



Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter¹

This standard is issued under the fixed designation D3035; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers polyethylene (PE) pipe made in thermoplastic pipe dimension ratios based on outside diameter and pressure rated for water (see [Appendix X1](#)). Included are ~~criteria for classifying PE plastic pipe materials~~ requirements for polyethylene compounds and PE plastic pipe, a system of nomenclature for PE plastic pipe, and requirements and test methods for materials, workmanship, dimensions, sustained pressure, ~~burst pressure, and environmental stress cracking~~, and burst pressure. Methods of marking are also given.

1.2 All pipes produced under this specification may be used for the transport of water, industrial process liquids, effluents, slurries, municipal sewage, etc. The user should consult the manufacturer to determine whether the material being transported is compatible with polyethylene pipe and will not affect the service life beyond limits acceptable to the user.

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

1.4 The following safety hazards caveat pertains only to the test methods 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

[D618 Practice for Conditioning Plastics for Testing](#)

[D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer](#)

[D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure](#)

[D1599 Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings](#)

[D1600 Terminology for Abbreviated Terms Relating to Plastics](#)

[D1603 Test Method for Carbon Black Content in Olefin Plastics](#)

[D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings](#)

[D2290 Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe by Split Disk Method](#)

[D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products](#)

[D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials](#)

[D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique](#)

[F412 Terminology Relating to Plastic Piping Systems](#)

2.2 NSF International Standards:

~~ANSI/NSF~~ [ANSI Standard No. 14 for Plastic Piping Components and Related Materials](#)³

~~ANSI/NSF~~ [ANSI Standard No. 61 for Drinking Water System Components—Health Effects](#)³

¹ This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.26 on Olefin Based Pipe.

Current edition approved Dec. 1, 2010/July 1, 2012. Published January 2011/October 2012. Originally approved in 1972. Last previous edition approved in 2008/2010 as ~~D3035—08~~ D3035 – 10. DOI: ~~10.1520/D3035-10~~ 10.1520/D3035-12.

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.

³ Available from the National Sanitation Foundation, P.O. Box 1468, Ann Arbor, MI 48106.

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

2.3 ~~PPI~~Other Documents:

~~TR-4 Listing of Hydrostatic Design Bases (HDB), Strength Design Bases (SDB), Pressure Design Bases (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe⁴~~

~~FR-9APWA Recommended Design Factors for Thermoplastic Pressure Pipe Uniform Color Code⁵~~

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology **F412**, and abbreviations are in accordance with Terminology **D1600**, unless otherwise specified.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *hydrostatic design stress*—the estimated maximum tensile stress in the wall of the pipe in the circumferential orientation due to internal hydrostatic water pressure that can be applied continuously with a high degree of certainty that failure of the pipe will not occur.

3.2.2 *pressure rating (PR)*—the estimated maximum pressure that water in the pipe can exert continuously with a high degree of certainty that failure of the pipe will not occur.

3.2.1 *relation between dimension ratio, hydrostatic design stress, and pressure rating*—the following expression, commonly known as the ISO equation,⁶ is used in this specification to relate dimension ratio, hydrostatic design stress, and pressure rating:

$$2S/P = DR - 1 \text{ or } 2S/P = (D_o/t) - 1 \quad (1)$$

where:

S = hydrostatic design stress, psi (MPa);

S_w = hydrostatic design stress for water at 73°F (23°C), psi (MPa),

P = pressure rating, psi (MPa),

D_o = average outside diameter, in. (mm)

t = minimum wall thickness, in. (mm), and,

DR = thermoplastic pipe dimension ratio (D_o/t for PE pipe).

3.2.4 *thermoplastic pipe dimension ratio (DR)*—the ratio of pipe diameter to wall thickness. For PE pipe covered by this specification it is calculated by dividing the average outside diameter of the pipe, in inches, by the minimum wall thickness, in inches. If the wall thickness calculated by this formula is less than 0.062 in. (1.6 mm), it shall be arbitrarily increased to 0.062 in.

3.2.5 *thermoplastic pipe materials designation code*—the polyethylene pipe materials designation code shall consist of the abbreviation PE for the type of plastics, followed by the ASTM grade in Arabic numerals and the hydrostatic design stress in units of 100 psi with any decimal figures dropped. Where the hydrostatic design stress code contains less than two figures, a zero shall be used before the number. Thus, a complete material code shall consist of two letters and four figures for PE plastic pipe materials (see Section 5).

