



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

This standard is issued under the fixed designation F714; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

^ε¹ NOTE—Sections 5.3.2 and 5.4 were editorially revised in July 2012.

1. Scope*

1.1 This specification covers polyethylene (PE) pipe made in dimensions based on outside diameters of 90 mm (3.500 in.) and larger.

1.2 Three standard outside diameter sizing systems are detailed: one known as the ISO metric system, one known as the IPS system, and the other known as the DIPS system. See 5.2.5 for guidelines for special sizes.

1.3 The piping is intended for new construction and insertion renewal of old piping systems used for the transport of water, municipal sewage, domestic sewage, industrial process liquids, effluents, slurries, etc., in both pressure and nonpressure systems.

NOTE 1—The user should consult the manufacturer to ensure that any damage to the polyethylene pipe caused by the material being transported will not affect the service life beyond limits acceptable to the user.

1.4 All pipes produced under this specification are pressure-rated. See Appendix X5 for information on pressure rating.

NOTE 2—References and material descriptions for PE2406, PE3406, PE3408 and materials having a HDB of 1450 psi have been removed from Specification F714 due to changes in Specification D3350 and PPI TR-3. For removed designations, refer to previous editions of Specification F714, Specification D3350, PPI TR-3 and PPI TR-4. The removal of these materials does not affect pipelines that are in service. See Notes 9 and 9.

1.5 This specification includes criteria for choice of raw material, together with performance requirements and test methods for determining conformance with the requirements.

1.6 Quality-control measures are to be taken by manufacturers. See Appendix X4 for general information on quality control.

1.7 In referee decisions, the SI units shall be used for metric-sized pipe and inch-pound units for pipe sized in the IPS system (ANSI B36.10) and DIPS system. In all cases, the values given in parentheses are provided for information only.

1.8 The following safety hazards caveat pertains only to the test methods portion, Section 6, 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

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 by Split Disk Method

D2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

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

F585 Practice for Insertion of Flexible Polyethylene Pipe Into Existing Sewers

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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.

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

2.2 ANSI Standard:

B36.10 Standard Dimensions of Steel Pipe (IPS)³

2.3 ISO Standards:

161 Thermoplastic Pipe for the Transport of Fluids - Nominal Outside Diameters and Nominal Pressures⁴

3607 Polyethylene Pipe: Tolerances on Outside Diameters and Wall Thicknesses⁴

4427 Polyethylene Pipes and Fittings for Water Supply Specification⁴

2.4 Federal Standard:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)⁵

2.5 Military Standard:

MIL-STD-129 Marking for Shipment and Storage⁵

2.6 Canadian Standard:

CGSB 41 GP-25M Pipe, Polyethylene for the Transport of Liquids⁶

2.7 NSF/ANSI Standards:

Standard No. 14 for Plastic Piping Components and Related Materials⁷

Standard No. 61 for Drinking Water Systems Components—Health Effects⁷

2.8 Other Documents:

PPI TR-3 Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe⁸

PPI TR-4 HDB/SDB/PDB/MRS Listed Materials, PPI Listing of Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe⁸

APWA Uniform Color Code⁹

3. Terminology

3.1 Unless otherwise specified, definitions are in accordance with Terminology **F412** and abbreviations are in accordance with Terminology **D1600**.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *dimension ratio, hydrostatic design stress, and pressure rating relationship*:—

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

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁴ Available from International Organization for Standardization (ISO), 1 rue de Varembe, Case postale 56, CH-1211, Geneva 20, Switzerland, <http://www.iso.ch>.

⁵ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

⁶ Available from Canadian Standards Association (CSA), 5060 Spectrum Way, Mississauga, ON L4W 5N6, Canada, <http://www.csa.ca>.

⁷ Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, <http://www.nsf.org>.

⁸ Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, <http://www.plasticpipe.org>.

⁹ American Public Works Association (APWA) 2345 Grand Boulevard, Suite 700 Kansas City, MO 64108-2625, <http://www.apwa.net>

S = hydrostatic design stress, HDS, for water at 73°F (23°C), psi (or kPa or MPa),

P = pressure rating, PR, psi (or kPa or MPa),

D_o = outside diameter, in. (or mm), per Tables 3, 4, or 5

t = minimum wall thickness, in. (or mm), per Tables 6, 7, or 8

D_o/t = dimension ratio (DR).

3.2.2 *hydrostatic design basis and hydrostatic design stress*—the hydrostatic design stress, S , is determined by multiplying the hydrostatic design basis (HDB) by a design factor, DF that has a value less than 1.0.

NOTE 3—Hydrostatic design stress (HDS) ratings for PE compounds are in accordance with this specification and are specified in Section 4.

4. Materials

4.1 *Polyethylene Compound*—Polyethylene compounds suitable for use in the manufacture of pipe under this specification shall meet thermoplastic materials designation codes PE2708 or PE3608 or PE4608 or PE4710, and shall meet **Table 1** requirements for PE2708 or PE3608 or PE4608 or PE4710, and shall meet thermal stability, brittleness temperature and elongation at break requirements in accordance with Specification **D3350**.

