Designation: ~~F1760 – 01 (Reapproved 2011)~~ F1760 – 16

Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content[1]

This standard is issued under the fixed designation F1760; 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~~ Scope*

1.1 This specification has been published in response to the special circumstance of regulatory requirements regarding federal procurement guidelines for plastic pipe having recycled content.

1.2 This specification covers coextruded Poly(Vinyl Chloride) (PVC) plastic pipe with a center layer and concentric inner and outer solid layers. The pipe is produced using a multi-layer coextrusion die. The inner and outer layers are made of virgin PVC compound and the center layer has reprocessed-recycled PVC content. The pipe is for non-pressure use in three series:

1.2.1 Sewer-Drain series with a sewer-pipe (PSM) outside diameter and a pipe stiffness of 46 psi (320 kPa),

1.2.2 IPS Schedule 40 series, and

1.2.3 IPS Pipe Stiffness (PS) series with pipe stiffnesses of 100 psi (690 kPa) and 120 psi (830 kPa).

1.3 Pipe that is outside-diameter controlled does not ~~necessarily~~ have an inside diameter suitable for use as a fitting socket.

1.4 All ~~series may be perforated.~~pipe series are allowed to be perforated during production.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *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]

D883 Terminology Relating to Plastics
D1243 Test Method for Dilute Solution Viscosity of Vinyl Chloride Polymers
D1600 Terminology for Abbreviated Terms Relating to Plastics
D1784 Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
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)
D2466 Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
D2467 Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
D2665 Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
D2855 Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
D3034 Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.25 on Vinyl Based Pipe.

Current edition approved ~~Feb. 1, 2011~~April 1, 2016. Published ~~March 2011~~June 2016. Originally approved in 1996. Last previous edition approved in ~~2005~~2011 as ~~F1760–01(2005)~~F1760–01(2011).~~ε1~~. DOI: ~~10.1520/F1760-01R11.~~10.1520/F1760-16.

[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**

D4396 Specification for Rigid Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds for Plastic Pipe and Fittings Used in Nonpressure Applications
D5260 Classification for Chemical Resistance of Poly(Vinyl Chloride) (PVC) Homopolymer and Copolymer Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
F412 Terminology Relating to Plastic Piping Systems
F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F512 Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation
F1336 Specification for Poly(Vinyl Chloride) (PVC) Gasketed Sewer Fittings
F1365 Test Method for Water Infiltration Resistance of Plastic Underground Conduit Joints Which Use Flexible Elastomeric Seals

2.2 *Plastic Pipe Institute Technical Report:*[3]
PPI-TR-7 Recommended Method for Calculation of Nominal Weight of Plastic Pipe

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions are in accordance with Terminologies D883, D1600, and F412, unless otherwise indicated.

3.1.2 *coextrusion*—a process whereby two or more plastic material streams are forced through one or more shaping orifices and become one continuously formed piece.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *center-layer compound*—general description for "internal recycled material" (3.2.5), "external recycled material" (3.2.4), and "post-consumer recycled material" (3.2.6). These materials can be used straight or blended with virgin materials to make a compound, in accordance with this specification.

3.2.2 *certificate of composition*—a certificate describing certain properties of an external recycled material or a post-consumer recycled material.

[3] Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, http://www.plasticpipe.org.

3.2.2.1 *Discussion—*

Examples include polymer, molecular weight, percentage of inorganic material, contamination type and level, tensile strength, modulus of elasticity, and izod impact.

3.2.3 *composition disclosure*—a document describing the formulation of an external recycled material.

3.2.4 *external recycled material*—industrial rework generated by a different company from the company manufacturing to this specification. Composition is known by the industrial source of the material.

3.2.5 *internal recycled material*—rework generated by the same company's production that is manufacturing to this specification. Composition of the material is known by the company manufacturing to this specification.

3.2.6 *post-consumer recycled material*—finished goods that have been purchased by the public, then returned to industry and reprocessed into raw materials. Identity of finished goods is known by the reprocessing company.

3.2.7 *thermoplastic coextruded pipe*—pipe consisting of two or more concentric thermoplastic layers formed through the process of coextrusion.

