



Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter¹

This standard is issued under the fixed designation D2239; 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 U.S. Department of Defense.

1. Scope*

1.1 This specification covers polyethylene (PE) pipe made in standard inside dimension ratios (SIDR) and pressure rated for water (see appendix). Included are requirements for PE compounds and requirements and test methods for workmanship, dimensions, elevated temperature sustained pressure, burst pressure, and marking.

1.2 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.

1.3 The text of this specification references notes, footnotes, and appendixes which provide explanatory material. These notes and footnotes shall not be considered as requirements of the specification. Notes and footnotes in tables and figures, and Supplementary Requirements are requirements of the specification.

NOTE 1—References and PE compound descriptions for PE2305, PE2406, PE3306, PE3406, and PE3408 have been removed due to changes in Specification **D3350** and PPI TR-3. For removed designations, refer to previous editions of Specification D2239, Specification **D3350**, PPI TR-3 and PPI TR-4. The removal of these PE compounds does not affect pipelines that are in service. PE compounds and material designations resulting from changes in Specification **D3350** and PPI TR-3 are addressed in Section 5.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—References and PE compound descriptions for PE2305, PE2406, PE3306, PE3406, and PE3408 have been removed due to changes in Specification **D3350** and PPI TR-3. For removed designations, refer to previous editions of Specification D2239, Specification **D3350**, PPI TR-3 and PPI TR-4. The removal of these PE compounds does not affect pipelines that are in service. PE compounds and material designations resulting from changes in Specification **D3350** and PPI TR-3 are addressed in Section 5.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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

Current edition approved Nov. 1, 2012/Nov. 1, 2020. Published December 2012/November 2020. Originally approved in 1964. Last previous edition approved in 2012 as ~~D2239–12~~ D2239 – 12a. DOI: 10.1520/D2239-12A:10.1520/D2239-12AR20.

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

2. Referenced Documents

2.1 ASTM Standards:²

- D618 Practice for Conditioning Plastics for Testing
- D638 Test Method for Tensile Properties of Plastics
- D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
- D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
- D1599 Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D1603 Test Method for Carbon Black Content in Olefin Plastics
- D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- D2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications
- D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
- D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
- D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
- F412 Terminology Relating to Plastic Piping Systems
- G154 Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials
- G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

2.2 APWA Standard:³

- APWA Uniform Color Code

2.3 NSF Standards:⁴

- NSF/ANSI Standard No. 14 for Plastic Piping Components and Related Materials
- NSF/ANSI Standard No. 61 for Drinking Water Systems Components—Health Effects

2.4 PPI Standards:⁵

- 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 Pipe
- 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 Pipe

3. Terminology

ASTM D2239-12a(2020)

3.1 *Definitions*—Definitions are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600, unless otherwise specified. The abbreviation for polyethylene plastic is PE.

4. Pipe Classification

4.1 *General*—This specification covers inside diameter controlled PE pipe made from PE compounds in standard inside dimension ratios and pressure rated for water. Pressure ratings for water are dependent on the PE compound in accordance with the following relationship:

$$PR = \frac{2 \times HDS}{(SIDR + 1)} \quad (1)$$

Where:

- PR = pressure rating for water, psi (kPa)
- HDS = hydrostatic design stress for water at 73°F (23°C), psi (kPa)
- HDS = hydrostatic design stress for water at 73 °F (23 °C), psi (kPa)
- SIDR = standard inside dimension ratio

NOTE 2—PR and HDS must have the same units. See Appendix X1 for maximum pressure ratings for water.

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 APWA, 2345 Grand Boulevard, suite 500, Kansas, City, MO 64108-2641.

⁴ Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, <http://www.nsf.org>.

⁵ Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, <http://www.plasticpipe.org>.

5. Materials

5.1 *Polyethylene Compound*—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 1**, 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 D or E polyethylene compounds shall have sufficient UV stabilizer to protect pipe from deleterious UV exposure effects during unprotected outdoor shipping and storage for at least eighteen (18) months.

NOTE 3—Pipe users should consult with the pipe manufacturer about the outdoor exposure life of the product under consideration. Evaluation of UV stabilizer in Code E color PE compound using Practice **D2565** or Practice **G154** or Practice **G155** may be useful for this purpose.