4.1.1 Polyethylene compounds suitable for use in the manufacture of DIPS pipe per **Table 2** and **Table 3** are identified by thermoplastic pipe material designation code, and shall be PE4710 or PE3608 in accordance with **4.1**, **4.1.2** and **4.2**.

4.1.2 *Color and Ultraviolet (UV) Stabilization*—Per **Table 1**, polyethylene compounds shall meet Specification **D3350** code C 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.

4.1.3 *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.

4.2 *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.

4.3 *Rework Material*—Clean polyethylene compound from the manufacturer's own pipe production that met **4.1** through **4.1.2** as new compound is suitable for reextrusion into pipe, when blended with new compound of the same thermoplastic pipe material designation code. Pipe containing rework material shall meet the requirements of this specification.

5. Requirements

5.1 *Workmanship*—The pipe shall be homogeneous throughout and essentially uniform in color, opacity, density, and other properties. The inside and outside surfaces shall be

TABLE 1 Polyethylene Compound Requirements

Requirement	Material Designation			
	PE2708	PE3608	PE4608	PE4710
	Required Value			
HDB at 140°F (60°C), psi (MPa), per D2837 and PPI TR-3 ^A	A	A	A	A
HDS for water at 73°F (23°C) psi (MPa), per D2837 and PPI TR-3 ^B	800 (5.5)	800 (5.5)	800 (5.5)	1000 (6.9)
Melt flow rate per D1238	≤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	Required Value			
Cell Classification Property				
Density (natural base resin)	2	3	4	4
SCG Resistance	7	6	6	7
Color and UV Stabilizer Code ^C	C or E	C or E	C or E	C or E

^AHDB at 140°F (60°C) required. Contact manufacturer or see PPI TR-4 for listed value.

^BContact manufacturer or see PPI TR-4 for listed value.

^CSee 4.1.1.

TABLE 2 Outside Diameters and Tolerances-DIPS Sizing System

Nominal Size	Outside Diameter, in. (mm)	Minimum Outside Diameter, in. (mm)	Maximum Outside Diameter, in. (mm)
3	3.960 (100.58)	3.942 (100.13)	3.976 (100.99)
4	4.800 (121.92)	4.778 (121.37)	4.822 (122.48)
6	6.900 (175.26)	6.869 (174.47)	6.931 (176.05)
8	9.050 (229.87)	9.009 (228.84)	9.091 (230.91)
10	11.100 (281.94)	11.050 (280.67)	11.150 (283.21)
12	13.200 (335.28)	13.141 (333.77)	13.259 (336.78)
14	15.300 (388.62)	15.231 (386.87)	15.369 (390.37)
16	17.400 (441.96)	17.322 (439.97)	17.478 (443.94)
18	19.500 (495.30)	19.412 (493.07)	19.588 (497.54)
20	21.600 (548.64)	21.503 (546.17)	21.697 (551.10)
24	25.800 (655.32)	25.684 (652.37)	25.916 (658.27)
30	32.000 (815.80)	31.856 (809.14)	32.144 (816.46)
36	38.300 (972.82)	38.128 (968.44)	38.472 (977.19)
42	44.500 (1130.30)	44.300 (1125.21)	44.700 (1135.38)
48	50.800 (1290.32)	50.571 (1284.51)	51.029 (1296.14)

semimatte or glossy in appearance (depending on the PE compound) and free of chalking, sticky, or tacky material. The surfaces shall be free of excessive bloom, that is, slight bloom is acceptable. The pipe walls shall be free of cracks, holes, blisters, voids, foreign inclusion, or other defects that are visible to the naked eye and that may affect the wall integrity. Holes deliberately placed in perforated pipe are acceptable. Bloom or chalking may develop in pipe exposed to direct rays of the sun (ultraviolet radiant energy) for extended periods and, consequently, these requirements do not apply to pipe after extended exposure to direct rays of the sun.

5.2 Dimensions and Tolerances:

5.2.1 Outside Diameters—These shall be in accordance with **Table 2** (inch-pound units), **Table 4** (SI units), **Table 5** (inch-pound units) or when measured in accordance with Test Method **D2122** at any point not closer than 300 mm (11.8 in.)

to the cut end of a length of pipe. Conditioning to standard temperature without regard to relative humidity is required.

5.2.2 Wall Thicknesses—The minimum thicknesses shall be in accordance with **Table 3**, **Table 6**, or **Table 7** when measured in accordance with Test Method **D2122**. Conditioning to standard temperature without regard to relative humidity is required.

5.2.3 Eccentricity—The wall thickness variability as measured and calculated in accordance with Test Method **D2122** in any diametrical cross section of the pipe shall not exceed 12 %.

5.2.4 Toe-In—When measured in accordance with **5.2.1**, the outside diameter at the cut end of the pipe shall not be more than 1.5 % smaller than the undistorted outside diameter. Measurement of the undistorted outside diameter shall be made no closer than 1.5 pipe diameters or 11.8 in. (300 mm), whichever distance is less, from the cut end of the pipe. Undistorted outside diameter shall meet specifications in **Table 2**, **Table 4**, or **Table 5**.

