C])~~	~~D256~~	~~ft-lb/in [J/m]~~	~~8 (427)~~	~~No Break~~
IZOD Impact Strength (73.0°F [23.0°C]) †	D256	ft-lb/in [J/m]	8 (427)	No Break
Oxidative-Induction Time (392°F [200°C])	D3895	min	25	200
Long-Term Modulus of Elasticity (50-yr)	D2990	psi (MPa)	27 000 (186)	...
Long-Term Tensile Strength (50-yr)	D2990	psi (MPa)	1000 (7)	...

† Editorially corrected in August 2017.

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 *Minimum Inside Diameter*—The minimum inside diameter shall be as shown in Table 2, when measured in accordance with section 7.3.3. In no case shall the manufacturer's stated inside diameter minus the tolerance in Table 2 be less than the required minimum inside diameter.

NOTE 2—The manufacturer's stated inside diameter is the nominal diameter plus or minus the inside diameter tolerances. The minimum inside diameter is the smallest diameter the pipe can be with these tolerances and is used for the hydraulic design of the pipe.

NOTE 3—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.

6.2.3 *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.

6.2.4 *Minimum Wall, Crest, 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.

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 4—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 and Eq 2 for dual wall and triple wall profiles, respectively, the specimen shall be considered as failing this test when the load does not increase continuously with increasing deflection.

Buckling Defection Limit:

Double Wall:

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

Triple Wall:

$$\Delta = 0.0129 \cdot \left(\frac{D}{0.5(D_o - D_i)} \right) \tag{2}$$

where:

Δ = minimum buckling deflection limit (in/in [mm/mm])
D = mean diameter (centroid) of pipe (in [mm])

TABLE 2 Pipe Stiffness and Pipe Dimensions

Pipe Inside Diameter[A]		Minimum Inside Diameter		Inside Diameter Tolerances		Minimum Pipe Stiffness at 5 % Deflection		Minimum Inner Liner Thickness		Minimum Outer Liner Thickness		Minimum Valley Thickness		Minimum Crown Thickness	
in.	[mm]	in.	[mm]	in.	[mm]	lb/in/in	[kPa]	in.	[mm]	in.	[mm]	in.	[mm]	in.	[mm]
6	[150]	5.61	[142]	+0.04/-0.04	+1.0/-1.0	46	[317]	0.040	[1.0]	...	...	...	...	...	...
8	[200]	7.70	[196]	+0.05/-0.05	+1.1/-1.1	46	[317]	0.045	[1.1]	...	...	...	...	...	...
10	[250]	9.70	[246]	+0.06/-0.06	+1.4/-1.4	46	[317]	0.050	[1.3]	...	...	...	...	...	...
12	[300]	11.90	[302]	+010/-0.10	+2.5/-2.5	46	[317]	0.054	[1.4]	...	...	...	...	...	...
15	[375]	14.85	[377]	+0.15/-0.15	+3.8/-3.8	46	[317]	0.065	[1.7]	...	...	...	...	...	...
18	[450]	17.93	[455]	+0.17/-0.17	+4.3/-4.3	46	[317]	0.075	[1.9]	...	...	...	...	...	...
21	[530]	20.75	[527]	+0.17/-0.17	+4.3/-4.3	46	[317]	0.077	[2.0]	...	...	...	...	...	...
24	[600]	23.90	[607]	+0.23/-0.23	+5.8/-58	46	[317]	0.086	[2.2]	...	...	...	...	...	...
30	[750]	29.79	[757]	+0.24/-0.24	+6.1/-6.1	46	[317]	0.108	[2.7]	...	...	...	...	...	...
30	[750]	29.62	[752]	+0.18/- 0.18	+4.6/-4.6	46	[317]	0.070	[1.8]	0.070	[1.8]	0.081	[2.1]	0.115	[2.9]
36	[900]	35.40	[899]	+0.21/- 0.21	+5.3/-5.3	46	[317]	0.095	[2.4]	0.095	[2.4]	0.109	[2.8]	0.165	[4.2]
42	[1050]	41.31	[1049]	+0.22/- 0.22	+5.6/-5.6	46	[317]	0.105	[2.7]	0.105	[2.7]	0.121	[3.1]	0.165	[4.2]
48	[1200]	47.31	[1201]	+0.27/- 0.27	+6.9/-6.9	46	[317]	0.105	[2.7]	0.105	[2.7]	0.126	[3.2]	0.170	[4.3]
54	[1350]	53.32	[1354]	+0.27/- 0.27	+6.9/-6.9	46	[317]	0.105	[2.7]	0.105	[2.7]	0.131	[3.3]	0.170	[4.3]
60	[1500]	59.30	[1506]	+0.31/- 0.31	+7.9/-7.9	46	[317]	0.105	[2.7]	0.105	[2.7]	0.137	[3.5]	0.210	[5.3]

[A] The triple wall profile wall pipe are only available in sizes 30 in. [750 mm] to 60 in. [1500 mm]. Double wall profile pipe are available in sizes 6 in. [150 mm] to 30 in. [750 mm]. At 30 in. [750 mm] diameter, where the dimensions for the outer liner thickness are defined, all the associated dimensions shall only pertain to the triple wall profile pipe .

$0.5\ (D_o - D_i)$ = height of the corrugation (outside diameter minus inside diameter)

NOTE 5—Eq 1 and Eq 2 are based on the results from NCHRP Report 631 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).