4. Classification

4.1 The pipes are produced in two diameter families: sewer-drain and IPS.

4.1.1 *Sewer-Drain Series*—Produced with a sewer pipe (PSM) OD and a pipe stiffness of 46 psi (320 kPa). Sewer-drain pipe is intended for use outside of buildings as sewer, sewer connections, underground drain, and storm drain. Wall thicknesses shall be produced so that minimum pipe stiffnesses are met, but shall not be thinner than the minimum wall thickness requirements in Table 1 ~~and~~ . ~~Table 2.~~

NOTE 1—Base inside diameters will be slightly smaller than those calculated for SDR 35 sewer-drain series pipe when wall thicknesses are increased to ensure minimum 46 pipe stiffness.

4.1.2 *IPS Diameter Family*—Produced in a Schedule 40 series and a Pipe Stiffness (PS) series.

4.1.2.1 *IPS Schedule 40 Series*—Produced to Schedule 40 wall thicknesses in accordance with Table ~~3~~2 ~~and Table 4~~. Schedule 40 pipe is intended for use as underground drain, DWV (drain, waste, and vent), sewer connections, and other non-pressure uses.

4.1.2.2 *IPS Pipe Stiffness Series*—Produced to pipe stiffness of 100 psi (690 kPa) or 120 psi (830 kPa). Intended uses include underground communications and electrical distribution. Wall thicknesses shall be produced so that minimum pipe stiffnesses are met, but shall not be thinner than the minimum wall thickness requirements in Table ~~5~~3 ~~and Table 6~~.

TABLE 1 Requirements for Sewer-Drain Pipe

Nominal ~~Size, in.~~Size	Average, OD, in. (mm)	Tolerance on Average, in. (mm)	Minimum Wall Thickness, in. (mm)[A]	Impact Resistance, ft-lb (J)
4	4.215 (107.06)	±0.009 (±0.23)	0.120 (3.05)	150 (203)
6	6.275 (159.39)	±0.011 (±0.28)	0.180 (4.57)	210 (284)
8	8.400 (213.36)	±0.012 (±0.30)	0.240 (6.10)	210 (284)
10	10.500 (266.70)	±0.015 (±0.38)	0.300 (7.62)	220 (299)
12	12.500 (317.50)	±0.018 (±0.46)	0.360 (9.14)	220 (299)
15	15.300 (388.62)	±0.023 (±0.58)	0.437 (11.10)	220 (299)

[A] The maximum wall thickness shall not be greater than 1.25 times the minimum wall thickness.

NOTE 2—The IPS Pipe Stiffness (PS) series having pipe stiffnesses of 100 psi (690 kPa) and 120 psi (830 kPa) is designed for direct burial (DB). Encasement in concrete is not necessary.

NOTE 3—Before installing pipe for industrial waste disposal use, the approval of the code official having jurisdiction should be obtained, as conditions not commonly found in normal use may be encountered.

~~4.1.3 Before installing pipe for industrial waste disposal use, the approval of the code official having jurisdiction should be obtained, as conditions not commonly found in normal use may be encountered.~~

5. Material

5.1 *Center-layer Compounds*—Center-layer compounds (internal recycled, external recycled, and post-consumer recycled materials) shall be characterized as being PVC-polymer-based. Other PVC-compatible additives (such as lubricants, stabilizers, non-polyvinyl-chloride resin modifiers, pigments, and inorganic fillers) ~~may be present~~ are allowed in these materials. The three plastic material types ~~may~~shall be used in the percentages by weight as specified in 5.1.1, 5.1.2, and 5.1.3, to equal 100% of the pipe center layer, provided that the pipe produced meets all of the requirements of this specification.

5.1.1 *Internal Recycled Material*—~~May comprise up~~ Material composition of 0% to 100 % of the center layer. This material shall not be used in the inner or outer layers.

5.1.2 *External Recycled Material*—~~May comprise up~~ Material composition of 0% to 100 % of the center layer. This material shall not be used in the inner or outer layers.

5.1.3 *Post-Consumer Recycled Material*—~~May comprise up~~ Material composition of 0% to a maximum of 60 % by weight of center layer. This material shall not be used in the inner or outer layers.

NOTE 4—Post-consumer recycled material is limited to 60 % by weight of the center layer due to current technology. As more experience is gained with process and materials, this standard may be amended to increase the percentage.

5.1.4 When requested by the pipe manufacturer, the supplier shall provide with the external recycled and post-consumer recycled materials a certificate of composition, a composition disclosure, or both.