5.2.5 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 for engineered applications when mutually agreed upon by the customer and the manufacturer, if the pipe is manufactured from plastic compounds meeting the material requirements of this specification, and the strength and design requirements are calculated on the same basis as those used in this specification. For diameters not shown in **Table 2**, **Table 4**, or **Table 5**, the tolerance shall be the same percentage as that used in the corresponding table for the next smaller listed size. Minimum wall thicknesses for DRs not shown in **Table 3**, **Table 6**, or **Table 7** or shall be determined by dividing the average outside diameter by the DR and rounding to three decimal places for inch sized pipes or two decimal places for metric sized pipes, and the tolerance shall comply with **5.2.3**.

TABLE 3 Minimum Wall Thickness DIPS Sizing System, in.

		PE4710 ^A						PE3608 ^A					
		PR350 ^B	PR300 ^B	PR250 ^B	PR200 ^B	PR150 ^B	PR100 ^B	PR350 ^B	PR300 ^B	PR250 ^B	PR200 ^B	PR150 ^B	PR100 ^B
Nominal Size	Outside Diameter in. (mm) ^C	350 psi (2415 kPa) ^D	300 psi (2070 kPa) ^D	250 psi (1725 kPa) ^D	200 psi (1380 kPa) ^D	150 psi (1035 kPa) ^D	100 psi (690 kPa) ^D	350 psi (2415 kPa) ^D	300 psi (2070 kPa) ^D	250 psi (1725 kPa) ^D	200 psi (1380 kPa) ^D	150 psi (1035 kPa) ^D	100 psi (690 kPa) ^D
		DR 6.7	DR 7.7	DR 9	DR 11	DR 14.3	DR 21	DR 5.6	DR 6.3	DR 7.4	DR 9	DR 11.7	DR 17
3	3.960 (100.58)	0.591 (15.01)	0.514 (13.06)	0.440 (11.18)	0.360 (9.14)	0.277 (7.04)	0.189 (4.80)	0.707 (17.96)	0.629 (15.97)	0.535 (13.59)	0.440 (11.18)	0.338 (8.59)	0.233 (5.92)
4	4.800 (121.92)	0.761 (19.20)	0.623 (15.83)	0.533 (13.54)	0.436 (11.07)	0.336 (8.53)	0.229 (5.82)	0.857 (21.77)	0.762 (19.35)	0.649 (16.48)	0.533 (13.54)	0.410 (10.41)	0.282 (7.16)
6	6.900 (175.26)	1.030 (26.16)	0.896 (22.76)	0.767 (19.48)	0.627 (15.93)	0.483 (12.27)	0.329 (8.36)	1.232 (31.30)	1.095 (27.82)	0.932 (23.67)	0.767 (19.48)	0.590 (14.99)	0.406 (10.31)
8	9.050 (229.87)	1.351 (34.31)	1.175 (29.85)	1.006 (25.55)	0.823 (20.90)	0.633 (16.08)	0.431 (10.95)	1.616 (41.05)	1.437 (36.49)	1.223 (31.06)	1.006 (25.55)	0.774 (19.66)	0.532 (13.51)
10	11.100 (281.94)	1.657 (42.08)	1.441 (36.62)	1.233 (31.32)	1.009 (25.63)	0.776 (19.71)	0.529 (13.44)	1.982 (50.35)	1.762 (44.75)	1.500 (38.10)	1.233 (31.32)	0.949 (24.10)	0.653 (16.59)
12	13.200 (335.28)	1.970 (50.04)	1.714 (43.54)	1.467 (37.26)	1.200 (30.48)	0.923 (23.44)	0.629 (15.98)	2.357 (59.87)	2.095 (53.22)	1.784 (45.31)	1.467 (37.26)	1.128 (28.65)	0.776 (19.71)
14	15.300 (388.62)	2.284 (58.00)	1.987 (50.47)	1.700 (43.18)	1.391 (35.33)	1.070 (27.18)	0.729 (18.52)	2.732 (69.40)	2.429 (61.69)	2.068 (52.53)	1.700 (43.18)	1.308 (33.22)	0.900 (22.86)
16	17.400 (441.96)	2.597 (65.96)	2.260 (57.40)	1.933 (49.10)	1.582 (39.67)	1.217 (30.91)	0.829 (21.06)	3.107 (78.92)	2.762 (70.15)	2.351 (59.72)	1.933 (49.10)	1.487 (37.77)	1.024 (26.01)
18	19.500 (495.30)	2.910 (73.93)	2.532 (64.32)	2.167 (55.04)	1.773 (45.03)	1.364 (34.65)	0.929 (23.60)	3.482 (88.45)	3.095 (78.62)	2.635 (66.93)	2.167 (55.04)	1.667 (42.34)	1.147 (29.13)
20	21.600 (548.64)	3.224 (81.89)	2.805 (71.25)	2.400 (60.96)	1.964 (49.89)	1.510 (38.35)	1.029 (26.14)	...	3.429 (87.09)	2.919 (74.14)	2.400 (60.96)	1.846 (46.89)	1.271 (32.28)
24	25.800 (655.32)	...	3.351 (85.11)	2.867 (72.82)	2.345 (59.56)	1.804 (45.82)	1.229 (31.22)	...	...	3.486 (88.54)	2.867 (72.82)	2.205 (56.01)	1.518 (38.56)
30	32.000 (815.80)	...	...	3.556 (90.32)	2.909 (73.89)	2.238 (56.85)	1.524 (38.71)	...	...	...	3.556 (90.32)	2.735 (69.47)	1.882 (47.80)
36	38.300 (972.82)	...	...	...	3.482 (88.44)	2.678 (68.02)	1.824 (46.33)	...	...	...	...	3.274 (83.16)	2.253 (57.23)
42	44.500 (1130.30)	...	...	...	...	3.112 (79.04)	2.119 (53.82)	...	...	...	...	...	2.618 (66.50)
48	50.800 (1290.32)	...	...	...	...	3.552 (90.22)	2.419 (61.44)	...	...	...	...	...	2.988 (75.90)