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

5.2 *Potable Water Requirement*—PE compound 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 a certifying organization acceptable to the regulatory authority having jurisdiction.

TABLE 1 Polyethylene Compound Requirements

Requirement	Material Designation				
	PE1404	PE2708	PE3608	PE4608	PE4710
Minimum HDB at 140°F (60°C), psi (MPa), per Test Method D2837 and PPI TR-3	△	800 (5.5) ^B	800 (5.5) ^B	800 (5.5) ^B	800 (5.5) ^B
Minimum HDB at 140 °F (60 °C), psi (MPa), per Test Method D2837 and PPI TR-3	△	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 Test Method D2837 and PPI TR-3	400 (2.76)	800 (5.5)	800 (5.5)	800 (5.5)	1000 (6.9)
HDS for water at 73 °F (23 °C) psi (MPa), per Test Method D2837 and PPI TR-3	400 (2.76)	800 (5.5)	800 (5.5)	800 (5.5)	1000 (6.9)
Melt flow rate per Test Method 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 Requirement	Required Value				
Density (natural base resin)	1	2	3	4	4
SCG Resistance	4	7	6	6	7
Color and UV Stabilizer Code ^C	C	C, D or E	C, D or E	C, D or E	C, D or E

^AHDB at 140°F (60°C)/140 °F (60 °C) not required. Contact manufacturer about pipe use at temperatures other than 73°F (23°C)/73 °F (23 °C).

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

^CSee 5.1.1.

5.3 *Rework Material*—Clean polyethylene compound from the manufacturer’s own pipe production that met 5.1 through 5.2 as new PE compound is suitable for re-extrusion into pipe when blended with new PE compound having the same material designation. Pipe containing rework material shall meet all the requirements of this specification.

6. Requirements

6.1 *Workmanship*—The pipe shall be homogeneous throughout and free of 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. See 5.1.2.

6.2 Dimensions and Tolerances:

6.2.1 *Inside Diameters*—The inside diameters and tolerances shall be as shown in Table 2 when measured in accordance with Test Method D2122.

6.2.2 *Wall Thicknesses*—Subject to 6.2.3, wall thickness and tolerance shall be as shown in Table 3 when measured in accordance with 7.4. Wall thickness shall be inclusive of all extruded concentric layers.

6.2.3 *Wall Thickness Range*—The wall thickness variation shall not exceed 12 % when measured in accordance with 7.4.

6.2.4 *Thickness of Outer Layer*—For pipe produced by simultaneous multiple extrusion, that is, pipe containing two or more concentric layers, the outer layer shall be at least 0.020-in. (0.5 mm) thick.

6.3 *Bond*—For pipe produced by simultaneous multiple extrusion, the bond between the layers shall be strong and uniform. It shall not be possible to cleanly separate any two layers with a probe or point of a knife blade at any point.

6.4 *Carbon Black*—Polyethylene pipe produced using Code C polyethylene compound per 5.1.1 shall contain 2 to 3 % carbon black when tested in accordance with 7.5.

6.5 *Burst Pressure*—The minimum burst pressure for pipe shall be in accordance with Table 4, when determined in accordance with 7.7. In addition, the failure shall be ductile.

6.6 *Sustained Pressure*—Pipe made from PE1404 compound shall be tested twice annually in accordance with 7.6. The average failure time shall be ≥ 80 hours at 580 psi (4.00 MPa) test pressure hoop stress, or ≥ 150 hours at 435 psi (3.00 MPa) test pressure hoop stress.

6.7 *Elevated Temperature Sustained Pressure*—Except as provided in 6.6, elevated temperature sustained pressure tests for each polyethylene compound designation per Table 1 used in production at the facility shall be conducted twice annually per 7.8.

6.8 *Inside Surface Ductility for Pipe*—~~Inside Surface Ductility for Pipe~~—Pipe—Pipe shall be tested for inside surface ductility in accordance with 7.9 or 7.10.

TABLE 2 Inside Diameters and Tolerances for SDR-PR PE Plastic Pipe, in.

Pipe Size	Inside Diameter	Tolerance
1/2	0.622	+0.010 -0.010
3/4	0.824	+0.010 -0.015
1	1.049	+0.010 -0.020
1 1/4	1.380	+0.010 -0.020
1 1/2	1.610	+0.015 -0.020
2	2.067	+0.015 -0.020
3	3.068	+0.015 -0.030

TABLE 3 Wall Thickness and Tolerance for SIDR-PR PE Plastic Pipe, in.

