Designation: D3035 – 15

Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter[1]

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.

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 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, and burst pressure. Methods of marking are also given.

1.2 All pipes produced under this specification are intended for use as the distribution and transmission of potable and non-potable water, grey water, reclaimed water, wastewater, force main and gravity 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 standard. The values given in parentheses are 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

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

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

F412 Terminology Relating to Plastic Piping Systems

2.2 *NSF International Standards:*[3]

NSF/ANSI Standard 14 for Plastic Piping Components and Related Materials

NSF/ANSI Standard 61 for Drinking Water System Components—Health Effects

2.3 *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 Pipe[4]

APWA Uniform Color Code[5]

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:*

[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 NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, http://www.nsf.org.

[4] .Available from Plastics Pipe 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.

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

TABLE 1 Polyethylene Compound Requirements

	Material Designation				
	PE1404	PE2708	PE3608	PE4608	PE4710
Requirement	Required Value				
HDB at 140ºF (60ºC), psi (MPa), per ASTM D2837 and PPI TR-3	[A]	800 (5.5)[B]	800 (5.5)[B]	800 (5.5)[B]	800 (5.5)[B]
HDS for water at 73°F (23°C) psi (MPa), per ASTM D2837 and PPI TR-3[C]	400 (2.76)	800 (5.5)	800 (5.5)	800 (5.5)	1000 (6.9)
Melt flow rate per ASTM D1238	1.0 to 0.4 g/10 min Cond. 190/2.16	≤0.40 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6	≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6	≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6	≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6
Specification D3350 Cell Classification Property	Required Value				
Density (natural base resin)	1	2	3	4	4
SCG Resistance	4	7	6	6	7
Color and UV Stabilizer Code[D]	C	C, D, or E	C, D, or E	C, D, or E	C, D, or E

[A] HDB at 140°F (60°C) not required. Contact manufacturer about pipe use at temperatures other than 73°F (23°C).
[B] Minimum value.
[C] Contact manufacturer or see PPI TR-4 for listed value.
[D] See 5.1.1.

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:

$$2S/P = DR - 1 \text{ or } 2S/P = (D_0/t) - 1 \quad (1)$$

where:

S = hydrostatic design stress for water at 73°F (23°C), psi (MPa),
P = pressure rating, psi (MPa),
D_0 = average outside diameter, in. (mm)
t = minimum wall thickness, in. (mm), and,
DR = thermoplastic pipe dimension ratio (D_0 /t for PE pipe).

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

TABLE 2 IPS Pipe-Outside Diameter[A] and Tolerance

IPS Size	Outside Diameter, in. (mm)	Tolerances, in. (mm)
½	0.840 (21.34)	±0.004 (0.10)
¾	1.050 (26.7)	±0.004 (0.10)
1	1.315 (33.4)	±0.005 (0.13)
1¼	1.660 (42.2)	±0.005 (0.13)
1½	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)
26	26.000 (660.4)	±0.117 (2.97)
28	28.000 (711.2)	±0.126 (3.20)
30	30.000 (762.0)	±0.135 (3.43)
32	32.000 (812.8)	±0.144 (3.66)
34	34.000 (863.6)	±0.153 (3.89)
36	36.000 (914.4)	±0.162 (4.11)
42	42.000 (1066.8)	±0.189 (4.80)
48	48.000 (1219.2)	±0.216 (5.49)
54	54.000 (1371.6)	±0.243 (6.17)
63	63.000 (1600.2)	±0.284 (6.71)
65	65.000 (1651.0)	±0.293 (7.44)

[A] For a distance to the cut end of the pipe that is the lesser of 11.8-in (300 mm) or 1.5 times the outside diameter, a diameter reduction of up to 1.5% shall be acceptable.

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

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 *Polyethylene Compounds*—Polyethylene compounds suitable for use in the manufacture of pipe under this specification shall meet thermoplastic 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

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.

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 *Potable Water Requirement*—When required by the regulatory authority having jurisdiction, products 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.