^A Thermoplastic material designation code per 4.1.1.

^B See 9.1.7.

^C Per Table 2

^D Per 3.2.1. Values rounded to the nearest 5 kPa.

TABLE 4 Outside Diameters and Tolerances

ISO Sizing System (ISO 161/1)			
Nominal Pipe Size	Equivalent	Outside Diameter, D _o , mm	
		min	max ^A
90	3.543	90	90.8
110	4.331	110	111.0
160	6.299	160	161.4
200	7.874	200	201.8
250	9.843	250	252.3
280	11.024	280	282.5
315	12.402	315	317.8
355	13.976	355	358.2
400	15.748	400	403.6
450	17.717	450	454.1
500	19.685	500	504.5
560	22.047	560	565.0
630	24.803	630	635.7
710	27.953	710	716.4
800	31.496	800	807.2
900	35.433	900	908.1
1000	39.370	1000	1009.0
1200	47.244	1200	1210.8
1400	55.118	1400	1412.6
1600	62.992	1600	1614.4

^A As specified in ISO 3607.

TABLE 5 Outside Diameters and Tolerances IPS Sizing System (ANSI B36.10)

Nominal Pipe Size, in.	Equivalent, mm	Actual Outside Diameters, in.	
		Average	Tolerance ± in.
3	88.9	3.500	0.016
4	114.3	4.500	0.020
5 ^A	136.5	5.375	0.025
5	141.3	5.563	0.025
6	168.3	6.625	0.030
7 ^A	181.0	7.125	0.034
8	219.1	8.625	0.039
10	273.1	10.750	0.048
12	323.8	12.750	0.057
13 ^A	339.7	13.375	0.060
14	355.6	14.000	0.063
16	406.4	16.000	0.072
18	457.2	18.000	0.081
20	508.0	20.000	0.090
21.5 ^A	546.1	21.500	0.097
22	558.8	22.000	0.099
24	609.6	24.000	0.108
26	660.4	26.000	0.117
28	711.2	28.000	0.126
30	762.0	30.000	0.135
32	812.8	32.000	0.144
34	863.6	34.000	0.153
36	914.4	36.000	0.162
42	1066.8	42.000	0.189
48	1219.2	48.000	0.216
54	1371.6	54.000	0.243

^A Irregular size.

5.3 Pressure Test Performance—All pipe shall meet the requirements of 5.3.2 and either 5.3.1 or 5.4.

NOTE 4—The requirements of 5.3.1 and 5.3.2 are for laboratory proof-testing only and should not be interpreted as applicable to in situ testing for acceptance of installed systems. See appropriate installation and leak testing standards or manufacturer's recommendations for field testing procedure.

5.3.1 Short-Term Pressurization—Quick burst or non-failure testing shall be conducted per 5.3.1.1 or 5.3.1.2. Test pressure shall be determined per 3.2.1 except that *S* shall be the prescribed hoop stress value, and *P* shall be test pressure.

5.3.1.1 Quick Burst—For pipe nominal 12-in. (315 mm) and smaller diameter, rupture shall be ductile when tested in accordance with 6.1. The minimum hoop stress shall be 2500 psi for Table 1 density cell 2 materials and 2900 psi for Table 1 density cell 3 and 4 materials.

5.3.1.2 Non-Failure—When raised to test pressure and held at test pressure for five (5) seconds, pipe shall not rupture, leak, nor exhibit localized deformation when tested in accordance with 6.1 at a test pressure determined using 2500 psi hoop stress for Table 1 density cell 2 materials, and 3200 psi hoop stress for Table 1 density cell 3 and 4 materials.

5.3.2 Elevated Temperature Sustained Pressure—Elevated-temperature sustained-pressure test for each Table 1 polyethylene pipe material (material designation) used in production at the facility shall be conducted twice annually per 6.2.

NOTE 5—Elevated temperature sustained pressure tests are intended to verify extrusion processing and are conducted in accordance with the manufacture's quality program.

5.3.2.1 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", 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 Table 8 "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 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.

5.3.2.2 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 6.2. For the retest, any specimen failure before the "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.