4. Pipe Classification

4.1 *General*—This specification covers PE pipe made from PE plastic pipe materials in various dimension ratios and water pressure ratings.

4.2 *Thermoplastic Pipe Dimension Ratios (DR)*—This specification covers PE pipe in various dimension ratios such as, but not limited to, DR 11, DR 13.5, DR 17, and DR 21. The pressure rating is uniform for all nominal sizes of pipe for a given PE pipe material and DR. (See **Table X1.1**.)

4.3 *Special Sizes*—Where existing system conditions or special local requirements make other diameters or dimension ratios necessary, other sizes or dimension ratios, or both, shall be acceptable in engineered products when mutually agreed upon by the customer and manufacturer if (1) the pipe is manufactured from plastic compounds meeting the material requirements of this specification and (2) the strength and design requirements are calculated on the same basis as those used in this specification.

5. Materials

5.1 *Classification—Polyethylene Compounds*—Polyethylene compounds suitable for use in the manufacture of pipe under this specification shall meet ~~Specification thermoplastic D3350~~ and shall be classified materials designation codes PE1404 or PE2708 or PE3608 or PE4608 or PE4710, and shall meet **Table 1** requirements for PE1404 or PE2708 or PE3608 or PE4608 or PE4710, and shall meet thermal stability, brittleness temperature and elongation at break requirements in accordance with Specification ~~D3350~~ and as shown in **Table 1**.

⁴ Available from the Plastics Pipe Institute, Inc., 1825 Connecticut Ave., NW, Suite 680 Washington, DC 20009; Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, <http://www.plasticpipe.org>.

⁵ APWA, 2345 Grand Boulevard, Suite 500, Kansas City, MO 64018-2641, <http://www.apwa.net>.

⁶ ISO R 161-1960, Pipes of Plastics Materials for the Transport of Fluids (Outside Diameters and Nominal Pressure), Part 1, Metric Series.

TABLE 1 Specification D3350 Cell Classifications for Polyethylene Pipe Materials

PE Material Designation Code	PE 1404	PE 2606	PE 2708	PE 3608	PE 3708	PE 3710	PE 4608
Physical Property:	Cell Classifications						
—Density	4	2	2	3	3	3	4
—Melt Index	2	3	3	3	3	3 or 4	3 or 4
—Flexural Modulus	3	3 or 4	3 or 4	4 or 5	4 or 5	4 or 5	4 or 5
—Tensile Strength at Yield	4	3 or 4	3 or 4	4 or 5	4 or 5	4 or 5	4 or 5
—Slow Crack Growth Resistance	4 ^A	6 ^B	7	6 ^B	7	7	6
—Hydrostatic strength Classification	4	3	3	4	4	4	4
Color and UV Stabilizer ^C	G	CoE	CoE	CoE	CoE	CoE	CoE

TABLE 1 Polyethylene Compound Requirements

Requirement	PE1404 ^A	PE2708 ^B	Material Designation PE360 Required Value ^B	PE4608 ^B	PE4710 ^B
HDB at 140°F (60°C), psi (MPa), per ASTM D2837 and PPI TR-3 HDS for water at 73°F (23°C) psi (MPa), per ASTM D2837 and PPI TR-3C Melt flow rate per ASTM D1238 Specification D3350 Cell Classification Property Density (natural base resin) SCG Resistance Color and UV Stabilizer Code ^E	400 (2.76) 1.0 to 0.4 g/10 min Cond. 190/2.16 <u>1</u> 4 C	800 (5.5) ≤0.40 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 <u>2</u> 7 C, Dor E	800 (5.5) ≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 <u>3</u> 6 C, Dor E	800 (5.5) ≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 <u>4</u> 6 C, Dor E	1000 (6.9) ≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 <u>4</u> 7 C, Dor E

^A Test Method HDB at D1693-ESGR-140°F (60°C) not required. Contact manufacturer about pipe use at temperatures other than 73°F (23°C).

^B Test Method HDB F1473-PENT at 140°F (60°C) required. Contact manufacturer or see PPI TR-4 for listed value.

^C Code C compounds shall contain 2 to 3 % carbon black when tested in accordance with Test Method Contact manufacturer D1603 or Test Method see PPI D4218. Code C and E compounds shall have sufficient antioxidants to meet requirements in Specification TR-4 D3350. Pipe produced from Code E compounds is not suitable for continuous use in exposed outdoor applications. Code E compounds shall have sufficient UV stabilizer to protect pipe from deleterious effects due to continuous outdoor exposure during shipping and unprotected outdoor storage for up to 18 months for listed value.

