



Standard Specification for Polybutylene (PB) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter¹

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

1. Scope

1.1 This specification covers polybutylene (PB) pipe that is inside diameter controlled, made in standard thermoplastic pipe dimension ratios, and pressure rated for water (see appendix). Included are criteria for classifying PB plastic pipe materials and PB plastic pipe; a system of nomenclature for PB plastic pipe; and requirements and test methods for materials, workmanship, dimensions, sustained pressure, and burst pressure. Methods of marking are also given.

1.2 The text of this specification references notes, footnotes, and appendixes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.

1.4 The following safety hazards caveat pertains only to the test methods portion, Section 7, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- D 618 Practice for Conditioning Plastics for Testing²
- D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure³
- D 1599 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings³
- D 1600 Terminology for Abbreviated Terms Relating to Plastics²
- D 1603 Test Method for Carbon Black in Olefin Plastics²

D 1708 Test Method for Tensile Properties of Plastics By Use of Microtensile Specimens²

D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings³

D 2581 Specification for Polybutylene (PB) Plastics Molding and Extrusion Materials⁴

D 2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials³

F 412 Terminology Relating to Plastic Piping Systems³

F 699 Practice for Accelerated Conditioning of Polybutylene Pipe and Tubing for Subsequent Quality Control Testing³

2.2 NSF Standard:

Standard No. 14 for Plastic Piping Components and Related Materials⁵

Standard No. 61 for Drinking Water System Components—Health Effects⁵

2.3 Federal Standard:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)⁶

2.4 Military Standard:

MIL-STD-129 Marking for Shipment and Storage⁶

3. Terminology

3.1 **Definitions**—Definitions are in accordance with Terminology F 412, and abbreviations are in accordance with Terminology D 1600, unless otherwise specified. The abbreviation for polybutylene plastic is PB.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 **hydrostatic design stress**—the estimated maximum tensile stress the material is capable of withstanding continuously with a high degree of certainty that failure of the pipe will not occur. This stress is circumferential when internal hydrostatic water pressure is applied.

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

¹ This specification is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.26 on Olefin-Based Pipe.

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² *Annual Book of ASTM Standards*, Vol 08.01.

³ *Annual Book of ASTM Standards*, Vol 08.04.

⁴ *Annual Book of ASTM Standards*, Vol 08.02.

⁵ Available from the National Sanitation Foundation, P.O. Box 1468, Ann Arbor, MI 48106.

⁶ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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3.2.3 *relation between standard dimension ratio, hydrostatic design stress, and pressure rating*—the following expression, commonly known as the ISO equation,⁷ is used in this specification to relate standard dimension ratio, hydrostatic design stress, and pressure rating:

$$2S/P = R + 1 \quad \text{or} \quad 2S/P = (D_i/t) + 1 \quad (1)$$

where:

- S = hydrostatic design stress, psi (or MPa),
- P = pressure rating, psi (or MPa)
- D_i = average inside diameter, in. (or mm),
- t = minimum wall thickness, in. (or mm), and
- R = standard thermoplastic pipe dimension ratio (D_i/t for PB pipe), also known as SIDR.

3.2.4 *standard thermoplastic pipe dimension ratio (SIDR)*—the ratio of pipe diameter to wall thickness. For PB pipe it is calculated by dividing the average inside diameter of the pipe in millimetres or in inches by the minimum wall thickness in millimetres or in inches. If the wall thickness calculated by this formula is less than 1.52 mm (0.060 in.), it shall be arbitrarily increased to 1.52 mm. The SIDR values shall be rounded to the nearest 0.5.

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

4. Pipe Classification

4.1 *General*—This specification covers PB pipe made from one PB plastic pipe material in four standard dimension ratios and four water pressure ratings.

4.2 *Standard Thermoplastic Pipe Dimension Ratios (SIDR)*—This specification covers PB pipe in four standard dimension ratios, namely, 7, 9, 11.5, and 15. These are referred to as SIDR7, SIDR9, SIDR11.5, and SIDR15, respectively. The pressure rating is uniform for all nominal pipe sizes for a given PB pipe material and SIDR (see Table Table X1.1).

5. Materials

5.1 *General*—Polybutylene plastics used to make pipe meeting the requirements of this specification are categorized by means of two criteria, namely, (1) short-term strength tests, and (2) long-term strength tests. Since the maximum physical properties of the pipe are not developed until 10 days after extrusion, burst testing must be delayed for this period.

5.2 *Basic Materials*—This specification covers PB pipe made from PB plastic in accordance with Specification D 2581. This is Type II, Grade 1.

5.3 *Hydrostatic Design Stresses*—This specification covers PB pipe made from PB plastics as defined by hydrostatic design stress developed on the basis of long-term tests (appendix).

5.4 *Compound*—The PB plastic extrusion compound shall meet the requirements of Type II, Grade 1, Class B with antioxidant, or Class C as described in Specification D 2581.

5.5 *Rework Material*—The manufacturers shall use only their own clean rework pipe material and the pipe produced shall meet all 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 *Inside Diameters*—The inside diameters and tolerances shall be as shown in Table 1 when measured in accordance with 7.4 and 7.4.1.

6.2.2 *Wall Thicknesses*—The wall thicknesses and tolerances shall be as shown in Table 2 when measured in accordance with 7.4 and 7.4.2.

6.2.3 *Wall Thickness Range*—The wall thickness shall be within 12 % when measured in accordance with 7.4 and 7.4.3.

6.3 *Carbon Black*—The polybutylene pipe extrusion compound Type II, Grade 1, Class C, shall contain at least 2 % carbon black when tested in accordance with 7.5.