5.3 *Rework Material*—Clean, rework material from the manufacturer's own pipe production that met 5.1 through 5.2 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 or Table 7 when measured in accordance with Test Method D2122. For diameters not shown in Table 2 or Table 7, 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 or Table 7 when measured in accordance with Test Method D2122. For wall thicknesses (DRs) not shown in Table 3 or Table 7, 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.

6.3.2 *Apparent Ring Tensile Strength*—The minimum apparent ring tensile strength at yield shall be 1250 psi (8.62 MPa) for PE 1404, 2520 psi (17.37 MPa) for Table 1 density cell 2 polyethylene pipe materials, and 2900 psi (20.00 MPa) for Table 1 density cell 3 and 4 polyethylene pipe materials when tested in accordance with Test Method D2290, Procedure B and 7.7. The failure shall be ductile.

6.4 *Sustained Pressure at Ambient and Elevated Temperature for PE1404*—PE1404 pipes shall be tested in accordance with 7.4 at the stresses and temperatures specified in Table 6. Tests may be conducted on any pipe size, but tests conducted on 6 in. (168 mm) nominal size pipe shall be considered representative of all pipe sizes. At 176°F (80°C) pipes shall be tested at either stress. If ductile failures occur at the higher stress at 176°F (80°C), testing shall be repeated at the lower stress. Acceptable results are non-failure at the minimum average test time, or brittle failure at times exceeding the minimum average test time.

6.5 *Elevated Temperature Sustained Pressure for Pipes Other Than PE1404*—Elevated temperature sustained pressure tests for each Table 1 polyethylene pipe material (material designation) used in production at the facility shall be conducted twice annually per 7.5.

NOTE 1—Elevated temperature sustained pressure tests are intended to verify extrusion processing and are conducted in accordance with the manufacture's quality program.

6.5.1 Passing results are *(1)* non-failure for all three specimens at a time equal to or greater than the Table 8 "minimum average time before failure" for the selected Table 8 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 8 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 8 Condition of lower stress and longer minimum average time before failure for the material designation except that for Table 8 Condition 6 no retest is permissible. Brittle failure of any