5.1.5 ~~Virgin~~ The blending of virgin PVC homopolymer having an inherent viscosity greater than 0.68 (*K*-value 57) ~~may be blended~~ with center-layer compounds and compounding ingredients (lubricants, stabilizers, non-polyvinyl-chloride resin modifiers, pigments, and inorganic fillers) shall be acceptable for use in the center layer. Inherent viscosity shall be determined in accordance with Test Method D1243.

5.2 Inner and outer layers shall be made of virgin homopolymer PVC. Rework materials are not allowed.

5.3 *Cell Classification*—Properties of the compounds used to manufacture pipe in accordance with this standard shall be categorized using the cell classification method. The required cell values are considered minimums; compounds having higher values than those listed are considered acceptable.

5.3.1 Material for the Sewer-Drain series shall be categorized using Specification D1784. Compound for the inner and outer layers shall have a minimum cell class of 12454, or 12364 and for the center layer 12223.

5.3.2 Material for the IPS Schedule 40 series shall be categorized using Specification D4396 or D1784. Compound for the inside and outside layers shall have a minimum cell class of ~~11432,~~ 11432 (D4396) or 12344 (D1784), and for the center layer ~~11211. Compound~~11211 (D4396) or 12344 (D1784) . Product application chemical resistance for all layers ~~shall meet the chemical-resistance requirement of Specification~~when specified shall be classified in accordance with the classification section of Classification ~~D4396~~D5260 with a 130°F (55°C), 14-day immersion.

5.3.3 Material for the IPS Pipe Stiffness (PS) series shall be categorized using Specification D1784. Compound for the inner and outer layers shall have a minimum cell class of 12234, and for the center layer 12223.

TABLE 2 SI Requirements for Sewer-Drain Pipe

Nominal Size, in.	Average OD, mm	Tolerance on Average, mm	Minimum Wall Thickness, mm[A]	Impact Resistance, J
4	107.06	±0.23	3.05	203
6	159.39	±0.28	4.57	284
8	213.36	±0.30	6.10	284
10	266.70	±0.38	7.62	299
12	317.50	±0.46	9.14	299
15	388.62	±0.58	11.10	299

[A] The maximum wall thickness shall not be greater than 1.25 times the minimum wall thickness.

TABLE 32 Requirements for IPS Schedule 40 Pipe

Nominal Size, in.Size	Average OD, in. (mm)	Tolerance on Average, in.	Out of Round, in. (mm)[A]	Minimum Wall Thickness, in. (mm)[B]	Pipe Stiffness, psi (kPa)	Impact Resistance, ft-lb (J)
1¼	1.660 (42.16)	±0.005 (±0.13)	0.060 (1.52)	0.140 (3.56)	1100 (7600)	60 (80)
1½	1.900 (48.26)	±0.006 (±0.15)	0.060 (1.52)	0.145 (3.68)	800 (5500)	60 (80)
2	2.375 (60.32)	±0.006 (±0.15)	0.060 (1.52)	0.154 (3.91)	450 (3100)	60 (80)
3	3.500 (88.90)	±0.008 (±0.20)	0.060 (1.52)	0.216 (5.49)	400 (2750)	80 (110)
4	4.500 (114.30)	±0.009 (±0.23)	0.100 (2.54)	0.237 (6.02)	250 (1770)	100 (135)
6	6.625 (168.28)	±0.011 (±0.28)	0.100 (2.54)	0.280 (7.11)	120 (830)	120 (160)
8	8.625 (219.08)	±0.015 (±0.38)	0.150 (3.81)	0.322 (8.18)	80 (550)	140 (190)
10	10.750 (273.05)	±0.015 (±0.38)	0.150 (3.81)	0.365 (9.27)	60 (415)	160 (220)
12	12.750 (323.85)	±0.015 (±0.38)	0.150 (3.81)	0.406 (10.31)	50 (340)	180 (240)

[A] "Out of Round" is defined as maximum diameter minus minimum diameter.
[B] The maximum wall thickness shall not be greater than 1.25 times the minimum wall thickness.

