



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

This standard is issued under the fixed designation D 3035; 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 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. 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.

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 Documents²

2.1 ASTM Standards:

- D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing
- D 792 Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D 1238 Test Method for Flow Rates of Thermoplastics by

Extrusion Plastometer

- D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
 - D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
 - D 1599 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
 - D 1600 Terminology for Abbreviated Terms Relating to Plastics
 - D 1603 Test Method for Carbon Black in Olefin Plastics
 - D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
 - D 2290 Test Method for Apparent Tensile Strength of Ring or Tubular Plastics and Reinforced Plastics by Split Disk Method
 - D 2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
 - D 3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
 - F 412 Terminology Relating to Plastic Piping Systems
- ### 2.2 NSF International Standards:
- ANSI/NSF Standard No. 14 for Plastic Piping Components and Related Materials³
 - ANSI/NSF Standard No. 61 for Drinking Water System Components—Health Effects³
- ### 2.3 PPI 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
 - TR-9 Recommended Design Factors for Thermoplastic Pressure Pipe⁴

3. Terminology

3.1 Definitions—Definitions are in accordance with Terminology F 412, and abbreviations are in accordance with Terminology D 1600, unless otherwise specified.

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.

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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.

⁴ Available from the Plastics Pipe Institute, Inc., 1825 Connecticut Ave., NW, Suite 680 Washington, DC 20009.

TABLE 1 Specification D 3350 Cell Classifications for Polyethylene Pipe Materials

PE Material Designation Code	PE 1404	PE 2406	PE 3408
Physical Property: Cell Classifications			
Density	1	2	3
Melt Index	2	3 or 4	3 or 4
Flexural Modulus	3	3 or 4	4 or 5
Tensile Strength at Yield	1	3 or 4	4 or 5
Slow Crack Growth Resistance	1 ^A	6 ^B	6 ^B
Hydrostatic Design Basis	1	3	4
Color and UV Stabilizer ^C	C	C or E	C or E

^A Test Method D 1693 ESCR.

^B Test Method F 1473 PENT.

^C Classification C compounds shall contain 2 to 3.5 % carbon black when tested in accordance with Test Method D 1603. Classification C and E compounds shall have sufficient antioxidants to meet requirements in Specification D 3350. Pipe produced from Classification E compounds is not suitable for continuous use in exposed outdoor applications. Classification 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.

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.

3.2.3 relation between dimension ratio, hydrostatic design stress, and pressure rating—the following expression, commonly known as the ISO equation,⁵ is used in this specification to relate dimension ratio, hydrostatic design stress, and pressure rating:

$$2SIP = R - 1 \text{ or } 2SI P = (D_o/t) - 1 \quad (1)$$

where:

- S = hydrostatic design stress, psi (MPa),
- P = pressure rating, psi (MPa),
- D_o = average outside diameter, in. (mm)
- t = minimum wall thickness, in. (mm), and,
- R = 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

TABLE 2 Long-Term Property Requirements

PE Material Designation Code	Long-term Property in Accordance with Test Method D 2837 ^A
PE 1404	HDB of 800 psi at 73°F (5.52 MPa at 23°C)
PE 2406	HDB of 1250 psi at 73°F (8.62 MPa at 23°C)
PE 3408	HDB of 1600 psi at 73°F (11.03 MPa at 23°C)

^A The hydrostatic design basis shall be established using water or air as the pressurizing fluid.

TABLE 3 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)

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 three 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 suitable for use in the manufacture of pipe under this specification shall be classified in accordance with Specification D 3350 and as shown in Table 1.

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

⁵ ISO R 161-1960, Pipes of Plastics Materials for the Transport of Fluids (Outside Diameters and Nominal Pressure), Part 1, Metric Series.