TABLE 3 IPS Pipe[A] Minimum Wall Thickness and Tolerance

IPS Size	DR 32.5		DR 26		DR 21		DR 17		DR 15.5		DR 13.5		DR 11		DR 9		DR 7	
	Min.	Tol.[B]	Min.	Tol.[B]	Min.	Tol.[B]	Min.	Tol.[B]	Min.	Tol.[B]	Min.	Tol.[B]	Min.	Tol.[B]	Min.	Tol.[B]	Min.	Tol.[B]
	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	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)	0.093 (2.36)	0.020 (0.51)	0.120 (3.05)	0.020 (0.51)
¾	...	...	...	...	...	...	0.062 (1.57)	0.020 (0.51)	0.068 (1.73)	0.020 (0.51)	0.078 (1.98)	0.020 (0.51)	0.095 (2.41)	0.020 (0.51)	0.117 (2.97)	0.020 (0.51)	0.150 (3.81)	0.020 (0.51)
1	...	...	0.062 (1.57)	0.020 (0.51)	0.063 (1.60)	0.020 (0.51)	0.077 (1.96)	0.020 (0.51)	0.085 (2.16)	0.020 (0.51)	0.097 (2.46)	0.020 (0.51)	0.120 (3.05)	0.020 (0.51)	0.146 (3.71)	0.020 (0.51)	0.188 (4.78)	0.023 (0.58)
1¼			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)	0.123 (3.12)	0.020 (0.51)	0.151 (3.84)	0.020 (0.51)	0.184 (4.67)	0.022 (0.56)	0.237 (6.02)	0.028 (0.71)
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)	0.141 (3.58)	0.020 (0.51)	0.173 (4.39)	0.021 (0.53)	0.211 (5.36)	0.025 (0.64)	0.271 (6.88)	0.033 (0.84)
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)	0.176 (4.47)	0.021 (0.53)	0.216 (5.49)	0.026 (0.66)	0.264 (6.71)	0.032 (0.81)	0.339 (8.61)	0.041 (1.04)
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)	0.259 (6.58)	0.031 (0.79)	0.318 (8.08)	0.038 (0.97)	0.389 (9.88)	0.047 (1.19)	0.500 (12.70)	0.060 (1.52)
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)	0.290 (7.37)	0.035 (0.89)	0.333 (8.46)	0.040 (1.02)	0.409 (10.39)	0.049 (1.24)	0.500 (12.70)	0.060 (1.52)	0.643 (16.33)	0.077 (1.96)
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)	0.491 (12.47)	0.059 (1.50)	0.602 (15.29)	0.072 (1.83)	0.736 (18.69)	0.088 (2.24)	0.946 (24.03)	0.114 (2.90)
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)	0.639 (16.23)	0.077 (1.96)	0.784 (19.91)	0.094 (2.39)	0.958 (24.33)	0.115 (2.92)	1.232 (31.29)	0.148 (3.76)
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)	0.796 (20.22)	0.096 (2.44)	0.977 (24.82)	0.117 (2.97)	1.194 (30.33)	0.143 (3.63)	1.536 (39.01)	0.184 (4.67)
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)	0.944 (23.98)	0.113 (2.87)	1.159 (29.44)	0.139 (3.53)	1.417 (35.99)	0.170 (4.32)	1.821 (46.25)	0.219 (5.56)
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)	1.037 (26.34)	0.124 (3.15)	1.273 (32.33)	0.153 (3.89)	1.556 (39.52)	0.187 (4.75)	2.000 (50.80)	0.240 (6.10)
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)	1.185 (30.10)	0.142 (3.61)	1.455 (36.96)	0.175 (4.45)	1.778 (45.16)	0.213 (5.41)	2.286 (58.06)	0.274 (6.96)
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)	1.333 (33.86)	0.160 (4.06)	1.636 (41.55)	0.196 (4.98)	2.000 (50.80)	0.240 (6.10)	2.571 (65.30)	0.309 (7.85)
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)	1.481 (37.62)	0.178 (4.52)	1.818 (46.18)	0.218 (5.54)	2.222 (56.44)	0,267 (6.78)	2.857 (72.57)	0.343 (8.71)
22	0.677 (17.20)	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)	1.630 (41.40)	0.196 (4.98)	2.000 (50.80)	0.240 (6.10)	2.444 (62.08)	0.293 (7.44)	3.143 (79.83)	0.377 (9.58)
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)	1.778 (45.16)	0.213 (5.41)	2.182 (55.42)	0.262 (6.65)	2.667 (67.74)	0.320 (8.13)	3.429 (87.10)	0.411 (10.44)
26	0.800 (20.32)	0.096 (2.44)	1.000 (25.40)	0.120 (3.05)	1.238 (31.45)	0.149 (3.78)	1.529 (38.84)	0.183 (4.65)	1.677 (42.60)	0.201 (5.11)	1.926 (48.92)	0.231 (5.87)	2.364 (60.05)	0.284 (7.21)	2.889 (73.38)	0.347 (8.81)	...	...
28	0.862 (21.89)	0.103 (2.62)	1.077 (27.36)	0.129 (3.28)	1.333 (33.86)	0.160 (4.06)	1.647 (41.83)	0.198 (5.03)	1.806 (45.87)	0.217 (5.51)	2.074 (52.68)	0.249 (6.32)	2.545 (64.64)	0.305 (7.75)	3.111 (79.02)	0.373 (9.47)	...	...
30	0.923 (23.44)	0.111 (2.82)	1.154 (29.31)	0.138 (3.51)	1.429 (36.30)	0.171 (4.34)	1.765 (44.83)	0.212 (5.38)	1.935 (49.15)	0.232 (5.89)	2.222 (56.44)	0.267 (6.78)	2.727 (69.27)	0.327 (8.31)	3.333 (84.66)	0.400 (10.16)	...	...
32	0.985 (25.02)	0.118 (3.00)	1.231 (31.27)	0.148 (3.76)	1.524 (38.71)	0.183 (4.65)	1.882 (47.80)	0.226 (5.74)	2.065 (52.45)	0.248 (6.30)	2.370 (60.20)	0.284 (7.21)	2.909 (73.89)	0.349 (8.86)	3.556 (90.32)	0.427 (10.85)	...	...
34	1.046 (26.57)	0.126 (3.20)	1.308 (33.22)	0.157 (3.99)	1.619 (41.12)	0.194 (4.93)	2.000 (50.80)	0.240 (6.10)	2.194 (55.73)	0.263 (6.68)	2.519 (63.98)	0.302 (7.67)	3.091 (78.51)	0.371 (9.42)	...	...	...	...
36	1.108 (28.14)	0.133 (3.38)	1.385 (35.18)	0.166 (4.22)	1.714 (43.54)	0.206 (5.23)	2.118 (53.80)	0.254 (6.45)	2.323 (59.00)	0.279 (7.09)	2.667 (67.74)	0.320 (8.13)	3.273 (83.13)	0.393 (9.98)	...	...	...	...
42	1.292 (32.82)	0.155 (3.94)	1.615 (41.02)	0.194 (4.93)	2.000 (50.80)	0.240 (6.10)	2.471 (62.76)	0.297 (7.54)	2.710 (68.83)	0.325 (8.26)	3.111 (79.02)	0.373 (9.47)	...	...	...	...	...	...
48	1.477 (37.52)	0.177 (4.50)	1.846 (46.89)	0.222 (5.64)	2.286 (58.06)	0.274 (6.96)	2.824 (71.73)	0.339 (8.61)	3.097 (78.66)	0.372 (9.45)	3.556 (90.32)	0.427 (10.85)	...	...	...	...	...	...
54	1.662 (42.21)	0.199 (5.05)	2.077 (52.76)	0.249 (6.32)	2.571 (65.30)	0.309 (7.85)	3.176 (80.67)	0.381 (9.68)	3.484 (88.49)	0.418 (10.62)	...	...	...	...	...	...	...	...
63	1.938 (49.23)	0.233 (5.92)	2.423 (61.54)	0.291 (7.39)	3.000 (76.20)	0.360 (9.14)	...	...	...	...	...	...	...	...	...	...	...	...
65	2.000 (50.80)	0.240 (6.10)	2.500 (63.50)	0.300 (7.62)	3.095 (78.61)	0.371 (9.42)	...	...	...	...	...	...	...	...	...	...	...	...

