



Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content¹

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1. 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 have an inside diameter suitable for use as a fitting socket.

1.4 All 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.*

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.

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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

D4396 Specification for Rigid Poly(Vinyl Chloride) (PVC)

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

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.

3.2.2.1 *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**.

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 2**. 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 3**.

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.

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.

TABLE 1 Requirements for Sewer-Drain Pipe

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

⁴ The maximum wall thickness shall not be greater than 1.25 times the minimum wall thickness.

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

TABLE 2 Requirements for IPS Schedule 40 Pipe

| Nominal 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 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.

(<https://standards.iteh.ai>)

Other PVC-compatible additives (such as lubricants, stabilizers, non-polyvinyl-chloride resin modifiers, pigments, and inorganic fillers) are allowed in these materials. The three plastic material types 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*—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*—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*—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 The blending of virgin PVC homopolymer having an inherent viscosity greater than 0.68 (*K*-value 57) 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 (D4396) or 12344 (D1784), and for the center layer 11211 (D4396) or 12344 (D1784). Product application chemical resistance for all layers when specified shall be classified in accordance with the classification section of Classification 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.

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*—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*: See **Table 4**.

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 $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) and $50 \pm 5\%$ relative humidity. Testing shall be conducted under the same conditions.

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 uniform in color, opacity, density, and other physical properties.

8.2 *Outside Diameter*—The outside diameters and tolerances for Sewer-Drain series shall meet the requirements of **Table 1**. The outside diameter and tolerances for pipe having IPS outside diameters shall meet the requirements of **Table 2** for IPS Schedule 40 series and of **Table 3** 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**. The wall thickness for pipe having IPS outside diameters shall meet the requirements of **Table 2** for Schedule 40 pipe and shall meet the requirements of **Table 3** 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**. Energy test levels for IPS Schedule 40 series shall comply with **Table 2**. Energy test levels for IPS Pipe Stiffness (PS) series shall comply with **Table 3**. 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.

TABLE 4 Fittings

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