5.4 Apparent Tensile Strength at Yield—For pipe nominal 3-in. (90-mm) diameter and larger, Short-Term Pressurization requirement, 5.3.1, may be replaced by the apparent tensile strength at yield requirement, 5.4. The minimum apparent tensile strength at yield when determined in accordance with 6.3 shall be 2500 psi for Table 1 density cell 2 materials and 2900 psi for Table 1 density cell 3 and 4 materials.

5.5 Quality Control—To determine compliance with Section 5, the number of samples specified in the test method shall be tested. For quality control purposes, not for determining compliance with Section 5, Requirements, it is acceptable to test individual samples.

**TABLE 6 Minimum Wall Thickness
ISO 161 Sizing System, mm**

DR Nominal Pipe Size	41	32.5	26	21	17	11
90	...	...	3.5	4.3	5.3	8.2
110	...	3.4	4.2	5.2	6.5	10.0
160	...	4.9	6.2	7.6	9.4	14.5
200	...	6.2	7.7	9.5	11.8	18.2
250	...	7.7	9.6	11.9	14.7	22.7
280	...	8.6	10.8	13.3	16.5	25.5
315	...	9.7	12.1	15.0	18.5	28.6
355	...	10.9	13.7	16.9	20.9	32.3
400	...	12.3	15.4	19.0	23.5	36.4
450	...	13.8	17.3	21.4	26.5	...
500	...	15.4	19.2	23.8	29.4	...
560	...	17.2	21.5	26.7	32.9	...
630	...	19.4	24.2	30.0	37.1	...
710	...	21.8	27.3	33.8	41.8	...
800	...	24.6	30.8	38.1	47.1	...
900	...	27.7	34.6	42.9	...	...
1000	24.4	30.8	38.5	47.6	...	...
1200	29.3	36.9	46.2	...	...	...
1400	34.1	43.1	...	...	...	...
1600	39.0	49.2	...	...	...	...

**TABLE 7 Minimum Wall Thickness
IPS Sizing System, in. (ANSI B36.10)**

Nominal IPS Pipe Size	Actual Pipe Size	Dimension Ratio											
		41	32.5	26	21	17	15.5	13.5	11	9.3	9	8.3	7.3
3	3.500	0.085	0.108	0.135	0.167	0.206	0.226	0.259	0.318	0.376	0.389	0.422	0.479
4	4.500	0.110	0.138	0.173	0.214	0.265	0.290	0.333	0.409	0.484	0.500	0.542	0.616
5 ^A	5.375	0.131	0.165	0.207	0.256	0.316	0.347	0.398	0.489	0.578	0.597	0.648	0.736
5	5.563	0.136	0.171	0.214	0.265	0.327	0.359	0.412	0.506	0.598	0.618	0.670	0.762
6	6.625	0.162	0.204	0.255	0.315	0.390	0.427	0.491	0.602	0.712	0.736	0.798	0.908
7 ^A	7.125	0.174	0.219	0.274	0.340	0.420	0.460	0.528	0.648	0.766	0.792	0.858	0.976
8	8.625	0.210	0.265	0.332	0.411	0.507	0.556	0.639	0.784	0.927	0.958	1.039	1.182
10	10.750	0.262	0.331	0.413	0.512	0.632	0.694	0.796	0.977	1.156	1.194	1.295	1.473
12	12.750	0.310	0.392	0.490	0.607	0.750	0.823	0.944	1.159	1.371	1.417	1.536	1.747
13 ^A	13.375	0.326	0.412	0.514	0.637	0.787	0.863	0.991	1.216	1.438	1.486	1.611	1.832
14	14.000	0.341	0.431	0.538	0.667	0.824	0.903	1.037	1.273	1.505	1.556	1.687	1.918
16	16.000	0.390	0.492	0.615	0.762	0.941	1.032	1.185	1.455	1.720	1.778	1.928	2.192
18	18.000	0.439	0.554	0.692	0.857	1.059	1.161	1.333	1.636	1.935	2.000	2.169	2.466
20	20.000	0.488	0.615	0.769	0.952	1.176	1.290	1.481	1.818	2.151	2.222	2.409	...
21.5 ^A	21.500	0.524	0.662	0.827	1.024	1.265	1.387	1.593	...	...	...	...	...
22	22.000	0.537	0.677	0.846	1.048	1.294	1.419	1.630	2.000	2.366	2.444	...	...
24	24.000	0.585	0.738	0.923	1.143	1.412	1.548	1.778	2.182	2.581	2.667	...	...
26	26.000	0.634	0.800	1.000	1.238	1.529	1.677	1.926	2.364	2.796	...	...	...
28	28.000	0.683	0.862	1.077	1.333	1.647	1.806	2.074	2.545	3.011	...	...	...
30	30.000	0.732	0.923	1.154	1.429	1.765	1.935	2.222	2.727	3.226	...	...	...
32	32.000	0.780	0.985	1.231	1.524	1.882	2.065	2.370	2.909	...	...	...	...
34	34.000	0.829	1.046	1.308	1.619	2.000	2.194	2.519	3.091	...	...	...	...
36	36.000	0.878	1.108	1.385	1.714	2.118	2.323	2.667	3.273	...	...	...	...
42	42.000	1.024	1.292	1.615	2.000	2.471	2.710	...	...	...	...	...	...
48	48.000	1.171	1.477	1.846	2.286	2.824	3.097	...	...	...	...	...	...
54	54.000	1.317	1.662	2.077	2.571	3.176	...	...	...	...	...	...	...