[A] See 4.3 for sizes not shown.
[B] For IPS sizes greater than 24, tolerance applies to the minimum wall thickness obtained when measuring pipe.

specimen in the test sample when tested at Table 8 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

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 4608, PE 4710		PE 2708		PE 1404	
	psi	(MPa)	psi	(MPa)	psi	(MPa)
7	967	(6.67)	840	(5.79)	417	(2.87)
7.7[B]	866	(5.97)	...	...	...	...
9	725	(5.00)	630	(4.34)	313	(2.16)
11	580	(4.00)	504	(3.47)	250	(1.72)
13.5	464	(3.20)	403	(2.78)	200	(1.38)
14.3[B]	436	(3.01)	...	...	...	...
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 4608, PE 4710	2900	(20.00)
PE 2708	2520	(17.37)
PE 1404	1250	(8.62)

[B] Applies to PE4710 only. See Table 7.

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

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

sample per 7.5. For the retest, any specimen failure before the Table 8 "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 ± 3.6°F (23 ± 2°C), unless otherwise specified in the test methods or in this specification.

7.3 *Sampling*—The selection of the sample or samples of pipe shall be as agreed upon by the purchaser and the seller. In case of no prior agreement, random samples as selected by the testing laboratory shall be deemed adequate.

7.4 *Sustained Pressure Test at Ambient and Elevated Temperature*—Select three specimens of pipe at random and test each specimen individually with water at controlled temperatures under the stresses given in Table 6. Each specimen shall be at least ten times the nominal diameter in length, but not less than 10 in. (250 mm) or more than 3 ft (1000 mm) between end closures and containing the permanent marking on the pipe. Condition the specimens for at least 2 h at test temperature ± 3.6°F (2°C) prior to test. Test for the minimum failure time specified in Table 6 in accordance with Test Method D1598, at the stress and temperature values given in Table 6. Maintain the specimens at the test pressures ±10 psi (±70 kPa) and the test temperatures ± 3.6°F (± 2°C). Failure of one of the three specimens tested is cause for retest of three additional specimens. Failure of one of three specimens tested in retest constitutes failure in the test. Test and retest specimens shall be from the same production lot. Failure of the pipe test specimen shall be as defined in Test Method D1598. When testing at 176 ± 3.6°F (80 ± 2°C) at the higher stress, if ductile failure occurs before the minimum time, rerunning the test at the lower stress condition is not considered a retest.