TABLE 4 SI Requirements for IPS Schedule 40 Pipe

Nominal Size, in.	Average OD, mm	Tolerance on Average, mm	Out of Round, mm[A]	Minimum Wall, mm[B]	Pipe Stiffness, kPa	Impact Resistance, J
1¼	42.16	±0.13	1.52	3.56	7600	80
1½	48.26	±0.15	1.52	3.68	5500	80
2	60.32	±0.15	1.52	3.91	3100	80
3	88.90	±0.20	1.52	5.49	2750	110
4	114.30	±0.23	2.54	6.02	1700	135
6	168.28	±0.28	2.54	7.11	830	160
8	219.08	±0.38	3.81	8.18	550	190
10	273.05	±0.38	3.81	9.27	415	220
12	323.85	±0.38	3.81	10.31	340	240

[A] "Out of Round" is defined as maximum diameter minus minimum diameter.
[B] The maximum wall thickness shall not be greater than 1.25 times the minimum wall thickness.

TABLE 5 Requirements for IPS Pipe-Stiffness Pipe

Nominal Size, in.	Average OD, in.	Tolerance on Average, in.	Out of Round, in.[A]	Minimum Wall Thickness, in.[BC]		Impact Resistance, ft-lb
				DB 100	DB 120	
4C	4.350[D]	±0.009	0.100	0.141	0.149	100
4	4.500	±0.009	0.100	0.145	0.154	100
5	5.563	±0.010	0.100	0.179	0.191	120
6	6.625	±0.011	0.100	0.213	0.227	150

TABLE 3 Requirements for IPS Pipe-Stiffness Pipe

Nominal Size	Average OD, in. (mm)	Tolerance on Average, in. (mm)	Out of Round, in. (mm)[A]	Minimum Wall Thickness, in. (mm)[BC]		Impact Resistance, ft-lb (J)
				DB 100	DB 120	
110.49[D]	4.350 (110.49)[D]	±0.009 (±0.23)	0.100 (2.54)	0.141 (3.58)	0.149 (3.78)	100 (135)
4	4.500 (114.30)	±0.009 (±0.23)	0.100 (2.54)	0.145 (3.68)	0.154 (3.91)	100 (135)
5	5.563 (141.30)	±0.010 (±0.25)	0.100 (2.54)	0.179 (4.55)	0.191 (4.85)	120 (165)
6	6.625 (168.28)	±0.011 (±0.28)	0.100 (2.54)	0.213 (5.41)	0.227 (5.77)	150 (205)

[A] "Out of Round" is defined as maximum diameter minus minimum diameter.
[B] The maximum wall thickness shall not be greater than 1.25 times the minimum wall thickness.
[C] Minimum wall-thickness values are based on skin modulus of 400 000 psi combined with center-layer modulus of 500 000 psi.
[D] This is not an IPS OD, but is a standard-OD pipe-stiffness pipe used by communications utilities.

5.4 *Color*—The center layer for all series shall contrast in color with the inner and outer layers such that wall measurements may be taken.

6. Joining Systems

6.1 *Solvent-Cement Joints*—~~In the solvent cement joint, the pipe spigot wedges into the tapered socket and the surfaces fuse together. The tapered socket may be a portion of a molded fitting or it may be a belled end of the pipe section.~~Molded fittings with tapered sockets and spigots or a pipe section with adjoining pipe bell shall be used to make a solvent cemented joint.

6.1.1 The assembly of joints shall be in accordance with the recommendations of pipe, solvent cement, and fitting manufacturers pertaining to the particular system being employed or, in their absence, the methods described in Practice D2855.

6.2 *Elastomeric-Gasket Joints*—In this system an elastomeric seal is situated in the bell or molded fitting, lubrication is applied to the spigot/gasket, and the pipe spigot is pushed past the gasket and into the bell forming a watertight joint. The design and control of the dimensions of gasketed bells, fittings, and elastomeric seals are not controlled by this specification, but are the responsibility of the manufacturers of the pipe, fittings, and gaskets.

6.2.1 The assembly of the joints shall be in accordance with the pipe manufacturer's recommendation. The lubricant shall be that recommended by the pipe manufacturer. Elastomeric seals shall meet the requirements of Specification F477.

NOTE 5—Straight alignment is essential when assembling gasketed pipe joints. Bar and block assembly is recommended. (The major advantage of this method is that the worker can feel the amount of force being used and whether the joint goes together smoothly. This helps ensure that gaskets remain properly seated.)