TABLE 4 Wall Thicknesses and Tolerances^A for DR-PR PE Plastic Pipe

Nominal Pipe Size, IPS, in.	DR 32.5				DR 26				DR 21				DR 17				DR 15.5			
	Minimum		Tolerance		Minimum		Tolerance		Minimum		Tolerance		Minimum		Tolerance		Minimum		Tolerance	
	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
½	0.062	(1.57)	0.020	(0.51)	0.062	(1.57)	0.020	(0.51)	0.062	(1.57)	0.020	(0.51)	0.062	(1.57)	0.020	(0.51)	0.062	(1.57)	0.020	(0.51)
¾	0.062	(1.57)	0.020	(0.51)	0.062	(1.57)	0.020	(0.51)	0.062	(1.57)	0.020	(0.51)	0.062	(1.57)	0.020	(0.51)	0.068	(1.73)	0.020	(0.51)
1	0.062	(1.57)	0.020	(0.51)	0.062	(1.57)	0.020	(0.51)	0.063	(1.60)	0.020	(0.51)	0.077	(1.96)	0.020	(0.51)	0.084	(2.13)	0.020	(0.51)
1¼	0.062	(1.57)	0.020	(0.51)	0.064	(1.63)	0.020	(0.51)	0.079	(2.01)	0.020	(0.51)	0.098	(2.49)	0.020	(0.51)	0.107	(2.72)	0.020	(0.51)
1½	0.062	(1.57)	0.020	(0.51)	0.073	(1.85)	0.020	(0.51)	0.090	(2.29)	0.020	(0.51)	0.112	(2.84)	0.020	(0.51)	0.123	(3.12)	0.020	(0.51)
2	0.073	(1.85)	0.020	(0.51)	0.091	(2.31)	0.020	(0.51)	0.113	(2.87)	0.020	(0.51)	0.140	(3.56)	0.020	(0.51)	0.153	(3.89)	0.020	(0.51)
3	0.108	(2.74)	0.020	(0.51)	0.135	(3.43)	0.020	(0.51)	0.167	(4.24)	0.020	(0.51)	0.206	(5.23)	0.025	(0.64)	0.226	(5.74)	0.027	(0.69)
4	0.138	(3.51)	0.020	(0.51)	0.173	(4.39)	0.021	(0.53)	0.214	(5.44)	0.026	(0.66)	0.265	(6.73)	0.032	(0.81)	0.327	(8.31)	0.039	(0.99)
5	0.171	(4.34)	0.021	(0.53)	0.214	(5.44)	0.026	(0.66)	0.265	(6.73)	0.032	(0.81)	0.327	(8.31)	0.039	(0.99)	0.359	(9.12)	0.043	(1.09)
6	0.204	(5.18)	0.024	(0.61)	0.255	(6.48)	0.031	(0.79)	0.315	(8.00)	0.038	(0.97)	0.390	(9.91)	0.047	(1.19)	0.427	(10.85)	0.051	(1.30)
8	0.265	(6.73)	0.032	(0.81)	0.332	(8.43)	0.040	(1.02)	0.411	(10.44)	0.049	(1.24)	0.507	(12.88)	0.061	(1.55)	0.556	(14.12)	0.067	(1.70)
10	0.331	(8.41)	0.040	(1.02)	0.413	(10.49)	0.050	(1.27)	0.512	(13.00)	0.061	(1.55)	0.632	(16.05)	0.076	(1.93)	0.694	(17.63)	0.083	(2.11)
12	0.392	(9.96)	0.047	(1.19)	0.490	(12.45)	0.059	(1.50)	0.607	(15.42)	0.073	(1.85)	0.750	(19.05)	0.090	(2.29)	0.823	(20.90)	0.099	(2.51)
14	0.431	(10.95)	0.052	(1.32)	0.538	(13.67)	0.065	(1.65)	0.667	(16.94)	0.080	(2.03)	0.824	(20.93)	0.099	(2.51)	0.903	(22.94)	0.108	(2.74)
16	0.492	(12.50)	0.059	(1.50)	0.615	(15.62)	0.074	(1.88)	0.762	(19.35)	0.091	(2.31)	0.941	(23.90)	0.113	(2.87)	1.032	(26.21)	0.124	(3.15)
18	0.554	(14.07)	0.066	(1.68)	0.692	(17.58)	0.083	(2.11)	0.857	(21.77)	0.103	(2.62)	1.059	(26.90)	0.127	(3.23)	1.161	(29.49)	0.139	(3.53)
20	0.615	(15.62)	0.074	(1.88)	0.769	(19.53)	0.092	(2.34)	0.952	(24.18)	0.114	(2.90)	1.176	(29.87)	0.141	(3.58)	1.290	(32.77)	0.155	(3.94)
22	0.677	(16.94)	0.081	(2.06)	0.846	(21.49)	0.102	(2.59)	1.048	(26.62)	0.126	(3.20)	1.294	(32.87)	0.155	(3.94)	1.419	(36.04)	0.170	(4.32)
24	0.738	(18.75)	0.089	(2.26)	0.923	(23.44)	0.111	(2.82)	1.143	(29.03)	0.137	(3.48)	1.412	(35.86)	0.169	(4.29)	1.548	(39.32)	0.186	(4.72)