7.5 *Elevated Temperature Sustained Pressure Test*—The "test sample" shall be three specimens of a generally representative pipe or tubing size produced at the manufacturer's facility using the Table 1 polyethylene pipe material (material designation). Select one Table 8 Condition for the Table 1 polyethylene pipe material (material designation) and test the three specimen test sample in accordance with Test Method D1598 using water as the internal test medium.

7.6 *Hydrostatic Burst Pressure*—The test equipment, procedures, and failure definitions shall be as specified in Test Method D1599.

7.7 *Apparent Ring Tensile Strength at Yield*—The method and test equipment shall be as specified in Test Method D2290, Procedure B. Test a minimum of five specimens.

8. Retest and Rejection

8.1 Except as specified in 6.4, 6.5, 6.5.1 and 6.5.2, if the results of any test(s) do not meet the requirements of this specification, the test(s) may be conducted again in accordance with an agreement between the purchaser and the seller. There

TABLE 6 Stress and Time Requirements for Sustained Pressure Test[A]

Pipe Material	Minimum Hours Before Failure at 73°F (23°C)	Minimum Average Hours to Failure at 176°F (80°C)		
	S = 800 psi (5.5 MPa)	S = 670 psi (4.6 MPa)	S = 580 psi (4 MPa)	S = 435 psi (3 MPa)
PE 1404	1000		80	150

[A] Calculate internal pressure in accordance with the following formula:

$$P = \frac{2S}{\frac{D_o}{t} - 1}$$

where:

P = pressure, psig (MPa),
S = hoop stress, psi (MPa),
D_o = average outside diameter, in. (mm), and
t = minimum wall thickness, in. (mm).