^A Irregular size.

NOTE 6—Manufacturers conduct appropriate quality control tests at a frequency appropriate to their manufacturing operations. See [Appendix X4](#).

6. Test Methods

6.1 Short-Term Pressurization Tests—When tested to rupture, this test is applicable to nominal 12-in. (315-mm) and smaller pipes and is conducted in accordance with Test Method [D1599](#). When tested for non-failure, this test is applicable to all pipe sizes and is conducted in accordance with Test Method [D1598](#) except that no failure will have occurred when tested at

the test pressure and duration per [5.3.1.2](#). The test shall be conducted at $73.4 \pm 3.6^{\circ}\text{F}$ ($23 \pm 2^{\circ}\text{C}$) without regard to relative humidity.

NOTE 7—**Warning:** Pressurization of specimens being tested under [6.1](#) should not commence until it is certain that all entrapped air has been bled from the water-filled specimens.

6.2 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

TABLE 8 Elevated Temperature Sustained Pressure Test Requirements

Condition	Test Temperature °F (°C) ^A	PE2708, PE3608, PE4608		PE4710	
		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

^ATest temperature tolerance $\pm 3.6^{\circ}\text{F}$ ($\pm 2^{\circ}\text{C}$). Test pressure tolerance ± 5 psi (± 35 kPa); test pressure hoop stress values are rounded to the nearest 5 psi or 5 kPa. Note: **Table 1** 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 $(200 + (750 - 670) \cdot ((1200 - 200) / (750 - 640)) = 927)$.

^BCalculate internal test pressure in accordance with:

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

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)

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.

6.3 Apparent Tensile Properties—The procedure and test equipment shall be as specified in Test Method **D2290**. Cut specimens from pipe. Test a minimum of five specimens at $73.4 \pm 3.6^{\circ}\text{F}$ ($23 \pm 2^{\circ}\text{C}$) without regard to relative humidity. This test is applicable to all pipe of nominal 3-in. (90-mm) outside diameter and larger.

7. Retest and Rejection

7.1 Except as required in **5.3.2.1** or **5.3.2.2**, 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 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.

8. Certification

8.1 When specified in the purchase order or contract, a manufacturer's certification shall be furnished to the purchaser that pipe was manufactured, sampled, tested, and inspected in accordance with this specification, and met the requirements of this specification. When specified in the purchase order or contract, a report of the test results shall be furnished. Each certification so furnished shall be signed by an authorized agent of the manufacturer.

9. Marking

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

9.1.1 Markings placed at each end of each shipped length are acceptable by agreement between the manufacturer and the purchaser.

NOTE 8—End of pipe markings are intended for use only per a manufacturer-purchaser agreement where pipe is to be used as a subcomponent by the purchaser for the manufacture of another product such as fabricated fittings, transition fittings, coupling devices or other piping appurtenances where continuous markings along the pipe length may be undesirable. Where pipe is used as the fluid transporting conduit in a piping system, continuous marking per **9.1** is used.

9.1.2 The letters ASTM followed by the designation number of this specification.

9.1.3 The thermoplastic pipe materials designation code, such as PE3608, in accordance with **4.1** and **4.1.1**.

NOTE 9—Earlier editions of Specification F714 included PE material designations PE2406, PE3406, PE3407 and PE3408. Changes to Specification **D3350** and PPI TR-3 led to changes in thermoplastic material designation codes, resulting in material designation PE2406 being superseded by material designations PE2606 and PE2708, material designation PE3406 being superseded by PE3606, material designation PE3407 being discontinued, and material designation PE3408 being superseded by material designations PE3608, PE3708, PE3710, PE4708 and PE4710. 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 PE2406/PE2606, may occur.

9.1.4 Nominal pipe outside diameter in mm or inches in accordance with **Table 4**, **Table 5**, or **Table 2**, and the designated sizing system: “XX mm ISO,” or “XX in IPS,” or “XX in DIPS.” For metric outside diameter pipe, the omission of “ISO” is acceptable, and for inch sized outside diameter pipe, omitting “in” or using a double-quotation mark (“) are acceptable.

9.1.5 For ISO (metric) and IPS sizing system pipe, the dimension ratio, DR, as “DR YY” where “YY” is the numerical value of the dimension ratio.

9.1.6 For ISO (metric) and IPS sizing system pipe, a marking for pressure rating is optional. In kilopascals, the marking for pressure rating per 3.2.1 is shown as “ZZZ kPa” where “ZZZ” is the numerical value of the pressure rating for water in kPa. In pounds-force per square inch, the marking for pressure rating per 3.2.1 is shown as “WWW psi” or “PRWWW” where “WWW” is the numerical value of the pressure rating for water in psi. (**Appendix X5**).