^D See 5.1.1.

^E

NOTE 1—Piping intended for use in the transport of potable water should be evaluated and certified as safe for this purpose by a testing agency acceptable to the local health authority. The evaluation should be in accordance with requirements for chemical extraction, taste, and odor that are no less restrictive than those included in ANSI/NSF Standard No. 14 or ANSI/NSF Standard No. 61. The seal or mark of the laboratory making the evaluation should be included on the piping.

5.1.1 *Color and Ultraviolet (UV) Stabilization*—Per Table 3, polyethylene compounds shall meet Specification D3350 code C, D or E. In addition, Code C polyethylene compounds shall have 2 to 3 percent carbon black, and Code E polyethylene compounds shall have sufficient UV stabilizer to protect pipe from deleterious UV exposure effects during unprotected outdoor shipping and storage for at least eighteen (18) months.

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

TABLE 2 Outside Diameters and Tolerances for DR-PR PE Plastic Pipe

Nominal Pipe Size, in.	Outside Diameter, in. (mm)	Tolerances, in. (mm)
1/2	0.840 (21.34)	±0.004 (0.10)
3/4	1.050 (26.7)	±0.004 (0.10)
1	1.315 (33.4)	±0.005 (0.13)
1 1/4	1.660 (42.2)	±0.005 (0.13)
1 1/2	1.900 (48.3)	±0.006 (0.15)
2	2.375 (60.3)	±0.006 (0.15)
3	3.500 (88.9)	±0.008 (0.20)
4	4.500 (114.3)	±0.009 (0.23)
6	6.625 (168.28)	±0.011 (0.28)
8	8.625 (219.08)	±0.013 (0.33)
10	10.750 (273.05)	±0.015 (0.38)
12	12.750 (323.85)	±0.017 (0.43)
14	14.000 (355.60)	±0.063 (1.60)
16	16.000 (406.40)	±0.072 (1.83)
18	18.000 (457.20)	±0.081 (2.06)
20	20.000 (508.00)	±0.090 (2.29)
22	22.000 (558.80)	±0.099 (2.51)
24	24.000 (609.60)	±0.108 (2.74)

5.1.2 Colors for solid color, a color shell layer, or color stripes—In accordance with the APWA Uniform Color Code, blue shall identify potable water service; green shall identify sewer service; purple (lavender) shall identify reclaimed water service. Yellow identifies gas service and shall not be used.

5.2 *Long-term Property Requirements—Potable Water Requirement*—Polyethylene compounds that are suitable for use in the manufacture of pipe under this specification shall meet Specification When required by the regulatory authority having jurisdiction, products ~~D3350~~ classification and property requirements in Table 1 and shall have PPI TR-4 HDB listings at 73°F (23°C). In addition, all pipe materials other than PE1404 that are intended to be suitable for use at temperatures from 80°F (27°C) through 140°F (60°C) shall have a minimum HDB at 140°F (60°C) of 630 psi (4.34 MPa). Materials that do not have an HDB at 140°F shall be limited to 80°F (27°C) and lower service temperatures. See intended for contact with potable water shall be evaluated, tested, and certified for conformance with NSF/ANSI Standard No. 61 or the health effects portion of NSF/ANSI Standard No. 14 by an acceptable certifying organization. ~~9.1.5~~.

NOTE 3—Additional information about long term stress ratings (HDB) for polyethylene compounds suitable for use in the manufacture of pipe under this specification is available in PPI TR-4.

NOTE 4—PPI TR-4 lists the maximum recommended hydrostatic design stress at 73°C for water; for PE 1404 materials as 400 psi; for PE 2606 materials as 630 psi; for PE 2708, PE 3708, PE 4608, and PE 4708 materials as 800 psi; and for PE 3710 and PE 4710 materials as 1000 psi.

5.3 *Rework Material*—Clean, rework material having the same cell classification or materials designation code and generated from the manufacturer’s own pipe production, may be used ~~production that met 5.1 by~~ through 5.2 the same manufacturer, as long as the pipe produced meets all of as new compound is suitable for use when blended with new compound of the same material designation. Pipe containing the rework material shall meet the requirements of this specification.

6. Requirements

6.1 *Workmanship*—The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other defects. The pipe shall be as uniform as commercially practicable in color, opacity, density, and other physical properties.