TABLE 7 PE4710 DIPS PR-DR Plastic Pipe—Outside Diameter and Wall Thickness

DIPS Size	Outside Diameter[A]		Wall Thickness, in. (mm)											
			PR 300 7.7		PR 250 DR 9		PR 200 DR 11		PR 150 DR 14.3		PR 125 DR 17		PR 100 DR 21	
	Average	± Tol.	Min.	Tol.[B]	Min.	Tol.[B]	Min.	Tol.[B]	Min.	Tol.[B]	Min.	Tol.[B]	Min.	Tol.[B]
3	3.960 (100.58)	0.018 (0.46)	0.514 (13.06)	0.062 (1.57)	0.440 (11.18)	0.053 (1.35)	0.360 (9.14)	0.043 (1.09)	0.277 (7.04)	0.033 (0.84)	0.233 (5.92)	0.028 (0.71)	0.189 (4.80)	0.023 (0.58)
4	4.800 (121.92)	0.022 (0.56)	0.623 (15.82)	0.075 (1.91)	0.533 (13.54)	0.064 (1.63)	0.436 (11.07)	0.052 (1.32)	0.336 (8.53)	0.040 (1.02)	0.282 (7.16)	0.034 (0.86)	0.229 (5.82)	0.027 (0.69)
6	6.900 (175.26)	0.031 (0.79)	0.896 (22.76)	0.108 (2.74)	0.767 (19.48)	0.092 (2.34)	0.627 (15.93)	0.075 (1.91)	0.483 (12.27)	0.058 (1.47)	0.406 (10.31)	0.049 (1.24)	0.329 (8.36)	0.039 (0.99)
8	9.050 (229.87)	0.041 (1.04)	1.175 (29.85)	0.141 (3.58)	1.006 (25.55)	0.121 (3.07)	0.823 (20.90)	0.099 (2.51)	0.633 (16.08)	0.076 (1.93)	0.532 (13.51)	0.064 (1.63)	0.431 (10.95)	0.052 (1.32)
10	11.100 (281.94)	0.050 (1.27)	1.442 (36.63)	0.173 (4.39)	1.233 (31.32)	0.148 (3.76)	1.009 (25.63)	0.121 (3.07)	0.776 (19.71)	0.093 (2.36)	0.653 (16.59)	0.078 (1.98)	0.529 (13.44)	0.063 (1.60)
12	13.200 (335.28)	0.059 (1.50)	1.714 (43.54)	0.206 (5.23)	1.467 (37.26)	0.176 (4.47)	1.200 (30.48)	0.144 (3.66)	0.923 (23.44)	0.111 (2.82)	0.776 (19.71)	0.093 (2.36)	0.629 (15.98)	0.075 (1.91)
14	15.300 (388.62)	0.069 (1.75)	1.987 (50.47)	0.238 (6.05)	1.700 (43.18)	0.204 (5.18)	1.391 (35.33)	0.167 (4.24)	1.070 (27.18)	0.128 (3.25)	0.900 (22.86)	0.108 (2.74)	0.729 (18.52)	0.087 (2.21)
16	17.400 (441.96)	0.078 (1.98)	2.260 (57.40)	0.271 (6.88)	1.933 (49.10)	0.232 (5.89)	1.582 (40.18)	0.190 (4.83)	1.217 (30.91)	0.146 (3.71)	1.024 (26.01)	0.123 (3.12)	0.829 (21.06)	0.099 (2.51)
18	19.500 (495.30)	0.088 (2.24)	2.532 (64.31)	0.304 (7.72)	2.167 (55.04)	0.260 (6.60)	1.773 (45.03)	0.213 (5.41)	1.364 (34.65)	0.164 (4.17)	1.147 (29.13)	0.138 (3.51)	0.929 (23.60)	0.111 (2.82)
20	21.600 (548.64)	0.097 (2.46)	2.805 (71.25)	0.337 (8.56)	2.400 (60.96)	0.288 (7.32)	1.964 (49.89)	0.236 (5.99)	1.510 (38.35)	0.181 (4.60)	1.271 (32.28)	0.153 (3.89)	1.029 (26.14)	0.123 (3.12)
24	25.800 (655.32)	0.116 (2.95)	3.351 (85.12)	0.402 (10.21)	2.867 (72.82)	0.344 (8.74)	2.345 (59.56)	0.281 (7.14)	1.804 (45.82)	0.216 (5.49)	1.518 (38.56)	0.182 (4.62)	1.229 (31.22)	0.147 (3.73)
30	32.000 (812.80)	0.144 (3.66)	4.156 (105.56)	0.499 (12.67)	3.556 (90.32)	0.427 (10.85)	2.909 (73.89)	0.349 (8.86)	2.238 (56.85)	0.269 (6.83)	1.882 (47.80)	0.226 (5.74)	1.524 (38.71)	0.183 (4.65)
36	38.300 (972.82)	0.172 (4.37)	4.974 (126.34)	0.597 (15.16)	4.256 (108.10)	0.511 (12.98)	3.482 (88.44)	0.418 (10.62)	2.678 (68.02)	0.321 (8.15)	2.253 (57.23)	0.270 (6.86)	1.824 (46.33)	0.219 (5.56)
42	44.500 (1130.30)	0.200 (5.08)	5.779 (146.79)	0.693 (17.60)	4.944 (125.58)	0.593 (15.06)	4.045 (102.74)	0.485 (12.32)	3.112 (79.04)	0.373 (9.47)	2.618 (66.50)	0.314 (7.98)	2.119 (53.82)	0.254 (6.45)
48	50.800 (1290.32)	0.229 (5.82)	6.597 (167.56)	0.792 (20.12)	5.644 (143.36)	0.677 (17.20)	4.618 (117.30)	0.554 (14.07)	3.552 (90.22)	0.426 (10.82)	2.988 (75.90)	0.359 (9.12)	2.419 (61.44)	0.290 (7.37)

[A] For a distance to the cut end of the pipe that is the lesser of 11.8–in. (300 mm) or 1.5 times the outside diameter, a diameter reduction of up to 1.5% shall be acceptable.
[B] For DIPS sizes greater than 24, tolerance applies to the minimum wall thickness obtained when measuring pipe.

shall be no agreement to lower the minimum requirement of the specification by such means as omitting tests that are a part of the specification, substituting or modifying a test method, or by changing the specification limits. In retesting, the product requirements of this specification shall be met, and the test methods designated in the specification shall be followed. If, upon retest, failure occurs, the quantity of product represented by the test(s) does not meet the requirements of this specification.