Nominal Pipe Size, IPS, in.	DR 13.5				DR 11				DR 9.3				DR 9				DR 7			
	Minimum		Tolerance		Minimum		Tolerance		Minimum		Tolerance		Minimum		Tolerance		Minimum		Tolerance	
	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
½	0.062	(1.57)	0.020	(0.51)	0.076	(1.93)	0.020	(0.51)	0.090	(2.29)	0.020	(0.51)	0.093	(2.36)	0.020	(0.51)	0.120	(3.05)	0.020	(0.51)
¾	0.078	(1.98)	0.020	(0.51)	0.095	(2.41)	0.020	(0.51)	0.113	(2.87)	0.020	(0.51)	0.117	(2.97)	0.020	(0.51)	0.150	(3.81)	0.020	(0.51)
1	0.097	(2.46)	0.020	(0.51)	0.120	(3.05)	0.020	(0.51)	0.141	(3.58)	0.020	(0.51)	0.146	(3.71)	0.020	(0.51)	0.188	(4.78)	0.023	(0.58)
1¼	0.123	(3.12)	0.020	(0.51)	0.151	(3.84)	0.020	(0.51)	0.178	(4.52)	0.021	(0.53)	0.184	(4.67)	0.022	(0.56)	0.237	(6.02)	0.028	(0.71)
1½	0.141	(3.58)	0.020	(0.51)	0.173	(4.39)	0.021	(0.53)	0.204	(5.18)	0.024	(0.61)	0.211	(5.36)	0.025	(0.64)	0.271	(6.88)	0.033	(0.84)
2	0.176	(4.47)	0.021	(0.53)	0.216	(5.49)	0.026	(0.66)	0.255	(6.48)	0.031	(0.79)	0.264	(6.71)	0.032	(0.81)	0.339	(8.61)	0.041	(1.04)
3	0.259	(6.58)	0.031	(0.79)	0.318	(8.08)	0.038	(0.97)	0.376	(9.55)	0.045	(1.14)	0.389	(9.88)	0.047	(1.19)	0.500	(12.70)	0.060	(1.52)
4	0.333	(8.46)	0.040	(1.02)	0.409	(10.39)	0.049	(1.24)	0.484	(12.29)	0.058	(1.47)	0.500	(12.70)	0.060	(1.52)	0.643	(16.33)	0.077	(1.96)
5	0.412	(10.46)	0.049	(1.24)	0.506	(12.85)	0.061	(1.55)	0.598	(15.19)	0.072	(1.83)	0.618	(15.70)	0.074	(1.88)	0.795	(20.19)	0.095	(2.41)
6	0.491	(12.47)	0.059	(1.50)	0.602	(15.29)	0.072	(1.83)	0.712	(18.08)	0.085	(2.16)	0.736	(18.69)	0.088	(2.24)	0.946	(24.03)	0.114	(2.90)
8	0.639	(16.23)	0.077	(1.96)	0.784	(19.91)	0.094	(2.39)	0.927	(23.55)	0.111	(2.82)	0.958	(24.33)	0.115	(2.92)	1.232	(31.29)	0.147	(3.73)
10	0.796	(20.22)	0.096	(2.44)	0.977	(24.82)	0.117	(2.97)	1.156	(29.36)	0.139	(3.53)	1.194	(30.33)	0.143	(3.63)	1.536	(39.01)	0.184	(4.67)
12	0.944	(23.98)	0.113	(2.87)	1.159	(29.44)	0.139	(3.53)	1.371	(34.82)	0.165	(4.19)	1.417	(35.99)	0.170	(4.32)	1.821	(46.25)	0.219	(5.56)
14	1.037	(26.34)	0.124	(3.15)	1.273	(32.33)	0.153	(3.89)	1.505	(38.23)	0.181	(4.60)	1.556	(39.52)	0.187	(4.75)	2.000	(50.80)	0.240	(6.10)
16	1.185	(30.10)	0.142	(3.61)	1.455	(36.96)	0.175	(4.45)	1.720	(43.69)	0.206	(5.23)	1.778	(45.16)	0.213	(5.41)	2.286	(58.06)	0.274	(6.96)
18	1.333	(33.86)	0.160	(4.06)	1.636	(41.55)	0.196	(4.98)	1.935	(49.15)	0.232	(5.89)	2.000	(50.80)	0.240	(6.10)	2.571	(65.30)	0.309	(7.85)
20	1.481	(37.62)	0.178	(4.52)	1.818	(46.18)	0.218	(5.54)	2.151	(54.64)	0.258	(6.55)	2.222	(56.44)	0.267	(6.78)	2.857	(72.57)	0.343	(8.71)
22	1.630	(41.40)	0.196	(4.98)	2.000	(50.80)	0.240	(6.10)	2.366	(60.10)	0.284	(7.21)	2.444	(62.08)	0.293	(7.44)	3.143	(79.83)	0.377	(9.58)
24	1.778	(45.16)	0.213	(5.41)	2.182	(55.42)	0.262	(6.65)	2.581	(65.56)	0.310	(7.87)	2.667	(67.74)	0.320	(8.13)	3.429	(87.10)	0.411	(10.44)

^A The minimum is the lowest wall thickness of the pipe allowable at any cross section. The maximum permitted wall thickness, at any cross section, is the minimum wall thickness plus the stated tolerance. All tolerances are on the plus side of the minimum requirement.

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.

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

5.2 Long-term Property Requirements—Polyethylene compounds that are suitable for use in the manufacture of pipe under this specification shall meet or exceed the long-term property requirements in **Table 2**. In addition, PE 2406 and PE 3408 materials that are intended to be suitable for use at temperatures from 100°F (38°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 100°F and lower service temperatures. See **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.

5.3 Rework Material—Clean, rework material having the same classification and generated from the manufacturer’s own pipe production, may be used by the same manufacturer, as long as the pipe produced meets all of 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: