



Designation: D3309 – 96a (Reapproved 2002)

An American National Standard

Standard Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems¹

This standard is issued under the fixed designation D3309; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

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

1. Scope

1.1 This specification covers requirements, test methods, and methods of marking for polybutylene plastic system components made in one standard dimension ratio and intended for 0.69 MPa (100 psi) water service up to and including 82°C (180°F). These components comprise pipe and tubing, socket-fusion fittings, compression fittings, mechanical fittings, and plastic-to-metal transition fittings. Requirements and test methods are included for sustained, hydrostatic pressure strength, thermocycling resistance, joint strength, and dimensions and tolerances for pipe and socket fusion fittings. The components covered by this specification are intended for use in hot- and cold-water potable water service and distribution systems and such non-potable water applications as building services piping, water heating and cooling systems, fire sprinkler applications, and other miscellaneous applications involving the transport of water, ethylene glycol solutions, or other aqueous liquids shown not to adversely affect PB performance.

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 in SI units are the standard. The values stated in parentheses are for information only.

NOTE 1—Suggested hydrostatic design stresses and hydrostatic pressure ratings for pipe, tubing, and fittings are listed in [Appendix X1](#). Design, assembly, and installation considerations are discussed in [Appendix X2](#). An optional performance qualification and an in-plant quality control program are recommended in [Appendix X3](#).

1.4 The following precautionary caveat pertains only to the test method 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
- 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
- D1708 Test Method for Tensile Properties of Plastics by Use of Microtensile Specimens
- D1784 Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
- D1898 Practice for Sampling of Plastics
- D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- D2581 Classification System for Polybutylene (PB) Plastics Molding and Extrusion Materials
- D2749 Symbols for Dimensions of Plastic Pipe Fittings
- D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
- D3915 Specification for Rigid Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds for Plastic Pipe and Fittings Used in Pressure Applications
- D4181 Classification for Acetal (POM) Molding and Extrusion Materials³
- F412 Terminology Relating to Plastic Piping Systems

¹ This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.61 on Water.

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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 Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.



F699 Practice for Accelerated Conditioning of Polybutylene Pipe and Tubing for Subsequent Quality Control Testing³
F948 Test Method for Time-to-Failure of Plastic Piping Systems and Components Under Constant Internal Pressure With Flow

2.2 ANSI Standards:

ANSI B 36.10 Welded and Seamless Wrought Steel Pipe⁴

ANSI Z 17.1 Preferred Numbers⁴

2.3 AWWA Standard:

Manual M-11 Steel Pipe Design and Insulation⁵

2.4 Federal Standard:

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

2.5 Military Standard:

MIL-STD-129 Marking for Shipment and Storage⁶

2.6 NSF Standard:

Standard No. 14 for Plastic Piping Components and Related Materials⁷

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

3. Terminology

3.1 Definitions:

3.1.1 General—Definitions are in accordance with Terminology **F412**, and abbreviations are in accordance with Terminology **D1600** and Symbols **D2749**, unless otherwise specified. The abbreviation for polybutylene is PB. Plastic tubing denotes a particular diameter schedule of plastic pipe in which the outside diameter of the tubing is equal to the nominal size plus 1/8 in. Plastic pipe outside diameter schedule conforms to ANSI B 36.10.

3.1.2 polybutylene plastics—plastics prepared by the polymerization of no less than 85 % butene-1 and no less than 95 weight % of total olefins.

3.1.3 relation between standard dimension ratio, stress, and internal pressure—The following expression, commonly known as the ISO equation, is used to relate standard dimension ratio, stress, and internal pressure for pipe and tubing:

$$2S/P = R - 1 \quad (1)$$

or

$$2S/P = (D_o/t) - 1 \quad (2)$$

where:

S = stress in circumferential or hoop direction, psi (MPa),

P = internal pressure, psi (MPa) gage,

D_o = average outside diameter, in.,

t = minimum wall thickness, in., and

R = standard dimension ratio, SDR.

3.1.4 standard dimension ratio (SDR)—a selected series of numbers in which the average outside diameter to minimum

wall thickness dimension ratios are constant for all sizes of pipe and tubing in each standard dimension ratio, and which are the ANSI Z 17.1 Preferred Number Series R 10 modified by +1. SDR fittings shall by definition be equivalent in minimum socket wall thickness to the minimum wall thickness of the corresponding SDR and size of pipe or tubing, and the minimum body wall thickness shall be 125 % of that value.

3.1.5 standard material designation code—The polybutylene material designation code shall consist of the abbreviation PB followed by two digits indicating the ASTM type and grade in Arabic numerals. A third and fourth digit shall be added to indicate the hydrostatic design stress for water at 23°C (73°F) in units of 100 psi.

4. Classification

4.1 Pipe, Tubing, and Socket-Fusion Fittings—This specification classifies PB 2110 pipe, tubing, and socket-fusion fittings by a single standard dimension ratio that shall be SDR 11 and by a maximum continuous use temperature that shall be 82°C (180°F), and by nominal pipe or tubing diameters from 1/8 in. through 2 in.

4.2 Plastic-to-Metal Transition Fittings—This specification classifies plastic-to-metal transition fittings intended for use in systems with PB 2110 tubing and pipe by a maximum use temperature that shall be 82°C (180°F) and by nominal sizes from 1/8 in. through 2 in. on the basis of resistance to burst pressure and to failure by thermocycling.

4.3 Compression and Mechanical Plastic Fittings—This specification classifies compression-type plastic fittings intended for use in systems with PB 2110 tubing by a maximum continuous use temperature that shall be 82°C (180°F) and by nominal sizes from 1/8 in. through 1 in. on the basis of resistance to burst pressure and to failure by thermocycling.

5. Materials

5.1 Basic Materials Description—Polybutylene plastics used to make pipe, tubing, and fittings meeting the requirements of this specification are categorized by two criteria, basic short-term properties, and long-term hydrostatic strength. Paragraphs **5.1.1** and **5.1.2** respectively define these categories.

5.1.1 Basic Short-Term Properties—This specification covers pipe, tubing, and fittings made from plastic materials meeting the mechanical strength, melt characteristics, and density requirements of Type 2, Grade 1 material in Specification **D2581**.

5.1.2 Long-Term Hydrostatic PB Strength—This specification covers pipe, tubing, and fittings that are made from polybutylene resins designated as PB 2110 and further have a long-term hydrostatic design stress of 500 psi (3.45 MPa) at 82°C (180°F). Pipe and tubing are also defined on the basis of long-term hydrostatic strength tests. Fittings are so defined by hydrostatic sustained pressure tests on fitting assemblies required by this specification (see **6.5**) based on the hydrostatic strength of the corresponding pipe or tubing.

NOTE 2—No hydrostatic design stress, as such, exists for fittings until such time as long-term hydrostatic strength test methods for fittings are developed.



5.1.3 Plastic fittings and components shall be made from either polybutylene meeting the mechanical strength, melt characteristics, and chemical resistance requirements of PB 21 in Specification **D2581**, or acetal plastic meeting the requirements of Class 1, Grade 1 in **Table 1** of Specification **D4181** or chlorinated poly (vinyl chloride) (CPVC) meeting the requirements of cell classification 23447 in Specifications **D1784** and **D3915** with applicable cells.

5.2 *Rework Material*—The manufacturers shall use only their own clean rework tube or fitting material, and the pipe, tubing, or fittings produced shall meet all the requirements of this specification.

6. Requirements for Pipe, Tubing, and Fittings Requirements for Pipe, Tubing, and Fittings

6.1 *Workmanship*—The pipe and fittings 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.

6.2 Dimensions and Tolerances:

6.2.1 *Pipe*—The outside diameters and wall thicknesses for pipe and tubing shall meet the requirements given in **Table 1** when measured in accordance with Test Method **D2122**. The maximum out-of-roundness requirements shown in **Table 1** apply to the average measured diameter after rounding with a rounding tool approved by the manufacturer. Calculated SDR-11 tubing wall thicknesses that fall below 0.062 in. (1.6 mm) shall be arbitrarily increased to that value.

6.2.2 *Socket-Fusion Fittings*—Fitting sockets inside diameters (waterways) and laying lengths shall meet the requirements given in **Table 2** and **Table 3** when measured in accordance with Test Method **D2122**. The out-of-roundness requirements shown in **Table 2** apply to the average measured diameter. Calculated SDR 11 fitting wall thicknesses that fall

below 0.102 in. (2.6 mm) for the fitting socket or 0.128 in. (3.2 mm) for the fitting body shall be arbitrarily increased to these values.

6.2.3 *Interference Fit*—The pipes and fitting dimensions and tolerances in **Table 1** and **Table 2** provide for socket fusion joints having an interference fit based on the major diameter of pipe and tubing after rounding with a rounding tool approved by the manufacturer.

6.3 *Plastic-to-Metal Transition Fittings, Mechanical Fittings and Compression Type Plastic Fittings*—Dimensions shall be compatible with the requirements of **Table 1**. Components shall be corrosion-resistant and assembled in accordance with the manufacturer's instructions.

6.4 Hydrostatic Burst:

6.4.1 Pipe, tubing, and fittings (tested as assemblies) shall meet the minimum hydrostatic burst requirements shown in **Table 4** when tested in accordance with **7.6**.

6.4.2 Socket-type joints heat fused according to the manufacturer's instructions and conditioned in accordance with **7.1** shall meet the minimum hydrostatic burst requirement shown in **Table 4** when tested in accordance with **7.6**.

6.4.3 Plastic-to-metal transition fittings and compression-type plastic fittings assembled using the manufacturer's instructions shall meet the minimum hydrostatic burst requirement shown in **Table 4** when tested in accordance with **7.6**.

6.5 Sustained, Hydrostatic Pressure Strength:

6.5.1 Pipe, tubing, and fittings (tested as assemblies) shall meet the minimum hydrostatic sustained pressure strength requirements shown in **Table 5** when tested in accordance with **7.4**.

6.5.2 Socket-type joints heat fused according to the manufacturer's instructions and conditioned in accordance with **7.1** shall meet the requirements of **6.5.1** when tested in accordance with **7.4**.

TABLE 1 Outside Diameters, Wall Thicknesses, and Tolerances for PB 21 SDR 11, Plastic Pipe and Tubing^A

Nominal Size	Average	Outside Diameter		Wall Thickness ^B	
		Tolerance on Average	Max Out-of-Round ^C	SDR 11	
				Min	Tolerance
Tubing					
1/8	0.250	±0.003	±0.003	0.040 ^D	+0.007
3/16	0.312	±0.003	±0.004	0.062 ^D	+0.010
1/4	0.375	±0.003	±0.004	0.062 ^D	+0.010
3/8	0.500	±0.003	±0.006	0.062 ^D	+0.010
1/2	0.625	±0.004	±0.008	0.062 ^D	+0.010
3/4	0.875	±0.004	±0.008	0.080	+0.010
1	1.125	±0.005	±0.010	0.102	+0.010
1 1/4	1.375	±0.005	±0.010	0.125	+0.013
1 1/2	1.625	±0.006	±0.012	0.148	+0.015
2	2.125	±0.006	±0.015	0.193	+0.019
Pipe					
3/4	1.050	±0.004	±0.010	0.095	+0.021
1	1.315	±0.005	±0.010	0.119	+0.026
1 1/4	1.660	±0.005	±0.012	0.151	+0.026
1 1/2	1.900	±0.006	±0.012	0.173	+0.026
2	2.375	±0.006	±0.012	0.216	+0.026

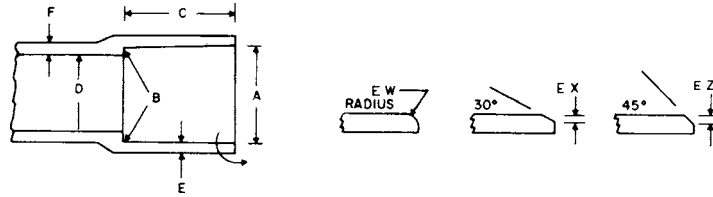
^AAll dimensions are in inches (1 in. = 25.4 mm).

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

^CThe maximum out-of-roundness apply to pipe or tubing as extruded.

^DFor tubing sizes of 1/2 in. and below, wall thickness minimums are not a function of SDR.