6.6 *Fittings and Joining Systems:*

6.6.1 Fittings shall be fabricated by the pipe manufacturer from pipe made in accordance with this standard. Fittings fabricated from double-wall pipe shall be used with double-wall pipe. Fittings fabricated from triple-wall pipe shall be used with triple-wall pipe. Fitting material shall comply with 5.1, 5.2 and 5.3.

6.6.1.1 Fittings shall be tested in an installation orientation, shall be uniformly supported (body and outlet(s)) by the lower plate, and uniformly loaded (body and outlet(s)) by the upper plate. Fittings shall meet or exceed a vertical load equivalent to the 5% deflection stiffness in accordance with Table 2 for pipe to which the fitting is to be joined. The equivalent maximum load shall be the 5% deflection stiffness in accordance with Table 2 unit load (psi/in or kPa /mm) multiplied by the length of the fitting (run plus branch(es) as applicable) that is loaded by the upper plate. Testing shall be for equivalent load, not deflection. Acceptance criteria shall be in accordance with 6.4.

NOTE 6—Installation orientation means that the fitting testing orientation is as though it were installed in a pipeline, for example, an elbow or tee with the directional outlet(s) to the side. In accordance with an established quality program, fittings should be tested to only qualify the overall design and integrity of the unit. As unique structures, testing of every angle orientation is not necessary.

6.6.1.2 The fitting body in an installation orientation shall be impact tested in accordance with 7.6. Acceptance criteria shall be in accordance with 6.5.

6.6.2 The joining system(s) between pipe and between pipe and fittings shall be of a design that preserves pipeline slope and alignment during construction and prevents separation at the joints while maintaining watertight requirements in accordance with 6.6.3. Fittings shall be tested in an installation orientation, shall be uniformly supported (body and outlet(s)) by the lower plate, and uniformly loaded (body and outlet(s)) by the upper plate.

6.6.3 Pipe and fittings shall have a 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. Note that special provisions must be taken in order to join field cut pipe that meets the requirements of Specification D3212. Any component used in the joining material shall be resistant to effluents being carried in the pipe.

6.6.4 Monolithic retaining bands utilized for the bells on joining systems shall have a structural tensile resistance of twice the operational pressure of the pipeline, but no less than 21.6 psi, when tested in accordance with 6.6.3. In lieu of a full Specification D3212 joint test, it shall be acceptable to exert only the bell to the internal pressure by either mechanical or hydrostatic means for the appropriate test time in Specification D3212. Bell retaining bands, when used, shall show no signs of cracking, separation, splitting or delamination from the pipe during this test.

6.6.5 A joint proof-of-design test shall be conducted in accordance with 7.10. This test is a one time validation test for the specific pipe diameter, gasket and joint configuration supplied by the manufacturer.

6.7 *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 7.8.

6.8 *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 7.9.

NOTE 7—The 50-year creep rupture strength and 50-year creep modulus values, determined by the test methods in 7.8 and 7.9, 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.

6.9 *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 Practice D2321 with a design that satisfies the safety factors specified in the AASHTO LRFD, Section 12, Bridge Design Specifications for Thermoplastic Pipe for earth and live loads, with consideration for impact and multiple vehicle presences.

6.10 *Structural Design:*

6.10.1 The manufacturer shall supply appropriate data necessary to satisfy the requirements of deflection, thrust, buckling, bending stress and long-term strain in accordance with the design criteria of the LRFD, Section 12. The design engineer shall verify that the data provided by the manufacturer satisfy the project requirements.

6.10.2 The minimum long-term (50-year) design values for modulus of elasticity and tensile strength for the PP compounds shall be 27 000 psi (186 MPa) and 1000 psi (7.0 MPa), respectively.

6.10.3 The maximum allowable long-term (50-year) factored compressive strain limit for design shall be 3.7%.

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 ± 3.6°F [23 ± 2°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.

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 ± 3.6°F [23 ± 2°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 ± 3.6°F [23 ± 2°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 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 seam line 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 axis of the seam line to measure the longitudinal profiles for two full corrugation periods to obtain a minimum of eight measurements for each section thickness.

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

7.4.1 The test specimens shall be 24-in. [609 mm] in length 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 ⅛ in. (3 mm). Use the first location as a reference point for rotation of 90°. Rotate the second specimen 45° and 90°. 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 %. The rate of loading shall be 2 in./min [50 mm/min]. It is acceptable to run the flattening test in conjunction with the pipe stiffness test at a loading rate of 0.5 ± 0.02 in./min [12.5 ± 0.5 mm/min] in accordance with Test Method D2412. The test specimens, when examined under normal light and the unaided eye, shall show no splitting, cracking, breaking, or separation of the pipe walls.

NOTE 8—Whitening of the pipe's color during the flattening test is not uncommon in areas where bending is localized.

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 *Slow-Crack Growth Resistance :*

7.7.1 *Base Resin for Pipe*—Test unpigmented polypropylene compound used for the pipe using procedures in Test Method F2136. The test stress shall be 600 psi [4.14 MPa].

7.8 *Creep Rupture Strength*—Determine creep rupture strength at 73°F [23°C] in accordance with the tensile creep test methods in Test Method 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.

7.9 *Creep Modulus*—Determine creep modulus at 73°F [23°C] in accordance with tensile creep test methods in Test Method 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 9—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.

7.10 *Joint Proof-of-Design Evaluation:*