6.4 *Sustained Pressure*—The pipe shall not fail, balloon, burst, or weep as defined in Test Method D 1598, at the test pressures given in Table 3, when tested in accordance with 7.6.

6.5 *Burst Pressure*—The minimum burst pressure for PB plastic pipe shall be as given in Table 4, when determined in accordance with 7.7.

TABLE 1 Inside Diameters and Tolerances for SIDR-PR PB Plastic Pipe, in.

Nominal Pipe Size	Average Inside Diameter	Tolerances
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
2 1/2	2.469	+0.015 -0.025
3	3.068	+0.015 -0.030
4	4.026	+0.015 -0.035
6	6.065	+0.020 -0.035

⁷ ISO R 161-1960, Pipes of Plastics Materials for the Transport of Fluids (Outside Diameters and Nominal Pressures) Part 1, Metric Series.

TABLE 2 Wall Thicknesses and Tolerances for SIDR-PR PB Plastic Pipe, in.

Nominal Pipe Size	Wall Thickness ^A							
	SIDR15		SIDR11.5 ^B		SIDR9		SIDR7	
	Minimum	Tolerance ^C	Minimum	Tolerance ^C	Minimum	Tolerance ^C	Minimum	Tolerance ^C
½	0.060	+0.020	0.060	+0.020	0.069	+0.020	0.089	+0.020
¾	0.060	+0.020	0.072	+0.020	0.092	+0.020	0.118	+0.020
1	0.070	+0.020	0.091	+0.020	0.117	+0.020	0.150	+0.020
1¼	0.092	+0.020	0.120	+0.020	0.153	+0.020	0.197	+0.024
1½	0.107	+0.020	0.140	+0.020	0.179	+0.020	0.230	+0.028
2	0.138	+0.020	0.180	+0.022	0.230	+0.028	0.295	+0.035
2½	0.165	+0.020	0.215	+0.025	...	...	...	...
3	0.205	+0.025	0.267	+0.032	...	...	...	...
4	0.268	+0.032	0.350	+0.042	...	...	...	...
6	0.404	+0.048	0.527	+0.063	...	...	...	...

^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 the plus side of the minimum requirement.

^B The 2½ to 6-in. pipe with a pressure rating of 0.69 MPa (100 psi) is not included.

^C This is limited by the eccentricity requirement (see 6.2.3).

TABLE 3 Sustained Pressure Test Conditions for Water for SIDR-PR PB Plastic Pipe

Standard Dimension Ratio	Pressure ^A Required for Test, (MPa) psi	
	At 100°F (37.8°C)	At 73°F (23°C)
	PB21110	PB2110
7	450 (3.1)	500 (3.4)
9	360 (2.5)	400 (2.8)
11.5	290 (2.0)	320 (2.2)
15	220 (1.5)	250 (1.7)

^A The fiber stress used to derive these pressures for PB2110 at 73°F (23°C) is 2000 psi (13.8 MPa).

The fiber stress used to derive these pressures for PB2110 at 100°F (37.3°C) is 1800 psi (12.4 MPa).

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

Standard Dimension Ratio	Minimum Burst Pressure, ^A psi (MPa) PB2110
7	550 (3.8)
9	440 (3.0)
11.5	350 (2.4)
15	280 (1.9)

^A The fiber stress used to derive the test pressure for PB2110 is 15.2 MPa (2200 psi).

6.6 Elongation Value at Break—The minimum pipe machine-direction elongation value at break shall exceed or equal an average of 125 % when samples are tested in accordance with 7.8.

7. Test Methods

7.1 Conditioning—Because of the crystalline transformation which takes place after polybutylene resins are cooled from the melt, it is necessary to delay physical testing until 10 days after pipe extrusion. During this 10-day period, store the pipe at temperatures between 40 and 100°F. Take the test specimen after 8 days and conditioned at 73 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D 618, for those tests where conditioning is required.

7.2 Test Conditions—Conduct the tests in the standard laboratory atmosphere of 73 ± 3.6°F (23 ± 2°C) and 50 ± 5 %

relative humidity, 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 between 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 pipe which is at least one pipe diameter away from an end closure.

7.4 Dimensions and Tolerances—Use any length of pipe to determine the dimensions. Measure in accordance with Test Method D 2122.

7.4.1 Inside Diameter—Measure the inside diameter of the pipe with a tapered plug gage in accordance with Test Method D 2122.

7.4.2 Wall Thickness—Make micrometer measurements of the wall thickness in accordance with Test Method D 2122 to determine the maximum and minimum values. Measure the wall thickness at both ends of the pipe to the nearest 0.025 mm (0.001 in.).

7.4.3 Wall Thickness Range—Measure in a manner such that the maximum, *A*, and minimum, *B*, wall thicknesses of each cross section measured are obtained. Calculate the wall thickness range, *E*, in percent, for each cross section as follows:

$$E = [(A - B)/A] \times 100 \quad (2)$$

The wall thickness range shall not exceed 12 % for any cross section measured.

7.5 Carbon Black—Determine in duplicate the carbon black content of the pipe, or the outer layer of pipe produced by simultaneous multiple extrusion, in accordance with Test Method D 1603.

7.6 Sustained Pressure Test—Select the test specimens at random. Test individually with water at two controlled temperatures under the pressures given in Table 3, twelve specimens of pipe, each specimen at least ten times the nominal diameter in length, but not less than 10 in. (25.4 cm) or more than 3 ft (91.4 cm) between end closures and containing the