Pipe Size	Wall Thickness ^A											
	SIDR 19		SIDR 15		SIDR 11.5		SIDR 9		SIDR 7		SIDR 5.3	
	Minimum	Tolerance	Minimum	Tolerance	Minimum	Tolerance	Minimum	Tolerance	Minimum	Tolerance	Minimum	Tolerance
½	0.060	+0.020	0.060	+0.020	0.060	+0.020	0.069	+0.020	0.089	+0.020	0.117	+0.020
¾	0.060	+0.020	0.060	+0.020	0.072	+0.020	0.092	+0.020	0.118	+0.020	0.155	+0.020
1	0.060	+0.020	0.070	+0.020	0.091	+0.020	0.117	+0.020	0.150	+0.020	0.198	+0.024
1¼	0.073	+0.020	0.092	+0.020	0.120	+0.020	0.153	+0.020	0.197	+0.024	0.260	+0.031
1½	0.085	+0.020	0.107	+0.020	0.140	+0.020	0.179	+0.020	0.230	+0.028	0.304	+0.036
2	0.109	+0.020	0.138	+0.020	0.180	+0.022	0.230	+0.028	0.295	+0.035	0.390	+0.047
3	...	...	0.205	+0.020	0.267	+0.032	...	...	...	...	...	...

^A The minimum is the lowest wall thickness of the pipe 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. Wall thickness variation shall be in accordance with 6.2.3.

TABLE 4 Minimum Burst Pressure for SIDR Pipe

SIDR	Minimum Burst Pressure ^A					
	PE1404		PE2708		PE3608, PE4608, PE4710	
	psi	(kPa)	psi	(kPa)	psi	(kPa)
5.3	400	(2759)	800	(5517)	921	(6352)
7	320	(2207)	630	(4345)	725	(5000)
9	250	(1724)	504	(3476)	580	(4000)
11.5	...	...	403	(2779)	464	(3200)
15	...	...	315	(2174)	363	(2503)
19	...	...	252	(1738)	290	(2000)

^AMinimum burst pressure calculated in accordance with

$$P_B = \frac{2S}{D_i} + 1$$

Where:

- P_B = burst test pressure, psi (kPa)
- S = minimum hoop fiber stress, psi. (kPa)
- S = 1260 psi (8690 kPa) for PE1404 compound
- S = 2520 psi (17,370 kPa) for PE2708 compound
- S = 2520 psi (17,370 kPa) for PE2708 compound
- S = 2900 psi (20,000 kPa) for PE3608, PE4608 and PE4710 compound
- S = 2900 psi (20,000 kPa) for PE3608, PE4608 and PE4710 compound
- D_i = measured average inside diameter, in. (mm)
- t = measured minimum wall thickness, in. (mm).

Test temperature tolerance $\pm 3.6^\circ\text{F} \pm 3.6^\circ\text{F}$ ($\pm 2^\circ\text{C}$), Test pressure tolerance ± 5 psi (± 35 kPa)

NOTE 4—Tensile elongation testing per 7.10 provides a quantifiable result and is used for referee testing and in cases of disagreement.

7. Test Methods

7.1 *Conditioning*—Condition as specified in the test method. Where conditioning is not specified in the test method, condition the test specimens at $73.4 \pm 3.6^\circ\text{F} \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C} \pm 2^\circ\text{C}$) without regard to humidity for not less than 4 h in accordance with Procedure A of Practice D618, or at $73.4 \pm 3.6^\circ\text{F} \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C} \pm 2^\circ\text{C}$) for not less than 1 h in accordance with Procedure D of Practice D618.

7.2 *Test Conditions*—Conduct tests in accordance with the conditions specified in the test method, or if not specified in the test method, at $73.4 \pm 3.6^\circ\text{F} \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C} \pm 2^\circ\text{C}$) without regard to relative humidity.

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, any sample selected by the testing laboratory shall be deemed adequate.

7.3.1 *Test Specimens*—Not less than 50 % of the test specimens required for any pressure test shall have at least a part of the marking in their central sections. The central section is that portion of the pipe sample that is at least one pipe diameter away from an end closure. The entire marking shall be documented in testing records.