6.3 *Fittings:*

~~6.3.1 *Sewer-Drain Series Pipe*—May be joined using molded or fabricated fittings meeting the requirements of Specification D3034 or F1336.~~See Table 4.

~~6.3.2 *IPS Schedule 40 Series Pipe*—May be joined using molded fittings meeting the requirements of Specification D2466 or D2665.~~

~~6.3.3 *IPS Pipe Stiffness (PS) Series Pipe*—May be joined using molded or fabricated fittings meeting the requirements of Specification F512.~~

7. General Requirements

7.1 *Conditioning*—Routine testing as part of the manufacturer's formal quality program may be conducted at the ambient temperature and humidity of the manufacturer's test area. Referee testing shall be conducted after conditioning the samples for a minimum of 40 h at 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity. Testing shall be conducted under the same conditions.

~~7.2 *Test Methods*—Only specified ASTM test methods shall be used.~~

8. Quality Control Test Requirements: Nondestructive Testing

8.1 *Workmanship*—The pipe layers shall be homogeneous throughout, and free from visible cracks, holes, foreign inclusions, and other injurious defects. The pipe layers shall be ~~as uniform as is commercially practical~~ uniform in color, opacity, density, and other physical properties.

TABLE ~~6 SI Requirements for IPS Pipe Stiffness Pipe~~

~~Nominal Size, in.~~	~~Average OD, mm~~	~~Tolerance on Average, mm~~	~~Out of Round, mm[A]~~	~~Minimum Wall Thickness, mm[B,C]~~		~~Impact Resistance, J~~
				~~DB 100~~	~~DB 120~~	
~~4C~~	~~110.49[D]~~	~~±0.23~~	~~2.54~~	~~3.58~~	~~3.78~~	~~135~~
~~4~~	~~114.30~~	~~±0.23~~	~~2.54~~	~~3.68~~	~~3.91~~	~~135~~
~~5~~	~~141.30~~	~~±0.25~~	~~2.54~~	~~4.55~~	~~4.85~~	~~165~~
~~6~~	~~168.28~~	~~±0.28~~	~~2.54~~	~~5.41~~	~~5.77~~	~~205~~

TABLE 4 Fittings

Pipe Series	Fitting Type	Specification for Fittings
Sewer-Drain	Molded or Fabricated	D3034 or F1336
Sch 40 IPS	Molded	D2466, D2467 or D2665
IPS Pipe Stiffness (PS)	Molded	F512

~~[A] "Out of Round" is defined as maximum diameter minus minimum diameter.~~

~~[B] The maximum wall thickness shall not be greater than 1.25 times the minimum wall thickness.~~

~~[C] Minimum wall-thickness values are based on skin modulus of 400 000 psi combined with center-layer modulus of 500 000 psi.~~

~~[D] This is not an IPS OD, but is a standard-OD pipe-stiffness pipe used by communications utilities.~~

8.2 *Outside Diameter*—The outside diameters and tolerances for Sewer-Drain series shall meet the requirements of Table 1 ~~and Table 2~~. The outside diameter and tolerances for pipe having IPS outside diameters shall meet the requirements of Table ~~3~~2 ~~and Table 4~~for IPS Schedule 40 series and of Table ~~5~~3 ~~and Table 6~~for IPS Pipe Stiffness (PS) series. Dimensions shall be determined in accordance with Test Method D2122. Tolerances for out-of-round shall apply only at the time of manufacture (prior to packaging and shipment).

8.3 *Wall Thickness*—The wall thickness for Sewer-Drain series shall meet the requirements of Table 1 ~~and Table 2~~. The wall thickness for pipe having IPS outside diameters shall meet the requirements of Table ~~3~~2 ~~and Table 4~~for Schedule 40 pipe and shall meet the requirements of Table ~~5~~3 ~~and Table 6~~for Pipe Stiffness (PS) pipe. Dimensions shall be determined in accordance with Test Method D2122.

8.4 *Layer Thickness*—The minimum thicknesses of the individual inner and outer layers shall be 10 % of the wall thicknesses specified in 8.3, rounded upward to the nearest 0.005 in. To measure the inner and outer layers, use a pocket optical comparator with a reticle scale graduated to 0.005 in. Make eight readings equally spaced around the pipe circumference. Report the layer thickness to the nearest 0.005 in.