9.1.7 DIPS sizing system pipe shall be marked with the pressure rating for water expressed as “PRZZZ” where “PRZZZ” shall be in accordance with Table 8 for the applicable thermoplastic material designation code.

9.1.8 Name or trademark of the manufacturer.

9.1.9 Production code from which location and date of manufacturer can be identified.

9.1.10 Pipe intended for the transport of potable water shall also include the seal or mark of the accredited laboratory. (See 4.3.)

9.2 *Using Color*—When color is applied, such as with stripes, a color shell layer or solid color, blue shall identify potable water; green shall identify sewer; and purple (violet, lavender) shall identify reclaimed water. Yellow identifies 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, ASTM F714, 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 industrial pipe; non-pressure pipe; plastic pipe; polyethylene pipe; pressure pipe; sewer pipe; water pipe

SUPPLEMENTARY REQUIREMENTS

GOVERNMENT/MILITARY PROCUREMENT

These requirements apply *only* to federal/military procurement, not domestic sales or transfers.

S1. *Responsibility for Inspection*— Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless the purchaser disapproves. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

NOTE S1.1—In federal contracts, the contractor is responsible for inspection.

S2. *Packaging and Marking for U.S. Government Procurement*

S2.1 *Packaging*—Unless otherwise specified in the contract, the materials shall be packaged in accordance with the supplier’s standard practice in a manner ensuring arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rates. Containers and packing shall comply with Uniform Freight Classification rules on National Motor Freight Classification rules.

S2.2 *Marking*—Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

NOTE S2.1—The inclusion of U.S. Government procurement requirements should not be construed as an indication that the U.S. Government uses or endorses the products described in this specification.

APPENDIXES

(Nonmandatory Information)

X1. GENERAL INFORMATION

X1.1 It has been demonstrated that pipe stiffness is not a controlling factor in design of buried polyethylene piping systems installed in accordance with Practice D2321 or equivalent recommended practices (1-15)¹⁰.

X1.1.1 For those wishing to use deflection control in unpressurized polyethylene piping systems for construction specification purposes, the following information is provided.

¹⁰ The boldface numbers in parentheses refer to the list of references at the end of this standard.

X2. DEFLECTION CONTROL IN UNPRESSURIZED POLYETHYLENE PIPING SYSTEMS

X2.1 Control of deflection is achieved primarily through control of the earthwork surrounding buried systems. Practice D2321 should be followed to achieve this control. All dimensions of pipe specified in this specification may be successfully installed if this practice is followed.

X2.2 When polyethylene pipe is to be installed by insertion into older existing pipes or is to be laid where no support from the surrounding environment is possible, Practice F585 should be followed in making a selection of appropriate dimension ratio pipe from this specification.

X2.3 The appropriate degree of deflection in buried piping may be calculated using the modified Spangler formula.

$$X = \frac{D_e K W_c}{0.149 PS + 0.061 E'} \quad \text{in. (or mm)}$$

- K = bedding constant, dependent on the support the pipe receives from the bottom of the trench (dimensionless),
 D_e = deflection lag factor (dimensionless),
 W_c = vertical load per unit of pipe length, lbf/in. (or N/m) of pipe,
 PS = pipe stiffness = $4.472E/(SDR-1)^3$ where E is the flexural modulus of its pipe material (see Section 4 of this specification), psi (or kPa), and
 E' = modulus of soil reaction, depending on soil strength and degree of compaction, psi (or kPa).

NOTE X2.1—Pipe stiffness (PS) may also be determined by measurement for datum at a constant 5 % deflection by Test Method D2412. See appendix to Test Method D2412 for correction of this test value to other deflection levels.

X2.4 For purposes of this calculation, the pipe stiffness values given in Table X2.1 may be used. For specific data on particular products, consult the manufacturer's literature.

TABLE X2.1 Pipe Stiffness Ranges for Specified Materials and DR's, psi

DR Modulus, Cell Classification	41	32.5	26	21	17	11
3	2–6	6–11	11–23	22–45	71–87	179–358
4	6–8	11–16	23–31	45–61	87–120	358–492
5	8–11	16–23	31–46	61–89	120–175	492–716

X3. ALLOWABLE DEFLECTION LIMITS

X3.1 Research reports, including case histories supporting the following information, are on file at ASTM Headquarters.

X3.2 When said support is achieved, polyethylene pipes made to this specification may deflect or otherwise distort without kinking or buckling, and remain structurally stable up to 20 % or more of the vertical diameter. However, the lower the DR, the lower is the amount of deflection which should be permitted to ensure that long-term structural integrity is maintained. The pipe manufacturer should be consulted for the safe value for the particular pipe material involved. In the absence of specific data on a particular pipe material, **Table X3.1** provides safe values for conventional polyethylene pipe materials. These values provide a safety factor of at least two against loss of structural integrity.

X3.3 If there is *no* external support around the pipe, structural integrity of the pipe is likely to be lost due to buckling if deflection exceeds 10 %. For selection of proper DR, see Practice **F585**.

X3.4 When polyethylene piping is subject to live external loading at buried depths of less than 4 ft (1200 mm), special precautions to ensure strong supporting soil conditions should be taken.