TABLE 2 Dimensions for Socket Fusion Fittings for PB 21, SDR 11.0 Pipe and Tubing^{A,B}



Nominal Size	A Socket Entrance Diameter			B Socket Bottom Diameter			C Socket Length, min	D Inside Diameter, min	Wall Thickness min ^C		Entrance, min EW EX EZ
	Average Diameter	Tolerance on Diameter	Max Out-of-Round ^D	Average Diameter	Tolerance on Diameter	Max Out-of-Round ^D			E	F	
Tubing											
3/8	0.485	±0.005	±0.008	0.481	±0.005	±0.008	0.500	0.364	0.102	0.128	0.031
1/2	0.605	±0.005	±0.008	0.601	±0.005	±0.008	0.500	0.489	0.102	0.128	0.031
3/4	0.845	±0.005	±0.008	0.839	±0.005	±0.008	0.625	0.715	0.102	0.128	0.031
1	1.095	±0.008	±0.010	1.087	±0.008	±0.010	0.625	0.921	0.102	0.128	0.031
1 1/4	1.340	±0.008	±0.010	1.332	±0.008	±0.010	0.687	1.125	0.125	0.156	0.031
1 1/2	1.590	±0.008	±0.012	1.582	±0.008	±0.012	0.875	1.329	0.148	0.185	0.031
2	2.085	±0.010	±0.012	2.074	±0.010	±0.012	0.875	1.739	0.193	0.241	0.031
Pipe											
3/4	1.020	±0.008	±0.012	1.012	±0.008	±0.010	0.625	0.920	0.102	0.128	0.031
1	1.275	±0.008	±0.012	1.267	±0.008	±0.010	0.687	1.100	0.119	0.149	0.031
1 1/4	1.620	±0.008	±0.012	1.612	±0.008	±0.012	0.875	1.300	0.151	0.189	0.031
1 1/2	1.860	±0.010	±0.012	1.849	±0.010	±0.012	0.875	1.494	0.173	0.216	0.031
2	2.335	±0.010	±0.012	2.234	±0.010	±0.012	0.875	1.933	0.216	0.270	0.031

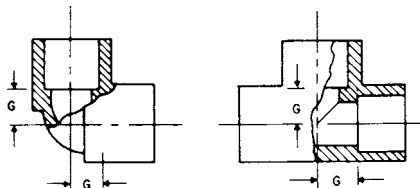
^AAll dimensions are in inches (1 in. = 25.4 mm).

^BAll sketches and designs of fittings are illustrative only.

^CThe minimum is the lowest wall thickness at any cross section.

^DMaximum out-of-roundness applies to the average measured inside diameter.

TABLE 3 Minimum Dimensions from Center to End of Sockets PB Socket Fusion Tees and 90° Elbows, SDR 11.0 PB Pipe and Tubing Fittings (Inches)



Nominal Size	G, min
Tubing	
3/8	0.359
1/2	0.382
3/4	0.507
1	0.633
1 1/4	0.758
1 1/2	0.884
2	1.134
Pipe	
3/4	0.750
1	0.875
1 1/4	1.000
1 1/2	1.250
2	1.500

TABLE 4 Minimum Hydrostatic Burst Strength Requirements for PB 21 Component Joints^A

Temperature, °C (°F)	Burst Pressure, MPa (psi) ^B
23 (73)	3.03 (440)
82 (180)	1.73 (250)

^APB 21 joint components shall include: 1. Nominal 1 in. PB 21 Heat fused joints after conditioning according to 7.1. 2. Nominal 1/2-in. compression-type plastic fittings. 3. Nominal 1/2-in. plastic-to-metal transition fitting.

^BThe fiber stress used to derive this test pressure is: 15.18 MPa (2200 psi) at 23°C (73°F) and 8.63 MPa (1250 psi) at 82°C (180°F).

TABLE 5 Minimum Hydrostatic Sustained Pressure Requirements for PB 21 SDR 11 Pipe Tubing and Fitting Assemblies, and Heat-Fused Joints^A

Test Duration, h	Hydrostatic Test Pressure Air Bath MPa (psi) ^B
1000	1.52 (220)

^ANominal 1-in. PB 21 heat-fused joints after conditioning according to 7.1.

^BThe fiber stress used to derive this test pressure is 7.57 MPa (1100 psi) at 82°C (180°F).

facturers' instructions shall not separate or leak when thermocycled 1000 times between the temperatures of 16°C (60°F) and 82°C (180°F) when tested in accordance with 7.5.

NOTE 3—Tests applicable to assemblies (6.4-6.6) are intended to be performance qualification tests and not tests required of each joint.