9. Marking

9.1 Marking on the pipe shall include the following, spaced at intervals of not more than 5 ft (1.5 m):

9.1.1 Nominal pipe size (for example, 2 in. IPS),

9.1.2 Type of plastic pipe material in accordance with the materials designation code given in per 5.1 (for example, PE 3608),

TABLE 8 Elevated Temperature Sustained Pressure Test Requirements

Condition	PE2708, PE3608, PE4608			PE4710	
	Test Temperature °F (°C)[A]	Test Pressure Hoop Stress[B] psi (kPa)[A]	Minimum Average Time Before Failure Hours	Test Pressure Hoop Stress[B] psi (kPa)[A]	Minimum Average Time Before Failure Hours
1	176 (80)	670 (4620)	170	750 (5170)	200
2	176 (80)	650 (4480)	340	730 (5020)	400
3	176 (80)	630 (4345)	510	705 (4870)	600
4	176 (80)	610 (4210)	680	685 (4715)	800
5	176 (80)	590 (4070)	850	660 (4565)	1000
6	176 (80)	580 (4000)	1000	640 (4415)	1200

[A]Test temperature tolerance ± 3.6ºF (+/- 2ºC). Test pressure tolerance ± 5 psi (±35 kPa); test pressure hoop stress values are rounded to the nearest 5 psi or 5 kPa.

Note: Table 2 conditions are based on PE validation requirements per PPI TR-3 with Condition 6 being 85% of Condition 1 test pressure hoop stress and six times greater minimum average time before failure. Conditions 2 through 5 are linear stress and time interpolations between Conditions 1 and 6. The intent of multiple conditions is to maintain equivalent performance criteria, but provide for retest in the event of ductile failure. The test pressure hoop stress levels for Conditions 2-5 are linear interpolations for arbitrarily chosen time increments. An equivalent performance requirement, however, may be determined by arbitrarily choosing a test pressure hoop stress between Conditions 1 and 6 and linearly interpolating the minimum average time before failure. For example for PE3710 and PE4710 material, at 670 psi test pressure hoop stress, the minimum average time before failure would be 927 hours (200 + (750 – 670) · ((1200 – 200) / (750 – 640)) = 927).

[B]Calculate internal test pressure in accordance with:

$$P = \frac{2s}{\left(\frac{D_o}{t} - 1\right)}$$

where:

P = test pressure, psig (kPa)
S = test pressure hoop stress, psi. (kPa)
D_o = measured outside diameter, in. (mm)
t = measured minimum wall thickness, in (mm)

9.1.3 Thermoplastic pipe dimension ratio in accordance with 4.2 (for example, DR 11),

9.1.4 The pressure rating in pounds-force per square inch for water at 73°F (23°C) shown as the number followed by psi (kPa), for example, 100 psi or 690 kPa,

9.1.5 "ASTM D3035,"

9.1.6 Manufacturer's name (or trademark) and code, and

9.1.7 Pipe intended for transporting potable water shall also include the seal of an accredited laboratory.

NOTE 2—Earlier editions of Specification D3035 included PE materials designations PE 2406, PE 3406, and PE 3408. Changes to Specification D3350 and PPI TR-3 led to changes in thermoplastic materials designation codes, resulting in materials designation PE 2406 being superseded by materials designations PE 2606 and PE 2708, materials designation PE 3406 being superseded by PE 3606 and materials designation PE 3408 being superseded by materials designations PE 3608, PE 3708, PE 3710, PE 4608, PE 4708, and PE 4710. Recognizing that a period of time is necessary for the dissemination of information and to update specifications and literature, during the transitional period, product markings that include both older and newer materials designations, for example PE 2406/PE 2606, may occur.