9. Quality Assurance Test Requirements: Destructive Testing

9.1 *Impact Resistance*—The impact resistance of the pipe shall be determined at the time of manufacture. Energy test levels for Sewer-Drain series shall comply with Table 1 ~~and Table 2~~. Energy test levels for IPS Schedule 40 series shall comply with Table ~~3~~2 ~~and Table 4~~. Energy test levels for IPS Pipe Stiffness (PS) series shall comply with Table ~~5~~3 ~~and Table 6~~. Failure in the test specimen shall be shattering or cracking of the specimen that is visible to the unaided eye.

9.1.1 *Impact Testing*—Test in accordance with Test Method D2444. A20 lb (9.07 kg) "A" Tup and "B" Holder shall be employed for the Sewer-Drain series. A20 lb (9.07 kg) "B" Tup and" B" Holder shall be employed for pipe having IPS outside diameter.

9.1.1.1 Test 10 specimens. When 9 or 10 pass, accept the lot. When 4 or more specimens fail, reject the lot. When 2 or 3 of 10 specimens fail, test 10 additional specimens. When 17 or more of 20 specimens tested pass, accept the lot. When 7 or more of 20 fail, reject the lot. When 4, 5, or 6 of 20 fail, test 20 additional specimens. When 32 of 40 specimens pass, accept the lot. When 9 or more of 40 specimens fail, reject the lot.

9.2 *Bond Integrity*—The bonding of the three layers shall be strong and uniform.

9.2.1 *Bond Testing*—A sharp point or blade shall be used to test the bond between layers. It shall not be possible to separate any two layers so that the layers separate cleanly. Separation of the layers shall not occur during any other testing performed under the requirements of this specification.

9.3 *Flattening Integrity*—There shall be no evidence of splitting, cracking, breaking, or separation of layers when pipe specimen is subjected to flattening test.

9.3.1 *Flattening Test*—Flatten three specimens of pipe, having a minimum length of 6 in. (150 mm), between parallel plates in a suitable press until the distance between the plates is 40 % of the outside diameter of the pipe. The rate of loading shall be uniform and such that the flattening is completed within 2 to 5 min.

9.4 *Pipe Stiffness*—Sewer-Drain series shall have a minimum pipe stiffness value of 46 psi (320 kPa). IPS Schedule 40 series shall comply with the minimum pipe stiffness requirements in Table ~~3~~2 ~~and Table 4~~. IPS Pipe Stiffness (PS) series shall have minimum pipe stiffness values of either 100 psi (690 kPa) or 120 psi (830 kPa).

NOTE 6—Pipe stiffness is a function of the pipe dimensions and the physical properties of the pipe materials. Pipe stiffness is used for engineering design when considering load-deflection characteristics of a pipe. Appendix X1 provides methods by which to estimate pipe stiffnesses of three-layer pipe constructions.

9.4.1 *Pipe Stiffness Testing*—Determine the pipe stiffness at 5 % deflection of inside diameter as described in Test Method D2412. Test three specimens. All three specimens shall meet the requirement.

10. Qualification Test Requirements: Performance Testing

10.1 *Joint Integrity, Solvent-Cement Joints*—Two systems of fit for integral bells are in common use: interference-fit (D2665 for DWV pipe, D2466 for electrical duct, and D3034 for sewer pipe) and clearance fit (F512 for electrical duct). Both systems shall be watertight when solvent cemented together in accordance with the manufacturer's recommendations.

10.1.1 *Joint-Tightness Testing*—Cement a section of pipe to a bell, using the manufacturer's recommendations or, in their absence, the methods described in Practice D2855. Unless otherwise specified, allow the assembly to stand for a minimum of 6 h. Then subject the assembly to an internal pressure of at least 25 psi (170 kPa), using water as the test medium. Maintain the pressure for at least 1 h. There shall be no leakage.

10.2 ~~*Joint Integrity, Elastomeric-Gasket Joints*—~~*Joint-Tightness Testing*—Piping intended for use in sewer or drainage applications shall ~~have watertight joints against both infiltration of ground~~meet the requirements of Specification D3212~~water and exfiltration of sewerage or storm water.~~ . Piping intended for electrical and communications cable shall ~~have watertight joints against infiltration of ground water.~~meet the requirements of Test Method F1365.