6.2 Dimensions and Tolerances:

6.2.1 *Outside Diameters*—The outside diameters and tolerances shall be as shown in Table 2 when measured in accordance with Test Method D2122. For diameters not shown in Table 2, the tolerances shall be the same percentage of the outside diameter as those for the closest listed diameter.

6.2.2 *Wall Thicknesses*—The wall thicknesses and tolerances shall be as shown in Table 3 when measured in accordance with Test Method D2122. For wall thicknesses (DRs) not shown in Table 3, the tolerances shall be the same percentage of the calculated minimum wall as for the closest listed minimum wall thickness.

6.2.3 *Wall Thickness Range*—The wall thickness range shall be within 12 % when measured in accordance with Test Method D2122.

6.3 *Short-term Properties*—Specimens of pipe shall be tested in accordance with either Test Method D1599 or Test Method D2290. The test method used, Test Method D1599 or Test Method D2290, is determined by the pipe size and the availability of appropriate test equipment. Test Method D1599 is generally used for 4 in. (114 mm) and smaller sizes and Test Method D2290 for 2 in. (60 mm) and larger sizes. Short-term hoop stress and failure mode data is provided by either test.

6.3.1 *Burst Pressure*—The minimum burst pressure for PE plastic pipe shall be as given in Table 4, when determined in accordance with Test Method D1599 and 7.6. The failure mode shall be ductile.

TABLE 4 Burst Pressure Requirements for Water at 73°F (23°C) for DR-PR PE Plastic Pipe

Dimension Ratio	Min Burst Pressure, ^A psi (MPa)					
	PE 3608, PE 3708, PE 3740, PE 4608, PE 4708, PE 4710		PE 2606, PE 2708		PE 1404	
	psi	(MPa)	psi	(MPa)	psi	(MPa)
7	967	(6.67)	840	(5.79)	417	(2.87)
9	725	(5.00)	630	(4.34)	313	(2.16)
9.3	699	(4.82)	607	(4.19)	301	(2.08)
11	580	(4.00)	504	(3.47)	250	(1.72)
13.5	464	(3.20)	403	(2.78)	200	(1.38)
15.5	400	(2.76)	348	(2.40)	172	(1.19)
17	363	(2.50)	315	(2.13)	156	(1.08)
21	290	(2.00)	252	(1.74)	125	(0.86)
26	232	(1.60)	202	(1.39)	100	(0.69)
32.5	184	(1.27)	160	(1.10)	79	(0.55)

^A The fiber stresses used to derive these test pressures are as follows:

	psi	(MPa)
PE 3608, PE 3708, PE 3740, PE 4608, PE 4708, PE 4710	2900	(20.00)
PE 3608, PE 4608, PE 4710	2900	(20.00)
PE 2606, PE 2708 PE 2708	2520 2520	(17.37) (17.37)
PE 1404	1250	(8.62)

TABLE 5 Apparent Tensile Strength at Yield of Ring Specimens Cut from Pipe

Material	psi	(MPa)
PE 2606, PE 2708, PE 2708	2520 2520	(17.37) (17.37)
PE 3608, PE 3708, PE 3740, PE 4608, PE 4708, PE 4710	2900	(20.00)
PE 3608, PE 4608, PE 4710	2900	(20.00)
PE 1404	1250	(8.62)

6.5.1 Passing results are (1) non-failure for all three specimens at a time equal to or greater than the **Table 7** “minimum average time before failure” for the selected **Table 7** Condition, or (2) not more than one ductile specimen failure and the average time before failure for all three specimens shall be greater than the specified “minimum average time before failure” for the selected **Table 7** Condition. If more than one ductile failure occurs before the “minimum average time before failure”, it is permissible to conduct one retest at a **Table 7** Condition of lower stress and longer minimum average time before failure for the material designation except that for **Table 7** Condition 6 no retest is permissible. Brittle failure of any specimen in the test sample when tested at **Table 7** Condition 1 through 6 constitutes failure to meet this requirement and no retest is allowed.

6.5.2 *Provision for retest (if needed)*—The retest sample shall be three specimens of the same pipe or tubing size and material designation from the same time frame as the test sample per **7.5**. For the retest, any specimen failure before the **Table 7** “minimum average time before failure” at the retest condition of lower stress and longer minimum average time before failure constitutes failure to meet this requirement.

7. Test Methods

7.1 *Conditioning*—Condition the test specimens for not less than 40 h prior to test in accordance with Procedure A of Practice **D618**, for those tests where conditioning is required.

7.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of $73 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$), unless otherwise specified in the test methods or in this specification.