X3.5 Polyethylene pipes having high DR's will require more careful handling in storage, transport, and installation to avoid inducing pre-installation deflection. Kinking of pipe should be considered destructive damage and sections which have been kinked should not be installed, even though no leakage is observed.

TABLE X3.1 Allowable Deflection of Buried Polyethylene Pipe, Short Term, %

DR	Allowable Deflection
41	10.9
32.5	8.6
26	6.5
21	5.0
17	4.0
11	3.3

X4. QUALITY CONTROL

X4.1 Visual inspection of every length of pipe for workmanship defects shall be carried out at the manufacturer's plant. Measurements of outside diameter and wall thickness shall be made for each hour's production or each length of pipe, whichever is less frequent. Tests for apparent tensile properties shall be carried out as agreed upon between the manufacturer and the purchaser.

X4.2 Lengths of pipe that are shorter than standard shipping lengths may be butt-fused to produce standard lengths. Such built-up lengths must otherwise meet all of the product

requirements of Section **5** of this specification.

X4.3 Manufacturers of pipe shall conduct such other quality control tests as are appropriate to their manufacturing operations and which will provide assurance that the product requirements of **5.3** will be met instead of the actual performance of the specified tests.

NOTE X4.1—The pressure tests required under product requirements are tests for performance. These tests are not adaptable to inplant quality control. Quality control tests have not been standardized because the requirements for such tests vary substantially from one manufacturing plant to another.

X5. PIPE PRESSURE RATING

X5.1 Pipe meeting the requirements of this specification is pressure rated for water in accordance with 3.2.1 at the maximum internal pressures in Table X5.1. Pressure ratings lower than those in Table X5.1 may be recommended by the pipe manufacturer or may be determined by the system designer for special or unusual application conditions such as those described in X5.2. Industry experience indicates that PE plastic pipe meeting the requirements of this specification that is handled with reasonable care, installed in accordance with applicable standards, and operated under normal service conditions gives satisfactory long-term service at the pressure ratings in Table X5.1.

X5.2 Pressure ratings for a particular application can vary from standard ratings for water service depending on actual application conditions. Pressure rating should be reduced for systems operating under special or unusual conditions or where the pipe transports fluids that are known to have some

degrading effect on the properties of polyethylene or where specified in Codes or Regulations or by the authority having jurisdiction. When used at elevated temperatures (temperatures above 80°F (27°C)), elevated temperature stress ratings for the material are used to determine pressure rating. The actual choice of pressure rating for a particular application rests with the system designer, taking into account applicable Codes and Regulations, transportation and on-site handling conditions, the quality of installation, the fluid being transported, the external environment, and the possibility of deviation from design operating conditions of internal pressure or external load. A reduced pressure rating should be applied at the designing engineer's discretion where warranted by consideration of these or other conditions for the particular application. Users should consult the pipe manufacturer for elevated temperature and other information relating to pipe performance in various applications and application conditions. Information is also available from the Plastics Pipe Institute, PPI.

TABLE X5.1 PE Plastic Pipe Pressure Ratings (PR) for Water

Thermoplastic Pipe Material Designation Code				
PE Pipe Material	PE4710	PE2708 PE3608 PE4608		
		HDS, ^A psi (kPa)		
Pipe DR	Pressure Rating, psi (kPa)	1000 psi (6890 kPa)	800 psi (5520 kPa)	
7.3	317	(2190)	254	(1750)
8.3	274	(1890)	219	(1510)
9	250	(1720)	200	(1380)
9.3	241	(1660)	193	(1330)
11	200	(1380)	160	(1100)
13.5	160	(1100)	128	(880)
15.5	138	(950)	110	(760)
17	125	(860)	100	(690)
21	100	(690)	80	(550)
26	80	(550)	64	(440)
32.5	63	(430)	51	(350)
41	50	(340)	40	(280)

^A HDS for water at 73°F (23°C) per 3.2.1 and 4.1.1.

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SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F714–10) that may impact the use of this standard.

- (1) *Title*— Changed SDR-PR to DR-PR.
- (2) **2.8** – Add APWA Uniform Color Code.
- (3) **3.2.1** – Add “for water at 73°F (23°C)” to definition for S; delete 3.2.2 (defined in F412).
- (4) **4.1**, **4.1.2**, **4.2**, and **5.1** for consistency with Specification **D3350**, editorial changes to PE compound rather than PE material or PE material compound.
- (5) **4.1** requirements clarified; added **4.1.1**.
- (6) **8.1** editorially clarified.

- (7) **9.1.3** revised; deleted Note 9; relocated pressure rating marking requirements from 9.1.5 to new **9.1.6** and **9.1.7** renumbered subsequent sections; **9.2** revised; **9.3** added.
- (8) **Table 8** – deleted PE2606, PE2706, PE3708, and PE4708.
- (9) **Table 1** replaced.
- (10) **Table 2** and **Table 3** replaced.
- (11) Deleted S1 (relocated as **4.2**); renumbered subsequent sections.
- (12) **X5.1**, **Table X5.1**, and footnote ^A revised.

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