NOTE 3—Manufacturers using the seal of approval of an accredited laboratory must obtain prior authorization from the laboratory concerned.

9.2 *Using Color*—When color is applied, such as with stripes, a color shell layer or a solid color; blue shall identify potable water; green shall identify sewer; and purple (violet, lavender) shall identify reclaimed water. Yellow identities gas and shall not be used.

9.3 Markings that identify gas, communications or electrical use are prohibited.

10. Quality Assurance

10.1 When the product is marked with this designation, D3035, the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.

11. Keywords

11.1 DR; OD controlled; PE pipe; plastic pipe; potable water pipe; polyethylene pipe; service pipe; SDR; water pipe; water service pipe

APPENDIX

(Nonmandatory Information)

X1. PIPE PRESSURE RATINGS

X1.1 The pipe is rated for use with water at 73°F (23°C) at the maximum internal pressures shown in Table X1.1. Lower pressure ratings than those calculated in accordance with 3.2.1 may be recommended by the pipe manufacturer where unusually high pressure surges, elevated temperatures, or unusual installation conditions exist. Pressure ratings at 73°F (23°C) are generally suitable for use at service temperatures not exceeding 80°F (27°C). Pressure ratings are reduced at temperatures above 80°F (27°C), and materials having an elevated temperature HDB should be used when service at temperatures above 80°F (27°C) is anticipated. Consult the pipe manufacturer for information about elevated temperature service and pressure ratings. Industry experience indicates that satisfactory long-term service can be provided by PE plastic pipe meeting this specification that is properly installed and operated within the identified pressure and temperature ratings. The sustained pressure requirements (see 6.4) are related to these ratings through the slopes of the strength-time plots of these materials in pipe form.

X1.2 The hydrostatic design stress recommended by the Plastics Pipe Institute are based on tests made on pipe ranging in size from ½ to 3 in. (12.7 to 50.8 mm).

TABLE X1.1 Thermoplastic Pipe Dimension Ratios (DR) and Water Pressure Ratings (PR) at 73°F (23°C) for DR-PR PE Plastic Pipe

Dimension Ratio	PE Pipe Materials[A]					
	PE4710		PE 2708, PE 3608, PE 4608		PE 1404	
	Pressure Rating, psi (MPa)		Pressure Rating, psi (MPa)		Pressure Rating, psi (MPa)	
7	333	(2.3)	267	(1.84)	133	(0.92)
7.7	300	(2.1)	...	...	...	...
9	250	(1.7)	200	(1.38)	100	(0.69)
11	200	(1.4)	160	(1.10)	80	(0.55)
13.5	160	(1.1)	128	(0.88)	64	(0.44)
14.3	150	(1.0)	...	...	...	...
15.5	138	(1.0)	110	(0.76)	55	(0.38)
17	125	(0.9)	100	(0.69)	50	(0.34)
21	100	(0.7)	80	(0.55)	40	(0.28)
26	80	(0.6)	64	(0.44)	32	(0.22)
32.5	63	(0.4)	51	(0.35)	25	(0.17)

[A] Hydrostatic Design Stress values obtained from PPI TR4. Other design factors may be appropriate under certain conditions. Values rounded to the nearest 5 psi (0.03 MPa)

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (D3035–14a) that may impact the use of this standard. (Approved March 1, 2015)

(1) Added DR 7.7 and DR 14.3 to Table 4.

Committee F17 has identified the location of selected changes to this standard since the last issue (D3035) that may impact the use of this standard. (Approved August 1, 2014.)

(1) Revised Table 2, Table 4, and Table X1.1.
(2) Replaced Table 3.
(3) Revised 1.2.
(4) Added Table 7; revised 6.2.1, 6.2.2, and Table X1.1to reflect Table 7.

Committee F17 has identified the location of selected changes to this standard since the last issue (D3035–12$^{\varepsilon 2}$) that may impact the use of this standard. (Approved March 1, 2014)

(1) Revised footnote B in Table 1.